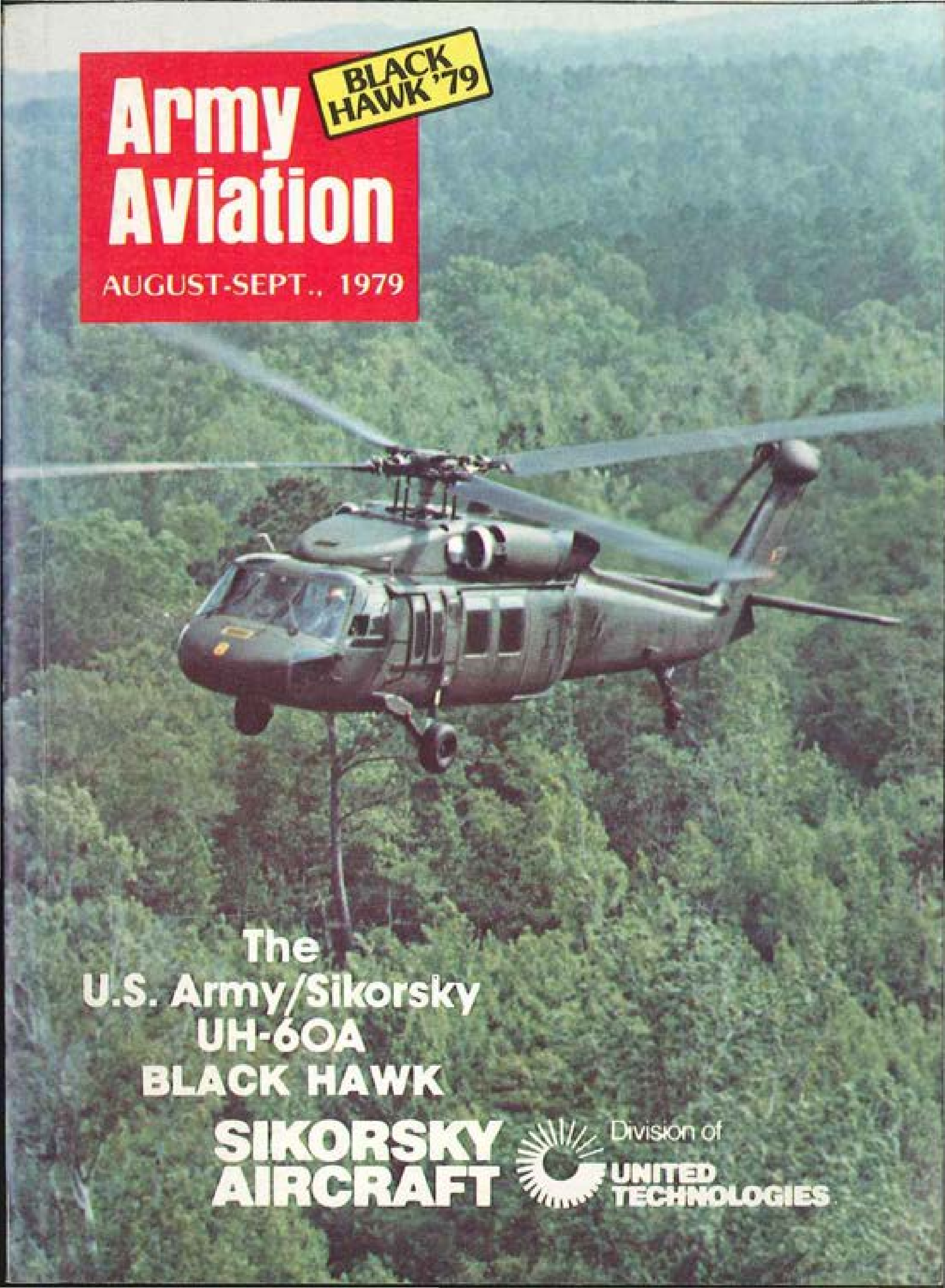
Army Aviation

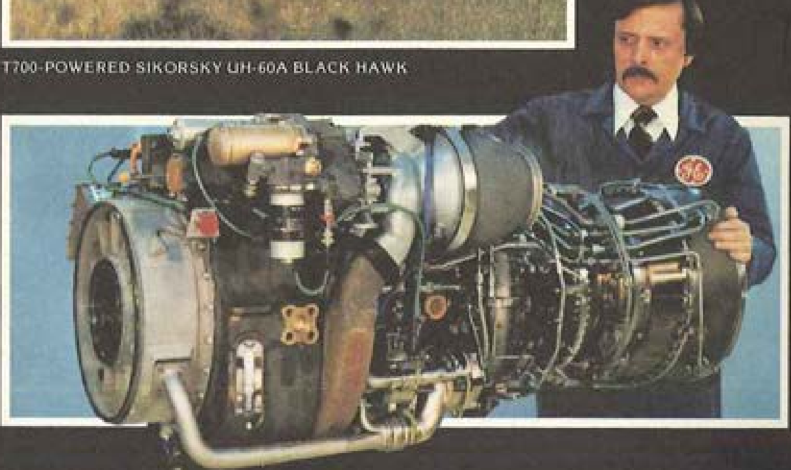
BLACK HAWK '79

AUGUST-SEPT., 1979



Black Hawk Power

T700-POWERED SIKORSKY UH-60A BLACK HAWK



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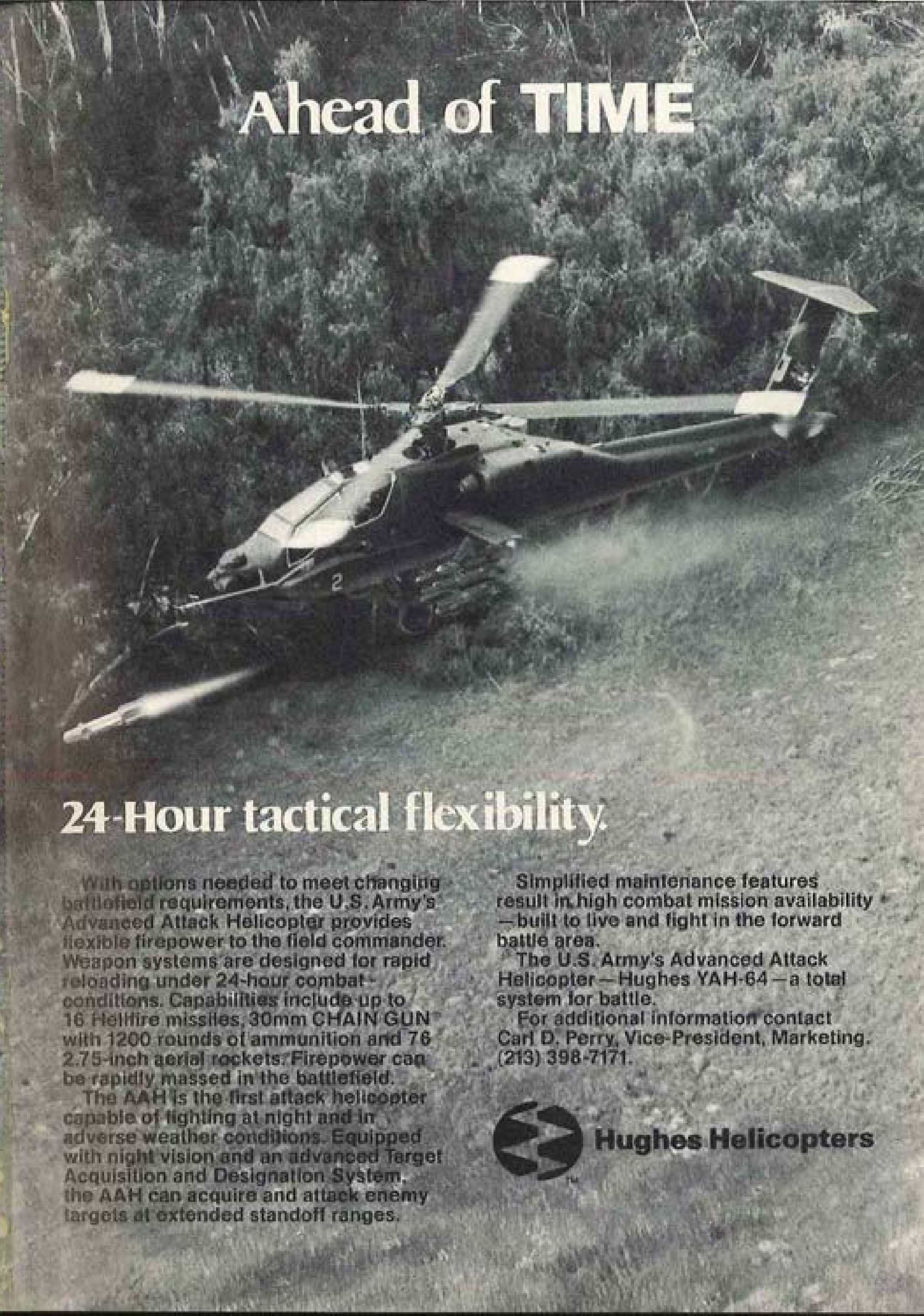
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Hughes Helicopters

ARMY AVIATION

Volume 28 — Aug.-Sept, 1979 — Numbers 8 & 9

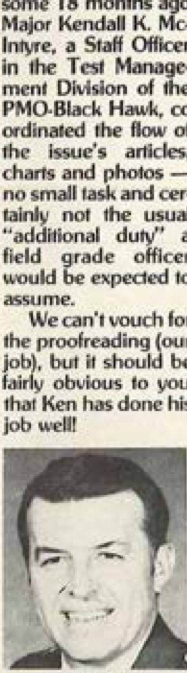
BLACK HAWK, 1979 — A SPECIAL ISSUE

This "Black Hawk Issue" is the first of three successive issues covering major Army Aviation hardware programs. In later months, you'll read about ASH as well as today's Advanced Attack Helicopter Program.

This particular issue is unique in several ways . . At 164 pages it's the largest issue that we've ever published. It's also the first issue that utilizes perfect binding, i.e., a glued cover, in lieu of staples.

Again, as he did some 18 months ago, Major Kendall K. McIntyre, a Staff Officer in the Test Management Division of the PMO-Black Hawk, coordinated the flow of the issue's articles, charts and photos — no small task and certainly not the usual "additional duty" a field grade officer would be expected to assume.

We can't vouch for the proofreading (our job), but it should be fairly obvious to you that Ken has done his job well!



McINTYRE

OVERVIEWS

PRODUCTION PERSPECTIVES

QUALIFICATION AND TESTING

FIELDING THE SYSTEM

SPECIALIZED TRAINING AREAS

SPECIFIC SUPPORT AREAS

THE OPERATIONAL BLACK HAWK

Masthead/Continued on Page 162

What's new on the Cobra? Everything that moves.

A new generation of Cobra has evolved. Over the past two years, every part of the highly advanced AH-1S's dynamics system has been dramatically upgraded!

There's been a powerful 29% increase in engine SHP, plus a boost in transmission capacity providing excellent hot day performance.

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But that's only part of what's new on the Cobra. Weapon systems, fire control, cockpit layout, active/passive defense systems: all designed to strengthen our anti-armor forces. Now, and for the next 20 years.

Bell's AH-1S Cobra: Everything's new but the name.

THE Army Aviator and the sword-swallower have more in common than you might think. Each practices a profession not eagerly sought by the crowd.

Each pays a high price for professional error, but neither expects nor receives high dollar rewards for success. Although neither practitioner would willingly exchange careers with a ribbon clerk, the skimpiness of their professional security blanket makes more pronounced their common survival instinct. That instinct expresses itself in many ways and in three areas; always personal, often through the family, and usually through the profession.

The key to survival

To a great extent, survival in any of these areas is dependent upon the tools of the trade. Fortunately, not all of the tools are manmade. To survive through a family, one must start with the tools of plumbing and procreation. These, though the subject of much attention throughout the centuries, have seldom been the objective for product improvement effort.

There have been user complaints, of course, but few have been related to design or systems integration. Many are concerned with the value of practice as a means for gaining skill as opposed by the onrushing years which reduce the capability to practice. For the non-manmade tools, it would appear that an aged tool design remains eminently satisfactory; it is the age of the user which is of concern.

Many of the tools used in professional survival, however, are manmade and have been subjected to man's improvement efforts. The sword, as an exception, would still be recognizable by the tool handlers of yesteryear.

TOOLS OF THE TRADE

The one disappearing down the gullet of the sword-swallower may be made from plastic because of the high cost of metal, and it may have been dulled in deference to a tender stomach lining, but it remains relatively unchanged in appearance from that which **King Arthur** pulled from a stone or the one **Joan d' Arc** obtained from a tomb. The only thing which would amaze those who remember the sword as a weapon is its use by the swallower.

Great imagination needed

The primary trade tool of the Army Aviator is, of course, the air vehicle. Its resemblance to a forebear, the **Cub,** is slight, and it takes a fair amount of imagination for the Cub Clubber to identify today's tools as direct descendants of the machine which took him to work. Even so, the appearance is less startling than the usage.

Those who used the **Cub** to go to work are somewhat amazed at the extent

To a great extent, the survival of both the sword-swallower and the Army Aviator is dependent upon the tools of their trade. Unfortunately, many of the tools used in their professions are manmade, writes LTC MORRIS G. RAWLINGS, a World War II Army L-Pilot. He astutely points out that his contemporaries flew a wide variety of missions in uncomplicated Piper Cubs while today's aviators are single mission-trained and operate highly-sophicated and far more complicated aircraft.

to which today's air vehicles have become the work.

What happened?

A Cub Clubber, as you may remember, is a survivor of the Forties; an era of grass strips and green pilots. He (girls in those days were sitting under apple trees awaiting his return) spent much of his early youth crammed in the cockpit of a fabric-covered machine which had a one-position propeller, a two-position throttle, a three-position joy stick and a landing gear held together by large rubber bands.

Fuel: Mess hall leavings

Powered by an internal combustion engine which had developed a taste for aviation fuel, but would run on potato whiskey or other fermented mess hall leavings, the **Cub** was used to get the operator to work.

Lacking in all but the basic instruments, the operator found his aerial way by comparing the visible terrain with his road map; maintaining, as a fall-back position, the memory of a railroad track, river bend, or range of hills. His live-reckoning (dead reckoning was reserved for those who failed to arrive) used a ruler, a pencil, and some grocery store arithmetic, but he still placed a great deal of confidence in the short hairs on the back of his neck which rose when expected checkpoints did not.

Sliding about on a stove-lid flak seat which offered far more psychological than physical protection against bottom blasts, he floated about between guns and target dependent upon sharp eyes and the laws of probability to protect him from solid objects in his chosen flight path.

Though somewhat protected by euphemisms, he was aware of the fact that he and his **Cub** were to replace a departed Army Air Corps which had declared itself willing to cooperate with, but not obey, the ground rules of the ground-bound.

He knew well the existing gap between

(THE TOOLS/Cont. on Page 10)

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THE TOOLS
(Continued from Page 7)

that which needed to be done and that which was being done, and to a large extent, equated the survival of his profession with his ability to close the gap. He was expected - and he tried hard - to perform missions for which neither he nor his trade tools were designed.

Hannibal must have felt somewhat the same way when he found himself on the wrong side of the Alps. He used warm-weather elephants whose designer apparently had not considered the possibility of icy feet and frozen trunks. The C-47 was called upon to overfly mountains with tops above its designed ceiling and some made it. Space vehicles were certainly not designed as ocean-going ships, but astronauts have been plucked from their confines while bouncing about on the briny.

The point is simple - it is routine to call upon man and machine to perform tasks for which they were not designed, and it is equally routine that most of such tasks be performed.

The **Cub** was required many times and in many places to be used in ways for which it was ill-suited, but it went. Because the gap between expectations and results was only partially closed, and because the instinct for professional survival was uppermost, Cub Clubbers asked and answered three questions almost forty years ago:

1. Would the performed missions have been better done had the machine been more sophisticated or the operator more adept?

(THE TOOLS/Cont. on 14)

PLAN AHEAD!

The 1980
AAAA National Convention
will be held at the Sheraton Atlanta Hotel during Thursday, April 10, to Sunday, April 13

★★★★★

General Robert M. Shoemaker, Army Aviation's most senior aviator, will again serve as Chairman of the Convention's Presentations Committee.

★★★★★

The AAAA Convention's Friday, April 11 Luncheon will serve as the 1980 site for the triennial inductions to the "Army Aviation Hall of Fame."

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A BREEZE HOIST CAN ADD RESCUE MISSION CAPABILITY TO THE SIKORSKY UH-60A

A small but powerful Breeze Rescue Hoist, reaching down where nothing else can go, can add greatly to the mission versatility of the UH-60A "Black Hawk" developed for the U.S. Army by Sikorsky Aircraft. And because this hoist design is mounted "off the floor and out of the door",

FOR THE ARMY'S "BLACK HAWK"

as on the Sikorsky SH-60B "Seahawk" helicopter for the U.S. Navy, it will allow full cabin access for mission requirements.

The Breeze Model BL-27100-10 Hoist provides a "systems interface" with the SH-60B, used in the Navy's LAMPS program — assuring the commonality of spares and system support sought throughout our Defense Forces for top operational and cost effectiveness.

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Electrical Components Division —The various electrical connectors located throughout the helicopter. The hand grips.

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Electrodynamics Division —Self-displacing accumulator for the engine-starting system.

BLACK HAWK: A rugged, dependable helicopter.

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Bendix

a lot of Bendix in the

THE TOOLS
(Continued from Page 10)

2. Were there unperformed, but desirable, missions which needed a more sophisticated air vehicle or a more ingenious operator?

3. With either answer in the affirmative, which should receive priority of effort for improvement; man or machine?

The answers!

The answers are affirmative for the first two, and in favor of the machine for the third. **Result?** The delivery and test of some 57 different fixed-wing models by the early Fifties, and the assignment to service of a rotary-winged craft in Korea.

Because the Army and subjective cost-effectiveness have not favored a hybrid since the mule, it did not result in a service V/STOL. Because both industry and the user prefer a set of open-end wrenches to a single adjustable monkey wrench, technology sought to oblige.

Today's air vehicles, with their competent operators, are primarily designed to perform one mission well; one to seek targets in fair weather, another in foul; one to engage located targets with ground artillery, another to fight with its own weapons; one to carry the boss and run his aerial errands, others to transport his troops and supplies.

The highly proficient operators find it difficult, it not impossible, to be equally proficient in **each** type. More to the point, they find it a full-time effort simply to maintain **total** readiness in one.

This does not imply a shortcoming on the part of the operator. Rather, it is meant to imply that an industry goal; to so sophisticate the machine as to reduce the requirements on the operator, has not been successful to date. It has, instead, forced specialization on the operator and has created a condition in which control of the machine has become an end in itself rather than a means to an end.

Since trade tools are simply aids for the accomplishment of a mission, and because their capabilities are potential rather than real, it is the operator who bears the responsibility for doing a job. That job should not be limited to mastery of the tool, but must be expanded to include the results of the work done by the combination. An on-time departure, a safe flight and a successful landing is an obvious objective for the Army Aviator, but it is by no means the goal of his profession.

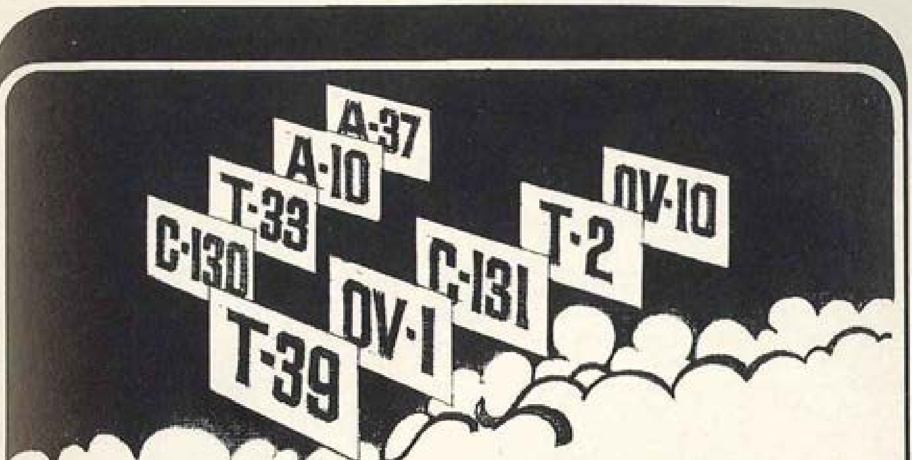
That which increases the difficulties of getting to work - or creates a need for greater skill or increased attention on the part of the operator while enroute - detracts from the goal of performing useful work. The enemy will present sufficient obstacles and it should not be us.

The same three questions

Perhaps, as in the case of non-manmade tools, the age of the operator is of greater concern than the age of tool design. Perhaps the aging Cub Clubber, with his memories of complicated missions and simple tools, is simply uncomfortable with a reversed trend. Flying the **Cub** was fun, **not** work.

Forty years from now, when today's Army Aviators gather to match grey hairs and trade success stories, they will have asked and answered the same three questions earlier posed by Cub Clubbers. There may be a single difference: they may be envious of their successors and the new crop of trade tools.

Few Cub Clubbers are.



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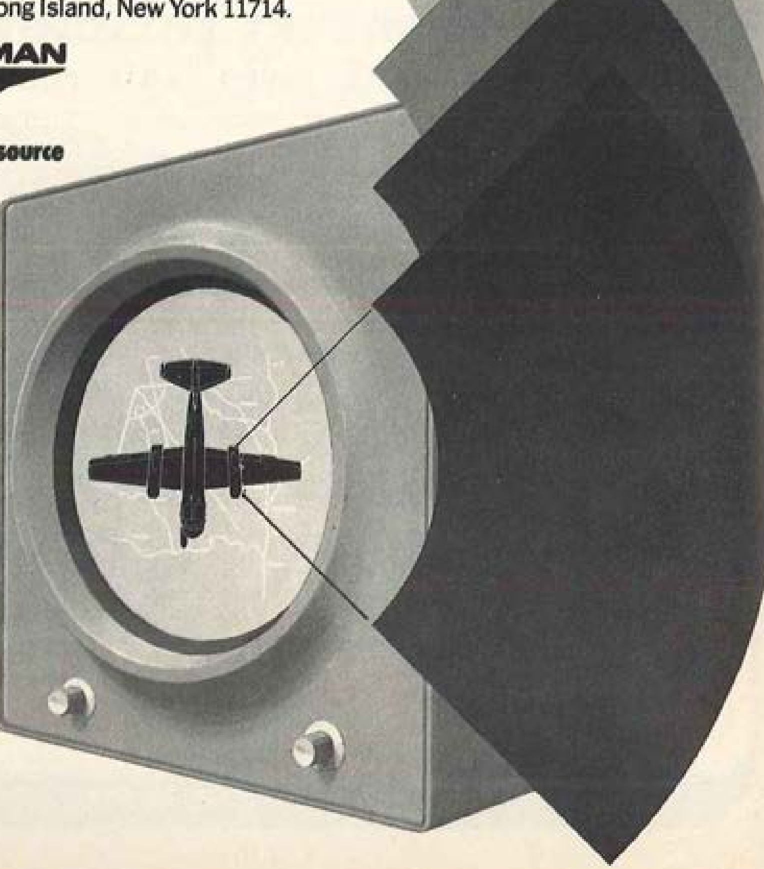

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OF THE TACTICAL KIND

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Close tactical encounters, close support demand a lot from the pilot. Flying NOE missions requires fast and accurate navigation, especially at night.

With our Projected Map Display, the pilot can remain terrain-oriented—regardless of weather, visibility, altitude, or speed. To establish position at any time during flight requires only a glance at the display.

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Comprehensive trials in five tactical aircraft have proven the PMD. Seven years of operational use have demonstrated pilot confidence and a reduction in cockpit workload.

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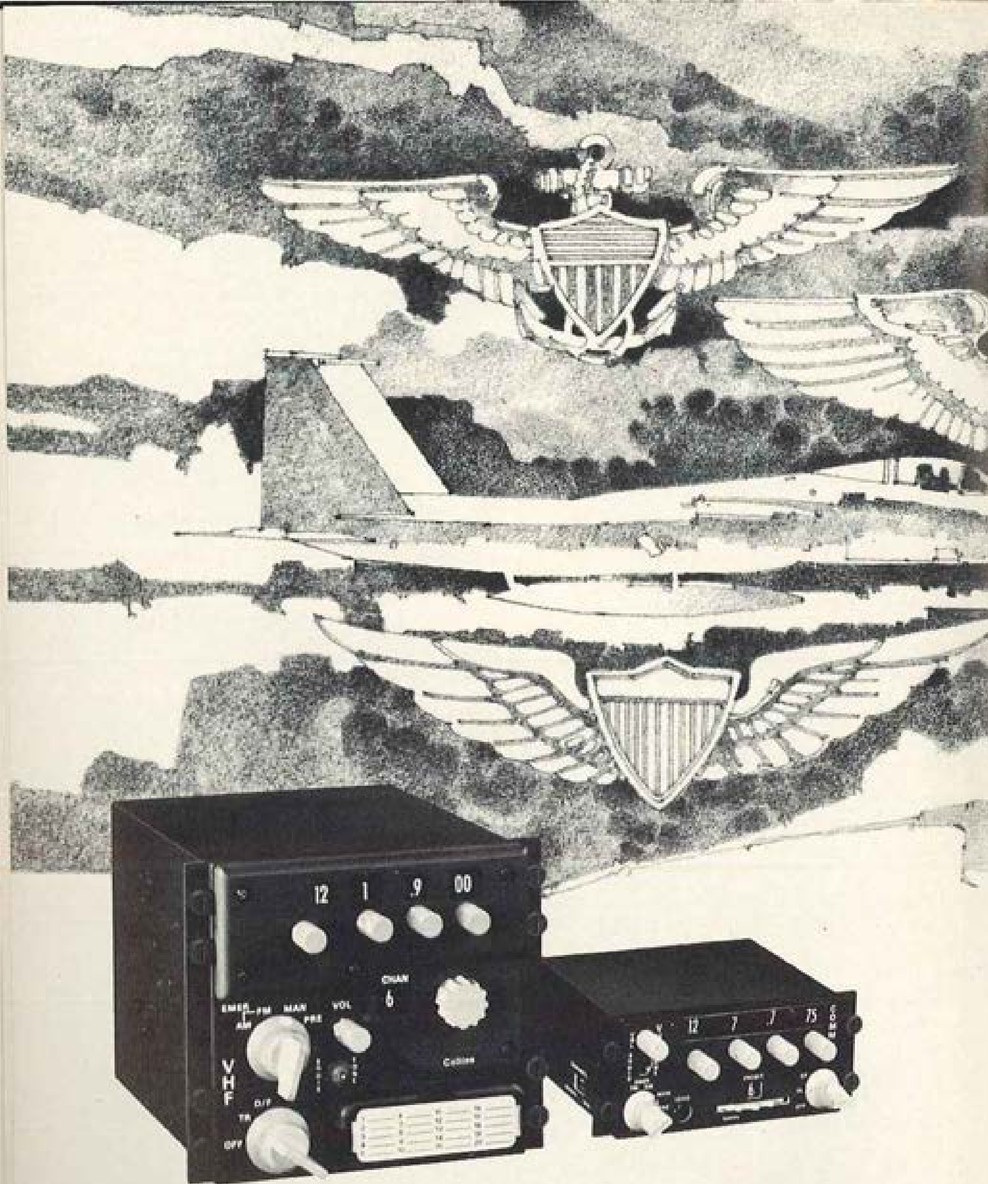
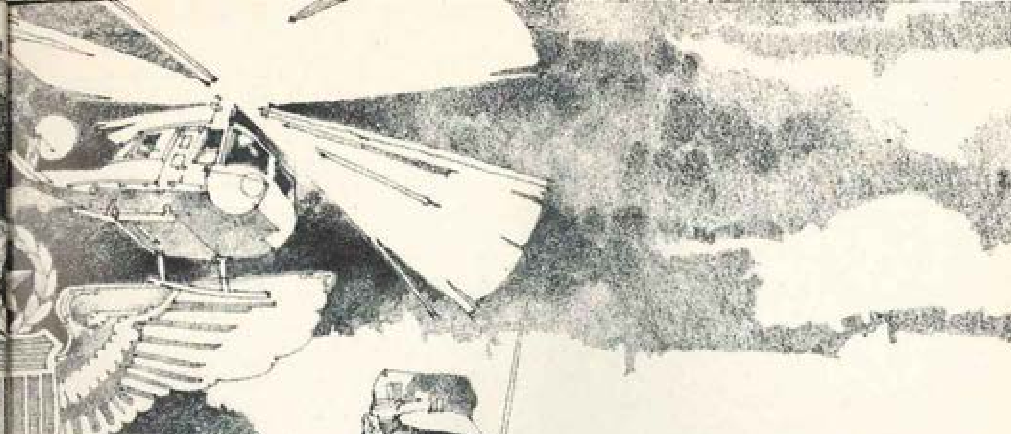


The Rockwell-Collins AN/ARC-186(V) tactical VHF. Big news because life cycle costs are so small.



Low acquisition and life cycle costs. Those are just two reasons why the U.S. Air Force recently selected the new Rockwell-Collins AN/ARC-186(V) VHF AM/FM tactical radio for their entire fleet.

ARC-186 will increase the MTBF nearly six times over the MTBF of VHF transceivers now in the Air Force's inventory. And life cycle cost savings projections are more than double original Air Force planned savings.

What's more, the ARC-186 will replace both their VHF AM transceivers and VHF FM transceivers since ARC-186 is the first production airborne military VHF AM/FM transceiver. Imagine the flexibility allowed by utilizing one radio to communicate either on the military FM frequencies for tactical use or on all VHF AM frequencies, either in plain text or secure speech with 25 kHz channel spacing.

Its weight is big news, too. A mere 6.5 lbs. It's capable of replacing VHF systems weighing up to seven times as much.

The ARC-186 is going to be a powerful voice with other domestic and international services as well. It can easily retrofit the ARC-131 (FM-622), ARC-134 (807), VHF-101 and it's directly replaceable for the ARC-115 — all that's needed is a screwdriver.

Available in either panel or remote mounted configurations.

For details, contact Collins Government Avionics Division, Rockwell International, Cedar Rapids, Iowa 52406. 319/395-4412.

Rockwell International

August-September, 1979 List of Advertisers

OCTOBER, 1979 ISSUE — THE ASH

A special insert of 64+ pages will be devoted to the Army's Advanced Scout Helicopter (ASH) Program with ten key authors highlighting the need for an effective and affordable scout helicopter program.

A foreword by MG Story C. Stevens, CG of AVRADCOM, is followed by an "ASH Overview" by MG James H. Patterson, Director of the ASH Special Study Group; the Developer's Overview by COL Ivar W. Rundgren, Jr., the PM-ASH; and the TRADOC System Manager's Overview by COL George W. Shallcross, the TSM-ASH.

Other October articles will cover a "Historical Summary" of ASH events; "What's New in ASH Design"; "ASH Mission Equipment"; and the "Modification of Alternatives" — What is effective and affordable?

Still another area is RSI — Rationalization, Standardization, and Affordability, and ASH COEA — a Cost and Operational Effectiveness Analysis on ASH.

All in all, the October issue provides a detailed, in depth October, 1979 look at whether or not the ASH has a definite place on the battlefield, and is not simply a companion piece to the attack helicopter.

A special
136-page
update

The Black Hawk

The Army's
operational
UH-60A
helicopter

DEPARTMENT OF THE ARMY
PROJECT MANAGER, BLACK HAWK, DARCOM
PO BOX 209, ST. LOUIS, MISSOURI 63166

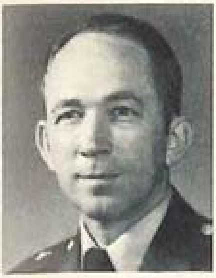
It is my personal pleasure to have recently taken over the reigns of the BLACK HAWK project leadership and to open this years editorial section of this UH-60A BLACK HAWK special issue.

The BLACK HAWK is here . . . it is now. Fielding of this advanced technology helicopter has taken place at Ft. Rucker where aviator training is now underway and at Ft. Campbell where missions in support of the 101st Airborne Division (AASLT) are now being flown.

Transporting a full infantry squad of 11 combat troops with the BLACK HAWK now gives the infantry ground commander the flexibility of moving a single fighting unit where needed in the battle area. Placement of artillery with basic load and firing crew is now possible by use of the BLACK HAWK.

This coming year, the Army/Industry team will continue to place into the hands of our fighting men a helicopter worthy of being called BLACK HAWK.

CHARLES F. DRENZ
Colonel, TC
Project Manager, BLACK HAWK



A View From the Top!

By BRIG. GEN. CARL H. McNAIR, JR.,
Army Aviation Officer, Hqs, Department of the Army

THROUGHOUT history, warfare has been studied from many aspects. Volumes have been published concerning mass, speed, surprise, unity of command, and the other principles of war. And while **Von Clausewitz** and **Napoleon**, among numerous others, recognized the requirement for mobility in the movement of troops (massing), even they were not totally original in their thought.

The earliest "users"

Historically, it would be difficult to trace the precise origin of mobility as a tool to influence decision on the battlefield. Perhaps it was **Joshua** when he fought the battle of Jericho, but some of the earliest users did include the Romans of earlier day who massed their infantry by double timing legions. This was followed by use of the chariots to mobilize combat power for decisiveness as well as shock actions.

With this mobility came the technique of flanking movements and the envelopment using cavalry. Thus, this multiplication of combat power led to success while the use of terrain and other tenets and rules of experience were still being developed and learned.

In later centuries, infantry remained a dominant factor in land warfare and methods were sought continuously to improve mobility. Although the double timing of Roman legions delivered mass at a speed greater than the marching of soldiers, the troops over distance and had more limited battle potential on arrival at their destination. They "traveled" lightly delivering only sword, shield, and light body armor.

Horse cavalry, on the other hand, delivered lance and saber, then muskets, and finally repeating weapons at a much greater speed. **Napoleon** used field artillery, given the speed of horses, to rule the battlefield in combination with the other elements of combat power.

Development of the modern machinegun signaled the beginning of the end of horse cavalry. And World War I saw the full evolution of automatic weapons and the introduction of the tank, which was developed to counter barbed wire and the machinegun.

Following World War I, intensive experimentation and development provided the foundations and mechanized warfare as we know it today. Tanks became the focus of combat power together with mechanized infantry and self propelled artillery to provide the commander with the capability to displace combat power with speed to influence the battle.

World War II saw the advent of vertical envelopment by parachute. Troops now were capable of being transported over great distances and delivered relatively fresh to the battle. This technique provided great strategic impact. Yet, the leadtime in planning, coupled with the effects of weather, loss of unit integrity during the drop, and vulnerability of light infantry to threat armor, detracted from its utility and ultimate tactical success.

A new era of mobility

But enter the helicopter on the scene in the '40's and a new era of battlefield mobility was born. Airmobile operations which have developed over the past two decades provide the field commander with the greatest battlefield flexibility and mobility in the history of warfare. Airmobile theory actually stems from the '30's, but for application it incited the development of a practical helicopter which would permit vertical take-off and landing.

Gliders, autogyros, and other such contrivances simply did not satisfy the requirement. So, the '50's dawned and the first practical and capable helicopters for large scale troop movement in the U.S. Army were the CH-21s and the CH-34s which could carry up to a squad of troops under ideal conditions. In turn, Army Aviation leadership pressed for the capability over the years to demonstrate the potential of large scale heliborne operations. The **Rogers Board,** the **Howze Board,** the Air Assault tests with the 11th Air Assault Division, and all the ideas of decades came to fruition during the Vietnam conflict.

During the 1962-1973 period, Army Aviation amassed an incredible record of effectiveness. While aerial medical evacuation and aerial fire support were perfected, the capability of the ground commander to influence the battle by displacement of infantry was expanded to include movement of medium artillery, light armored vehicles, and bulldozers - all by helicopter. The introduction of this dimension to combat revolutionized land warfare by lifting large amounts of equipment for long distances and delivering combat troops directly to the active battle-

field prepared to fight. The story of the helicopter in the Vietnam conflict will be legend.

Meeting the requirement

Evolution of the utility helicopter in the Army has been a classic case of Army requirements definition and meeting the requirement. The Bell UH-1 **Huey** has served the Army long and well in a variety of configurations. The UH-1A produced in 1959 carried five passengers. Improvements made via technological advances, which provided the engine power necessary for increased lift, brought us through the B model (seven passengers) to the first suitable infantry carrier, the UH-1D; it was introduced in 1963 with a passenger capacity of 11.

This model was later upgraded with improved engine (UH-1H) to provide a viable troop carrier under the temperature and high density altitude conditions in Vietnam. The crew was expanded to include a pilot, co-pilot, crew chief, and gunner. Only ten passenger seats remained; the performance envelope of the aircraft permitted inclusion of only limited ancillary equipment along with the typical troop capacity of seven to ten soldiers.

In 1966, the **Utility Transport Tactical Aircraft System (UTTAS)** was conceived as the required replacement for the UH-1H as the utility helicopter of the future, a true squad carrier. The **Black Hawk's** greatest capability will provide for unit economies by reducing the numbers of aircraft required to do a given mission. The UH-60A will replace the UH-1 at a rate of 15 for 23 in Combat Support Aviation Companies, seven for eight in air cavalry troops, and one for one in aeromedical evacuation units.

A great deal of excitement always accompanies the development and initial introduction of a new aircraft. Such has certainly been the case with the UTTAS. Among all the competitors for the development, Sikorsky won with its helicopter featuring a compendium of the most advanced technology. It provided significant advances in mission effectiveness through

Below: Plant searchlights enhance Sikorsky's winning UTTAS on Dec. 23, 1976.

improved maintainability, reliability, and availability and unprecedented crashworthiness and survivability.

The salient capabilities

Some of its more salient capabilities which enhance its operational suitability are:

- At 4000 feet, 95° temperature conditions, it will lift 11 combat equipped troops and climb vertically at the rate of about 795 fpm and cruise at 145 kts with a dash speed of over 160 kts.
- With added troop seats it will lift 14 troops. A **Combat Support Aviation Company (CSAC)** can simultaneously lift 168 troops. Three CSACs can lift a rifle battalion including its 81mm mortars, TOW teams including quarter ton vehicles, and REDEYE teams
- "Daily" maintenance inspections are now reduced to every 10 flight hours or 5 days; phased maintenance inspections (100 hours for the UH-1) are replaced by one inspection every 500 hours.
- Improved survivability for personnel is a great plus; the UH-60A is designed to impact vertically at a level orientation of 42 fps (approximately 30 mps) without injury to the occupants.
- Under ARCSA III, CSACs are authorized one per Corps, one per heavy division, and two per light division (except the 101st AAD which has 6). This distribution and basis of issue will provide for improved speed and a greatly increased capacity for troop displacement and resupply by air.
- Cargo capacity, at sea level, 95° for a 50 KM mission is 8,300 pounds.
- External (sling) load capacity at sea level is 8,000 pounds.

There are further savings in logistical requirements such as:

- Reduced maintenance due to RAM improvements in the aircraft.
- Higher payload capacity results in greater productivity per flight hour.
- Reduction in aborts and potential for forced landings/accidents due to twin engine reliability and system redundancy.

Savings in personnel will also accrue as the **Black Hawk** replaces the UH-1 because of the fewer number of UH-60s to do the UH-1 job. About 575 crew member spaces will be saved overall plus a reduction in maintenance personnel due to predicted RAM improvements.

Air Assault workhorse

At the same time, of necessity, the **Huey** will continue to be utilized in diverse units according to its capabilities in liaison, resupply, utility, and command and control roles; but the UH-60A will be the workhorse in the air assault role. It is only logical, therefore, that it be issued first to the 101st Airborne Division (Air Assault) where the **Force Development Test and Evaluation (FDTE)** will be performed as the final field evaluation of the **Black Hawk.**

After the 101st, the **Black Hawk** will be issued to the 82d Airborne Divison, USAREUR, and FORSCOM. Transition training for the aviators of the 101st was conducted at Fort Rucker; however, special exportable training courses will be provided to the 82d Airborne Division and USAREUR for subsequent aircraft distribution.

In sum, the Army is indeed proud to have the **Black Hawk** join in the heritage of the chariot, horse cavalry, and UH-1, promises an even brighter future for U.S. Army battlefield mobility.

First Delivery of the Black Hawk to an operational unit

Ft. Campbell, KY—June 19, 1979

A GREAT DAY FOR THE ARMY AND THE 101ST!

By GENERAL JOHN R. GUTHRIE, COMMANDER
USA MATERIEL DEVELOPMENT & READINESS COMMAND

GOOD morning, Ladies and Gentlemen and members of "D" Company, 158th Aviation Battalion.

This is, indeed, a great day for the Army, for American industry and for the 101st Airborne Division (Air Assault). It is also, for me, a personal and professional pleasure and honor to participate in another ceremony marking the achievement of a major milestone in the fielding of one of the **"Big Five,"** and to represent not one but two Chiefs of Staff of the Army who would, except for pressing duties, be here today. They did, however, ask me to express both their regrets at not being able to come and their great satisfaction that we have achieved this milestone in the **Black Hawk** program.

Too often we hear it said that you can't put your finger on who's responsible for what happens — good or bad — to a program. Normally, this is caused by the lack of continuity of people in the job. It is a personal pleasure, therefore, for me to point out that there are at least

PREVIOUS PAGE PHOTO—General John R. Guthrie, left, USA DARCOM Commander, is shown presenting the UH-60A plaque he'd received from Sikorsky Aircraft to Major General John N. Brandenburg, Division Commander. The latter accepted the trophy on behalf of the officers and men of the 101st Airborne Division (Air Assault).

four of us here — **Bill Crawford, Gerr Tobias, Dick Kenyon,** and I — o whom you can put the finger.

I'm proud to say that I was Director Development in the Office of Chief, Re search and Development when the dem onstrator engine program began, Depu Commanding General for Materiel Ac quisition at AMC when the UTTAS re quest for proposal was issued and th program began, that I contributed pe sonally to structuring the program (w had no engineering developmen phase), and that I was again back in a re sponsible position to help **Bill, Gerr** and **Dick** through their trials of initi production and deliveries. Now, **Dic** will be leaving us, at an appropriate tim in that the development phase is no complete with the deliveries of these fir production models to a TOE unit, b the rest of us will still be here to see ho well his integrated logistics support pla works.

Another first for the 101st!

So much for such reminiscing. This i by any measurement, a truly historic da for the Army and for the 101st Airborn Division (Air Assault). Another first for th 101st! Like that day 21 months ag when, with the help of **Jim Thorpe'** son, **Carl,** we named the UTTAS th

Black Hawk. This morning represents another milestone in the Army/Industry effort to provide the total Army with modern equipment to enable it to meet the threat of the 80's.

We are fielding the first production models of a modern, much needed troop-carrying helicopter of greatly increased capabilities to a regular TOE active Army unit, "D" Company, 158th Aviation Battalion, the **Ghost Riders.** In so doing, we not only fulfill a commitment made 14 months ago when the **Black Hawk** colors were presented to this unit upon its designation as the Army's first **Black Hawk** Company, but also initite a process which will see some 48 new systems fielded over the next 5 years.

The two aircraft you have seen in flight are symbolic of the culmination of many hard years of effort by General Electric, Sikorsky Aircraft, their sub-contractors in 43 states, and the government. Those years, I assure you, were sometimes very eventful for all of us who believed — who knew — that the Army had to have a new troop transport helicopter which could survive on the battlefield of today and tomorrow.

I said we are fulfilling a pledge to "D" Company. We are doing so despite the crash of a prototype in May 1978. That the program, despite an initial two-month delay, is now just one month off its original schedule. This is a tribute to every-one involved in its development and production.

A firm and steady hand

In particular, I would like to acknowledge the very firm and steady hand which guided the **Black Hawk** program through this period — **COL Richard Kenyon,** who, as I said, with the initial **Black Hawk** fielding almost completed, leaves the program. Because of his outstanding accomplishments, **COL Kenyon** was awarded the 1978 Secretary of the Army's Award for Project Management. He leaves the program in good shape and, for once, we are making the transition of PM's at a rational point — when the system is making its own transition from development to production and support.

Unquestionably, **Black Hawk** is a major improvement over the 20 year faithful workhorse of the Army, the UH-1. **Black Hawk** is our first true squad carrying helicopter with greatly improved survivability, reliability, and maintainability. (Just how greatly improved will be something for "D" Company to demonstrate.) It is not too much to say that **Black Hawk** is the first Army aircraft designed, developed, and produced specifically with the soldier in mind, from the combat squad members to the mechanics who will appreciate the modular concept used for the T700 engine and other aircraft parts. I might add that this aircraft is so highly regarded that, in addition to its primary role as a troop carrier, it is also being considered as the basic airframe for both Army and Navy electronics equipment.

Most of you know that **Black Hawk** is already being used at Fort Rucker for

A GREAT DAY!

(Continued from Page 29)

training, and I'm happy to say that we've had "good vibes" from there. The pilots have been elated by its performance and handling qualities, and I am confident that your experience with **Black Hawk** will be the same.

"D"' Company is, I am sure, proud to be the first operational unit to receive, maintain, and operate the **Black Hawk.** From a review of its history, I doubt that the Army could have found a better unit to which to entrust this new aerial combatant. "D" Company's record in war — 2 Presidential Unit Citations, 2 Valorous Unit Awards, 9 Vietnam campaigns — and in peach — on training exercises and in civilian relief — bespeaks the courage, dedication, and unselfishness which have always marked the American soldier.

As I looked, upon our arrival, from the men and women of "D" Company, 158th Aviation Battalion, to this helicopter, I was struck anew by the fortuitous circumstances which unite **Black Hawk** and the **"Ghost Riders"** for I understand that the latter have chosen as their unofficial song a ballad of many years ago entitled "Ghost Riders In The Sky,"

The pursuit of lasting peace

Like the Ghost Riders of the song, "D" Company's modern Ghost Riders, mounted on the **Black Hawk,** are also engaged, with the rest of this proud Division and all of our forces, on what must seem at times an equally endless chase — the pursuit of lasting peace in our world. Their mission — our mission — is, by being ready, to protect that peace by deterring war; but it that proves impossible, to

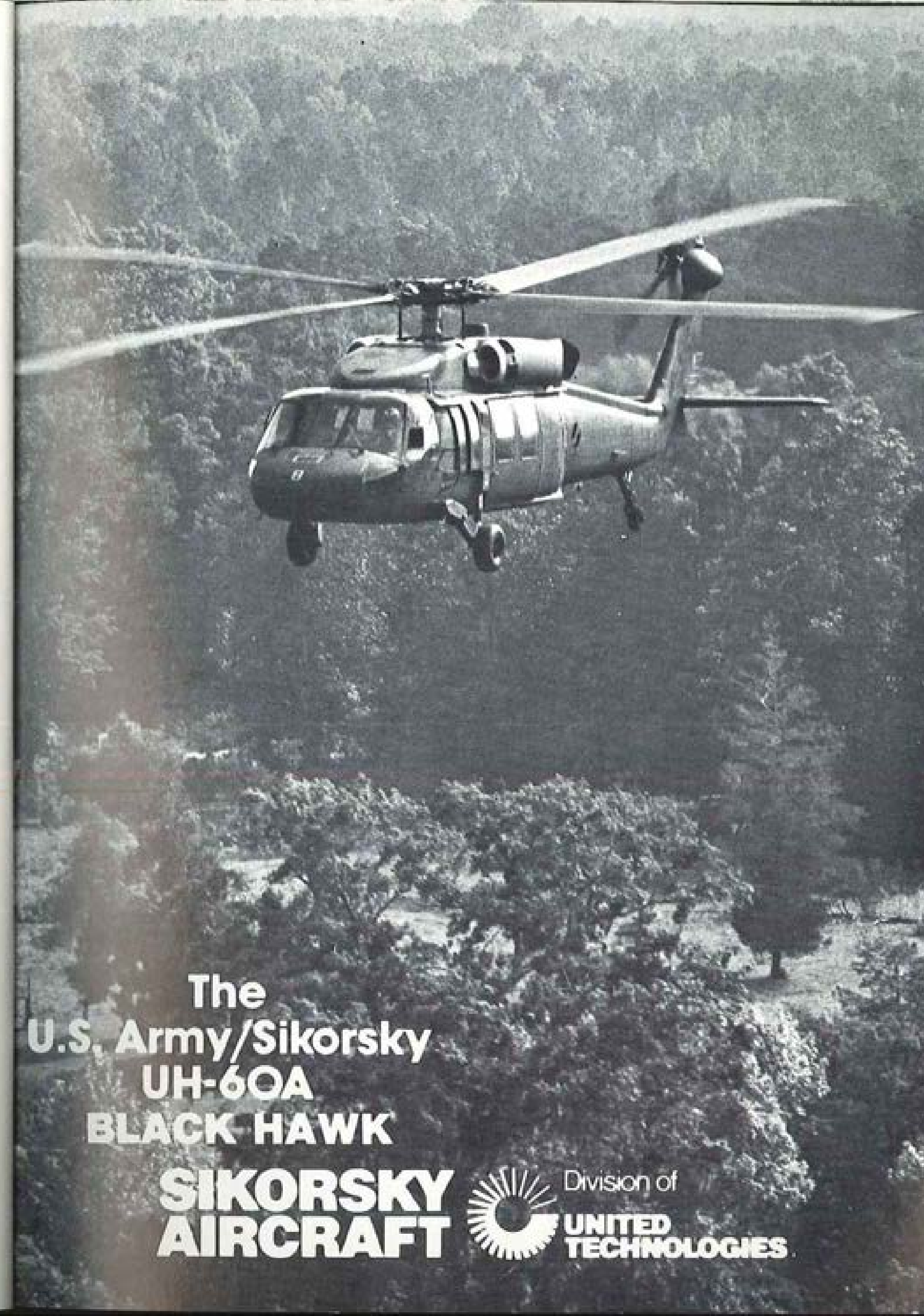
ACCEPTANCE—General John R. Guthrie, left, Commanding General, DARCOM, and MG John N. Brandenburg, the CG of the 101st Airborne Division (AASLT), are shown with the "Acceptance Plaque" presented to the US Army by Gerald J. Tobias, Sikorsky President, at the time of the turnover of the operational Black Hawks to the Fort Campbell unit.

fight to defend and protect our national interests — and to win.

Let me, in that spirit, close by repeating for the benefit of "D" Company and all those who will use this fine aircraft what **Carl Thorpe,** son of the great **Jim Thorpe** and member of the **SAUK** Indian tribe from which sprang the great Indian Chief whose name this helicopter bears, said of **Black Hawk** twenty-one months ago when it was christened:

To this bird we say —
"Go to the skies,
To the clouds, and
Challenge the thunder.
Bring upon your strong wings
The peace of **Black Hawk.**"

I would only add that, God willing, we trust that peace — and not war — will indeed be the **Ghost Riders** and **Black Hawk's** destiny.


The
U.S. Army/Sikorsky
UH-60A
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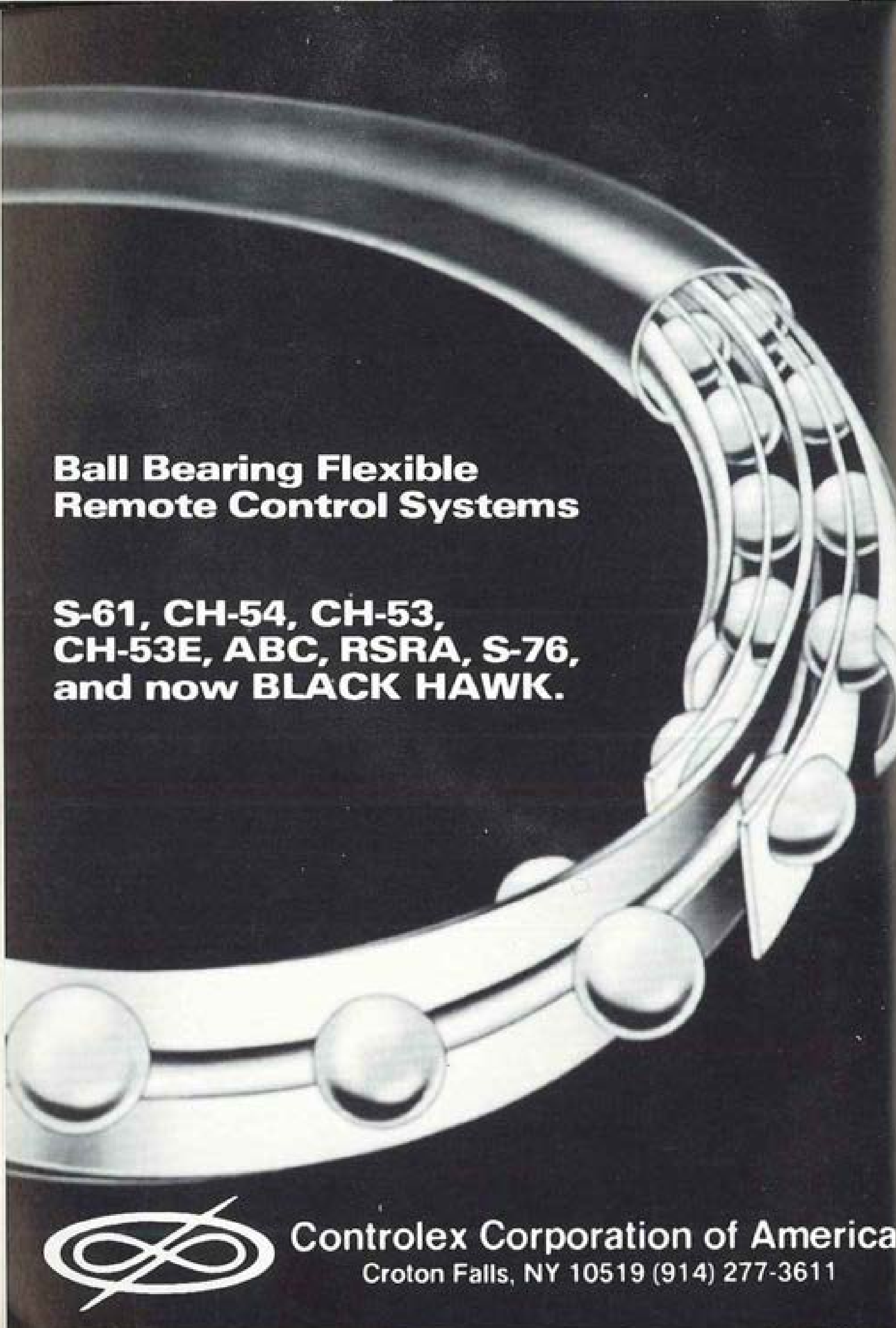
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We Helped Black Hawk Lose A Little Weight.

The installation of Hughes flexible printed circuitry in Black Hawk's control panels resulted in smaller, lighter panels than when hard wiring was used.

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Hughes flexible printed circuitry. Compact, light weight, reliable. It can save space, weight, time and money.

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OUR TITAN APU GIVES BLACK HAWK A GOOD START ON THE TOUGHEST MISSIONS.

When survival is your aircraft's first assignment only the fittest subsystems will do.

That's why Sikorsky went for the Solar® *Titan*® turbine auxiliary power unit for its UH-60A Black Hawk tactical transport helicopter.

The *Titan* APU provides pneumatic power for starting and electric power. When you need it. No matter whose territory you're in. So you can get in and out of a tough situation knowing your APU won't let you down.

The Black Hawk's *Titan* APU has an extra margin of performance for every pound of weight and low life-cycle costs to boot.

But even more important, the reliable *Titan* turbine is specially designed to get the job done in the dirty, dusty places helicopters go.

Does it? Every production military helicopter that uses an APU flies with the Solar *Titan* APU. Ask them. The F-16 relies on one, too. And so do a lot of commercial aircraft, including business jets. In all, over 8500 Solar turbine APU's have done their job for some 15 million operating hours.

Why are so many people sold on the *Titan* APU? To start with, it's reliable. For the rest of the reasons write Radial Engine Division, Solar Turbines International, Dept. B-184, San Diego, CA 92138.

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Black Hawk Required More — And Lord Kinematics Works With Sikorsky To Provide It.

The Black Hawk is designed for maximum reliability and minimum maintenance. Sikorsky Aircraft has used the latest technology to achieve these characteristics. They have also incorporated Lord Kinematics main rotor bearings and tail rotor pivot.

When the unique demands of the main rotor bearings were specified the state of the art had to be extended. Thrust bearing (A) was designed to the specification. It was not as tough as desired for the Black Hawk as evidenced by its condition after 19,000 ground-air-ground test cycles.

Lord's response . . . **triple life.**

Newly developed analytical techniques were applied to design bearing (B). As shown after 60,000 test cycles, it is still going strong.

The same analytical techniques and data base were used to analyze the requirements for the Tail Rotor Pivot. This part was designed to meet the severe test and operating conditions of the bearingless tail rotor.

(A)

(B)

For Lastoflex® Bearings and other high performance elastomeric product requirements, contact: **Lord Kinematics, Lord Corporation, P. O. Box 2051, Erie, Pa. 16512. Telephone: 814:456-8511.**

If we do not have what you need, we will do our best to develop it for you.

LORD Lord Kinematics

Tracor M-130

MISSIONIZED SURVIVABILITY EQUIPMENT

TRACOR'S M-130 — STANDARD EQUIPMENT ON UH-60

Mission completion on the modern battlefield demands protection from air-defense weapons. The lightweight M-130 provides the needed protection against radar and IR threats using the test-proven M-1 chaff and M-206 flare units. The M-130 can be used on a missionized basis to provide protection when needed in a 30 lb. package. The M-130 is in production at Tracor for the U.S. Army and for an international customer. The M-130 has been successfully test flown on the AH-1, UH-1, OH-58, CH-47, OV-1, RU-21, and the UH-60 Black Hawk. Flight tests will soon be conducted on AH-64 Advanced Attack Helicopter. Similarity to the USAF AN/ALE-40 standard tactical dispenser allows reduced logistic burden through commonality of expendables and many assemblies and spare parts.

For information contact David Wallace, Countermeasures Marketing, Tracor, Inc. 6500 Tracor Lane, Austin, Texas 78721. Telephone 512/926-2800. TLX Number 776410, or TWX Number 910/874-1372.

Tracor Sciences & Systems

Tracor, Inc. 6500 Tracor Lane Austin, Texas 78721 TWX-874-1372 Telex 77-6414

"THE LEADING EDGE IN ELECTRONIC SYSTEMS TECHNOLOGY"

Building the Black Hawk!

By FRED W. CARROLL
Executive Vice President, Sikorsky Aircraft Division, UTC

A new challenge awaited Sikorsky Aircraft Division of United Technologies Corporation on December 23, 1976. That was the day the U.S. Army selected Sikorsky to produce a new generation of military helicopters utilizing the latest available technology.

The aircraft, the UH-60A **Black Hawk,** had already demonstrated its capabilities impressively in prototype form. The next assignment for Sikorsky was bringing about an orderly transition from development to **low rate initial production (LRIP)** and then to full-scale production.

PEP approach used

Preparation for production began at Sikorsky long before the contract was awarded. The utility helicopter was designed from inception utilizing a **Producibility Engineering and Planning (PEP)** approach. This strategy indicated a multi-discipline team effort to coordinate and integrate engineering and associated producibility planning during basic engineering development, **PEP** Phases and actual manufacturing.

Sikorsky was determined not to delay needed design improvements. Every effort was made to make necessary adjustments prior to the production phase. Because of this policy, the prototype aircraft delivered to the Government for flight-testing and evaluation reflected very nearly the performance expected in the production **Black Hawk.**

The first **PEP** Phase was launched in September, 1975, to initiate long lead planning for the identification and definition of UH-60A design producibility, facilities and equipment requirements for **LRIP.** This comprehensive enterprise laid the groundwork for **PEP II,** a thorough cost effective manufacturing plan which is now being implemented at Sikorsky's Stratford plant.

Post-PEP II actions

The **PEP II** program led to the following actions:

- Producibility review of every drawing and specification to reduce cost to the lowest practical level. As a result, designed producibility from the early stages of the program reduces cost of direct labor, tooling, material and facilities.
- Early risk analysis providing timely development of cost effective alternatives in the manufacturing process, heading off potential delays and reducing cost.
- Interchangeability of parts to reduce tooling, inventory, storage and manufacturing costs.
- Heavy investment in automatic

manufacturing equipment for fabrication process to reduce labor cost and maintain repeatability.

- Standardization of tools and parts to reduce tooling and manufacturing costs, as well as life cycle costs.
- Self-contained final assembly stations with joining fixture stations that include tools, parts, work instructions, time standards, utilities, and a team concept that promotes efficiency.

Modular design pursued

One of the most interesting and productive concepts refined during the **PEP** programs is modular fuselage construction and fitout. Sikorsky gained experience in modular design through earlier use on the RH-53 cockpit canopy assembly, the S-61 cockpit canopy, and the S-64 airframe.

The purpose of the modular method is to build sectons of the aircraft as completely as possible before bringing them together for final assembly. The **PEP** planning of assembly modules on the UH-60A aircraft was accomplished by a team composed of engineering, manufacturing engineering, industrial engineering, and manufacturing representatives.

By bringing these disciplines together to refine the modular concept, Sikorsky has established a system which is quicker, more efficient, and less costly than the old methods. And quality control is greatly enhanced.

Many major assemblies on the **Black Hawk** are manufactured under the modular system. For example, the cockpit module consists of the lower fuselage assembly, bulkhead assembly, canopy assembly, all windows, a completed instrument panel, pilot doors, seats, flight controls, and instrumentation. Obviously, this is not a skeletal operation.

To the fullest extent possible, the "stuffing" which goes into the aircraft is installed at the modular stations. Also in the cockpit module are intercommunications systems, radio controls, circuit breaker panels, engine start and rotor control panels, lighting controls, associated wire harnesses, hydraulic lines, antennas, windshield wiper, anti-ice controllers, and contractor junction boxes. When completed, the cockpit is ready for rapid connection with the foward midfuselage, another modular unit, and so on until the total airframe is complete.

In addition, modular designs were incorporated into many of the **Black Hawk** components. This lends itself well to easy maintenance and repair after delivery. For example, the **Black Hawk** transmission consists of five modules, four of which are completely interchangeable, left and right, and have separate chip detectors. A damaged module can be independently removed and replaced without interfering with the remainder of the system.

A $100 million investment

And so it goes. A new manufacturing program of the dimensions already described obviously requires more than good engineering and planning. It requires capital, equipment and facilities. Sikorsky is investing $100 million in plant expansion, machinery, tools, and general modernization over a period of five years (1976—1980) to implement high rate production. A new materials control center covering a total of 170,500 square feet has been constructed at Sikorsky's Stratford plant to facilitite storage and retrieval of material as needed.

In addition, a 137,000 square foot

manufacturing addition has been completed at the Stratford plant to accommodate about 900 employees concerned with production of transmissions, rotor heads, gears, hydraulics, and electrical equipment. Sikorsky is also leasing facilities where work is being performed to support the production program.

Some additional equipment required for **Black Hawk** production includes titanium sheet milling and polishing machines, six autoclaves for bonding composite materials and the manufacture of new technology titanium rotor blades, cutting machines for composite materials, equipment for the production and assembly of transmissions, which previously had been subcontracted by Sikorsky, additional chemical milling, and heat treatment processing. Sikorsky is taking on a new manufacturing face to meet the rigid demands of the **Black Hawk** program.

Machines and computers

The computer is an essential tool in the effort to meet production schedules. Maximum cost effective use of a program called **Direct Numberical Control (DNC)** is used for **Black Hawk** production. **DNC** enhances the use of numerical control equipment through direct links between machines and computers. Improvements in machining programs can be made from a keyboard terminal at the machines which are tied in with the computer. As a result, manufacturing flow times and related costs are reduced through minimum equipment downtime and greater efficiency of programmers and machine operators.

Equipment however, must work in partnership with men, and this relationship is a major ingredient in producing the **Black Hawk.** Sikorsky currently employs approximately 10,000 people, an increase of 4,000 in three years. It is imperative to know where, when, and how well they are performing their tasks in order to increase efficiency, another extensive use of computers.

Obviously, the transition from prototype to production was a complex one for the **Black Hawk** program. There were decisions on what to make and what to subcontract. An elaborate quality control system was established to assure the integrity of every part and system. Concentrated efforts were made to keep the cost as low as possible, without compromising quality.

One interesting result was a design which provides for interchangeable left hand and right hand parts on engine cowlings, engine inlets, fuel tanks, hydraulic pump modules, cargo door structure, troop seats, crew seats, rotor spindles, and many other aircraft components. The results are fewer spare parts, less tooling, quicker installation and less labor. And there are hundreds of similar improvements.

The production program is maturing rapidly, a product of many years of preparation to utilize the best available technology, equipment, and management principles to efficiently produce a new generation helicopter. **Black Hawks** are rolling off the production lines and in service at the Army Aviation Center, Fort Rucker, AL, and with the 101st Airborne Division (Air Assault), Fort Campbell, KY.

An extensive Integrated Logistic Support system to service **Black Hawks** in the field is in place and being expanded as additional **Black Hawks** are delivered to their assigned units. The **Black Hawk** has come of age as the world's finest military helicopter. ◄

Powering the Black Hawk!

By WILLIAM J. CRAWFORD, III, General Manager
T58/T64/T700 Projects Dept., General Electric Co.

IN early April 1979, the Army's newest helicopter engine, the General Electric T700, went into service with troops of the Army Aviation Center at Fort Rucker.

Now it faces the ultimate test of successful operational service in the field — and this is where engine reputations are made. We all know that.

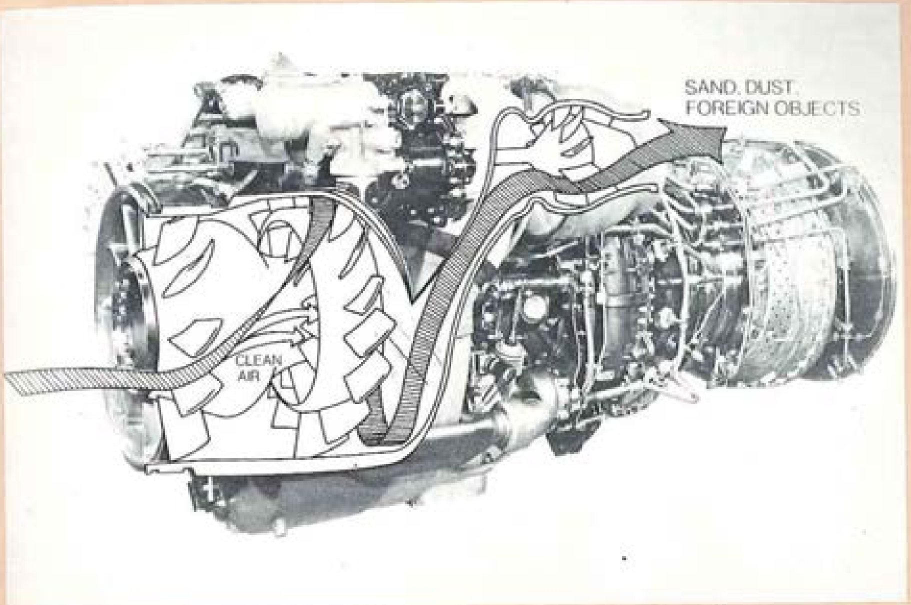
If there is one thing which all of us in aviation — contractors, aviators, maintainers, logisticians, and managers strive for, it's a successful field experience for our products — and so we spend a lot of time thinking about what **"success"** means, and how you prepare for it, measure it, and know when it has been achieved.

Most of all, we all want to achieve that success on a predictable, consistent basis. But how? What really creates success, especially with engines?

At General Electric, we've concluded there are two main ingredients — **Preparation** and **Responsiveness.** But no matter how well prepared you are — or think you are — it's certain that there will be problems — unforeseen problems.

If the **Preparation** is there, there won't be many problems but it still takes a **Responsiveness** to put them quickly to bed. We believe in such **Responsiveness** to problems at General Electric. We hope to demonstrate that fact as the T700-GE-700 turboshaft engine begins flying operationally in the Army's new twin-engine **Black Hawk** helicopter.

We feel we're ready for the effort — we've been planning and working for more than ten years as we developed and



tested this engine. In fact, one big reason we think the T700 is **Prepared** to meet Army needs as expressed by users, developers, and planners — with engine features and concepts.

Preparation for field use really begins when the initial product requirements and goals are specified. The Army did a thorough job here, setting out very specific objectives in the requirement documentation phase, and later, the development contract. These documents all addressed aspects important to field users: hot day performance, lower fuel consumption, compatibility with the Ar-- my environment, and low life-cycle costs.

Some tough specs

GE responded and we signed up to a tough spec for the T700. It required fuel consumption 20-30% better than engines the Army was then using — emphasized at cruise power. It contained new and unique requirements for reliability, easy maintenance, built-in diagnostics, and strict durability requirements — all these in addition to the normal performance-related items typically contained in such specifications.

To implement these Army requirements, we produced a design which featured an integral inlet particle separator so the engine could operate successfully in a sand and dust environment. We included integral lube and electrical systems to improve maintainability and reliability. And we developed a rugged axi-centrifugal compressor, combustor, and turbine which are not only suited to the Army environment, but meet the thermodynamic requirements for low SFC and hot day horsepower.

During the preliminary design phase,

Earlier Engine

500-800 Hours
Stamped Sheet Metal

T700

5,000 Hours
Machined Ring

maintainability engineers were used as consultants in establishing concepts, principals, and general engine layout. Then they worked right alongside the designers making sure that the requirements established by the Army were implemented in the final design.

Maintenance features

To speed and simplify maintenance, we included diagnostics such as oil and fuel filter condition indicators; a chip detector for the lube system; an engine life monitor; and borescope ports to ease internal inspection. Additional maintenance features included the elimination of all field adjustments; rigging for control replacements, and the use of lockwire in field maintenance.

Other advances included color-coded wiring harnesses for trouble shooting use; captured bolts on external accessories (so the bolts can't be misplaced); foolproof electrical connectors which are hand tightened; and many others.

Conceptually, the engine was designed into four replaceable modules and 27 **Line Replaceable Units (LRU).** LRU's, which traditionally demand the most maintenance, were designed to be easily replaceable. In fact, none takes more than 30 minutes to remove and replace with no more than ten simple tools found in the current AO7 tool kit. The modules also require only these ten tools for complete removal and replacement.

Very extensive testing

The next step was to prove that the design was a good one long before it entered the field, so that we could meet the demanding Army specifications and have time to improve things we didn't like. This involved very extensive testing, including hundreds of thousands of hours of component reliability testing.

We also had to engine-test our systems — systems for overspeed protection, load sharing, constant speed governing, engine performance, anti-icing, turbine cooling, and protection from foreign object damage and erosion.

The T700 was "wrung out"

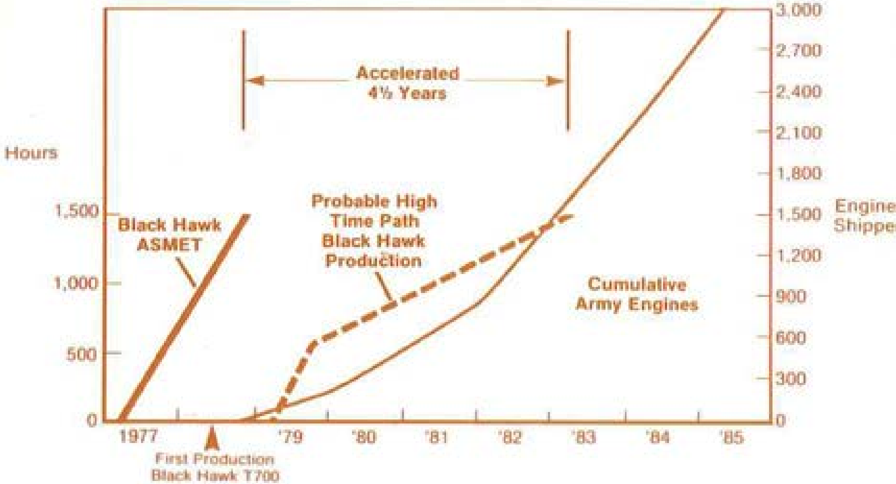
Finally, we really "wrung out" the T700 by initiating factory endurance tests nearly ten times more severe than planned mission usage in **Black Hawk,** and by testing for fatigue life, overspeed, and overtemperature margins. Before the first production engine was built, the T700 had flown in five different aircraft; several units had been operated more than 1,000 hours each; and the engines had been subjected to the Army environment at Fort Rucker and Fort Campbell, plus cold testing in Alaska including anti-icing capability at Eglin and altitude testing at Bishop and Coyote Flats in California.

During this time in the factory and field, we began to lay the basis for a dependable "on condition" maintenance system — which means no TBO — just run the engine until diagnostics say that something needs attention. We did this by running the prototype or flight-test engines "on-condition" by following a sampling plan drawn up with the Army.

The first engine to reach each sampling interval would undergo an analytical teardown. These teardowns always indicated that the engine condition was satisfactory for proceeding to the next sample interval. Later, we tested two production configuration engines for over 1,000 hours each.

One of the production engines was inspected every 150 hours and kept ahead

T700 Program Payoff



Maturity Accelerated 4½ Years

of the second engine in running time. The second engine was not inspected unless the diagnostics indicated that it should be. We were also careful to use the field manuals and tools during this phase so we could verify them.

Planning ahead

Experience has taught us that changes made to "productionize" engines sometimes lead to problems. Armed with this experience, and with the cooperation of the Army, we began to plan the details of the production process even before the engine was qualified. More than 100 prototype engines had been built for field and factory testing so we had a good experience base to build upon, but it was still necessary to plan for volume production including development of flow charts, processes, step-by-step operation procedures, complete quality plans for each part, and the proper tools and facilities.

This effort was called **PEP** for **Producibility Engineering Planning** — and it got the fullest production process started much earlier than is normal for engine programs. Addtionally, some of the new machines and techniques developed during this process save the Army and the U.S. taxpayer millions of dollars in production costs.

A planned Maturity Program

During the two years between formal engine qualification and production deliveries, the Army and General Electric ran a carefully planned Maturity Program to test new T700 features in the aircraft before the engine actually entered full production and field service.

Two important factory tests in this time period were aimed at verifying that predicted engine life could be met under field conditions and of running the production design so as to keep it always far head of field experience.

ASMET described

We began this confirmation in 1977 with an **ASMET (Accelerated Simulated Mission Endurance Test).** While this test was conducted in a test cell, the engine contained all of the aircraft installation hardware and was mounted on a "shake table" so that it could be vibrated at the frequencies and ampiltudes which our experience told us the engine sees in the aircraft.

The engine test cycle and power spectrum were based on typical **Black Hawk** missions except that it was "accelerated" or made more severe so that in 1,500 hours running time the engine would experience the same amount of high power time as would be seen in 4,500 hours of actual operation in the aircraft.

This testing allowed us to find problems which would not have been seen in field use for years and until hundreds of engines had been delivered. Thus, we were able to fix these problems early, saving maintenance and parts for the troops in the field.

During all this testing, we continued to use field manual procedures to run the engine and the field tools to maintain it. The basic engine — turbo-machinery, frames, etc. — performed marvelously through the whole 1,500 hours, but we did learn some things abut external accessories and their mounting brackets that we were able to fix.

Onto a test cell

In addition to the ASMET, we took the first production engine right off the production line and installed in a test cell and began running aircraft mission cycles on it. The test is now beyond the 1,000-hour point and has achieved nearly 3,000 cycles. We intend to keep this engine far ahead of those in the field so we can continue it as a "fleet leader".

"Fielding" the T700

The development and background of the "on condition" maintenance plan have already been described. Monitoring of the diagnostics, a ten-hour visual inspection are the only engine scheduled maintenance actions. Both inspections, incidently, are coincidental with aircraft inspections and are accomplished "on the wing". A simple **Health Indication Test (HIT)** is available to the pilot to assess overall engine health on a daily basis. This test is performed at part power on the ground.

A unique approach to spares

The demonstrated reliability which grew out of factory and flight testing plus the maintainability built into the engine have resulted in a unique approach to spares. Because the controls are easy to replace, spare engines are shipped without them. When an engine change is necessary, the controls are removed from the old engine and installed on the new one. The savings to the Government in parts cost is obvious. Similarly, the Prescribed Load List for unit level maintenance consists of only 54 items and the Authorized Stock List for intermediate maintenance contains 275 items.

Usage is monitored from the warehouse located at the overhaul Deport which initially, at least, is GE Strother Service Shop in Arkansas City, Kansas. Parts ordering has been automated and test runs made complete from the sending of a teletyped requisition to the receipt of the part so we know the system works and works quickly. As a depot, the Strother shop has already been in business with prototype and production overhauls. It is completely certified and standing ready.

This thoroughness of planning and preparation has also included maintenance manuals which are simple, filled with helpful illustrations, and printed so that action words are highlighted.

A G.E. training school

Troubleshooting "logic trees" guide personnel to the most frequent trouble source first. These manuals were proved in the field by Army crews during the development and production phases; we know they work because we've proved it.

To sharpen Army skills still further, General Electric runs its training school at Lynn, Massachusetts, facility.

Here, Army instructors receive actu "hands on" training, as well as technic orientation and systems reviews. Simila ly, General Electric's field Tech Reps we identified early and brought to Lynn mo ths ahead of time so that they would a quire T700 knowledge and experien which is essential in the field. They, to received countless hours of invaluab unforgettable "hands on" training.

A team dedication

This team dedication to the achiev ment of Army maintenance requiremen was evident at all levels, from our Gene Manager on down, since the day started the T700 design. At that point, made a commitment to:

- Design it right - and that means f maintainability.
- Build it right.
- Support it right.

It is a commitment we intend to live to. We're prepared to respond.

DISTINGUISHED GRADUATES—The top graduates of a recent WO, Officer, and Europe/NAT Rotary Wing Aviator Class are, 2nd from left, WO Cameron Ebel; CPOT Michael D. Homiller; an 1LT Heriberg H. Siffl (German AF). With them are MG George S. Beatty, Jr., right, AAAA's Nation President and graduation guest speaker, and BG (P) James H. Patterson, then Ft. Rucker's DC

The Maturity and Production Process

BY LT. COL. JOHN R. SMITH,* Asst Project Manager for Test and Evaluation, Office of the PM, Black Hawk

THE **Black Hawk** aircraft is well into production. It is also in the final stages of testing to demonstrate its ability to meet or exceed the rigid design requirements set forth by the Army and thus will achieve its status as a fully airworthy system which will take its place among other aircraft in tomorrow's Army. I would like to take this opportunity to share with you some of the highlights of the **Black Hawk** maturity and production programs and examine how changes are incorporated into the aircraft by virtue of the maturity test results.

The maturity and production contracts for the **Black Hawk** were awarded concurrently in December 1976. This unique approach to completing testing while at the same time initiating production was achieved because of the excellent results obtained from the **Basic Engineering Development (BED)** phase of the program. The maturity phase testing builds upon the BED phase testing and is accomplished to demonstrate that the aircraft will meet or exceed the design requirements specified in the aircraft **Prime Item Development Specification (PIDS).** The specifics of these qualifying tests are defined in the **Airworthiness Qualification Specification (AQS),** an attachment to the PIDS. It represents the contract statement of work

*LTC Smith has since retired and has been replaced by LTC John O. Turnage in the PMO.

tion(AQS), an attachment to the PIDS. It represents the contract statement of work for the testing of the aircraft and is structured such that the test conditions are representative of the true environment that the helicopter is likely to encounter in service.

A series of events

Since a process is a series of events leading to an end or a result, maturity can be described as a process which involves the test requirement; the test plan; the hardware and test; the test results; retest as necessary, and a qualified component, subsystem and ultimately the aircraft system. The **Black Hawk** contractor maturity effort can be further divided into five general categories as follows: the refurbishment of BED phase hardware for additional maturity phase testing and evaluation, the completion of design and development of items originally scheduled for the maturity phase; the evaluation and correction of **Government Competitive Test (GCT)** discrepancies; contractor qualification testing which includes component testing and system ground and flight testing; and the contractor's support of Government testing. Redesign as a result of the above testing must then be incorporated into the production line.

During the maturity phase the three flying prototypes, a **Ground Test Vehicle**

MATURITY PROCESS

(Continued from Page 47)

(GTV), and a **Static Test Article (STA)** were refurbished and selectively updated to incorporate the essential design improvement features of the production aircraft. Prototype aircraft S/N 73-21651 received the greatest amount of production hardware making it repesentative of a production article. Examples of the production items installed include: main and tail rotor blades; main landing gear; a one piece stabilator with an elastomeric mount; hydraulic pumps; and cockpit vibration absorbers. The majority of the mission flexibility kits were planned to have their design and development completed in maturity. Therefore, the components which made up these kits were designed and vendors were selected for testing and possible follow-on production.

Finding the shortcomings

GCT and subsequent flight testing identified several discrepancies which were analyzed by the contractor and changes were generated that were incorporated into the production design. For example, the GCT pilots identified a shortcoming concerning the over-the-nose visibility of the aircraft during a landing approach. This shortcoming was corrected by modifying the stabilator positioning schedule following several contractor flight tests. The revised stabilator schedule has since been incorporated into the production aircraft.

The bulk of the maturity effort lies in the area of contractor testing. Since January 1977, General Electric and Sikorsky have been engaged in a high level of activity testing components and systems in-house and managing the sub contracted vendor test programs. The ma jor T-700 activities include two 1,00 hour endurance tests to verify the o condition maintenance concept and 1,500 hour **accelerated simulate mission endurance test (ASMET** The latter event was conducted in a te environment which simulated a **Blac Hawk** installation with associated vibr tions and other characteristics that effe the durability of the engine.

Component and flight testin

Component testing conducted b Sikorsky in the maturity phase include the completion of dynamic compone fatigue tests; main and tail rotor whi testing; fuel subsystem component quali cation; hydraulic component qualificatio component controlled damage test completion of structural tests on the ST and flight control component and tran mission qualification tests. Sikorsky's sy tem ground testing was completed on th GTV with over 700 hours accumulate during the 300 hour **military qualifica tion test (MQT),** and subsequent 40 hours endurance test.

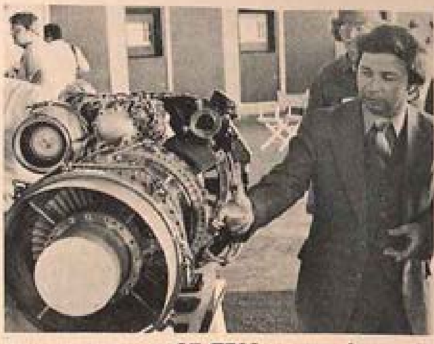
Flight testing has been conducted bo at Sikorsky's Stratford, CT, and We Palm Beach, FL, facilities and at remo locations such as Burlington, VT. Som of the major flight tests include: flig loads survey; propulsion subsystem; fl ing qualities; height-velocity; dynamic i stability; and structural demonstration and electrical and avionics subsyste flight tests.

The above flight testing has been co ducted to obtain data pursuant to aircr qualification. To further explain catagori of flight test, some flight tests are co ducted to obtain data for the purpose of analysis prior to the conduct of a formal demonstration. For example, a flight loads survey was performed for the purpose of obtaining in-flight stress data on aircraft components such as the rotor blades, swashplate, pushrods, and tail rotor pitch beam. These loads are then used for determining the load levels to be used for the conduct of component fatigue ground test and the resultant calculation of component fatigue lives.

By its very nature, a survey is a data gathering of exercise as given in the above example, and not a "must-pass" test as is the case with a demonstration. The handling qualities and structural demonstrations, for example, are "must-pass" tests and the helicopter must "demonstrate" that it can meet or exceed the prescribed requirements which are defined in the PIDS and other applicable documents. This demonstration testing result is the final flight envelope limits established on the aircraft.

Extensive vendor testing

In addition to the testing conducted by Sikorsky, there are many vendors throughout the country who are conducting qualification bench tests on their components. This effort has included functional; structural (static and fatigue); endurance; environmental (e.g., shock/vibration; sand/dust; acceleration; and salt fog); and **electromagnetic compatibility (EMC)** testing. Several components and systems have also been qualified by similarity to previous designs. Since the testing mentioned above is not meant to be all inclusive, the interested reader is referred to the AQS for information concerning the total scope of the maturity test program.



Attendees view a GE T700 engine during the early July turnover ceremony at Ft. Campbell.

Last but not least is the contractor's support of tests which are conducted by the Army. For example, when the Army is performing a test in the **Black Hawk** such as the **Preliminary Airworthiness Evaluation (PAE),** the contractor provides the engineering support for data generation and analysis, technical representatives, mechanics, and inspectors for aircraft maintenance.

So far only the maturity process has been examined and it has been stated that required changes have been incorporated into the production aircraft. What steps does a required change undergo in order to finally become part of the production configuration? Let us look at the actions that must occur in parallel with the maturity effort.

Once the contractor and the Government have agreed through the **engineering change proposal (ECP)** process that a change is required, the design engineer will take the production drawing and add the required modification called a **Development Engineering Order (DEO),** to record the change. The hardware is then reworked per the DEO drawing and testing is conducted to determine of the fix is adequate.

Design engineering will then prepare the final production design and submit it to the production change committee. The committee approves or disapproves the change and sets up the plan and schedule for incorporation of the part on the assembly line. Manufacturing engineering then prepares the operation sheets and the work orders. The operation sheet defines each required step in building up a component or assembly. This includes such information as when to heat treat, when to perform a bonding process, when to press in a bushing, when and where to inspect, etc. The drawings, operation sheets and work orders find their way to the production line where they are used to effect the installation of the correctly configured component. Product support personnel manage the incorporation of changes in the field when necessary and take care of the manual changes.

A detailed process

As can be seen, this is a very detailed and intricate process requiring coordination and communication among many and varied disciplines. It is a time consuming process. At times when a required change needs to be incorporated quickly due to safety of flight or other considerations, design engineering will ask for an emergency release which will in turn be executed by production control.

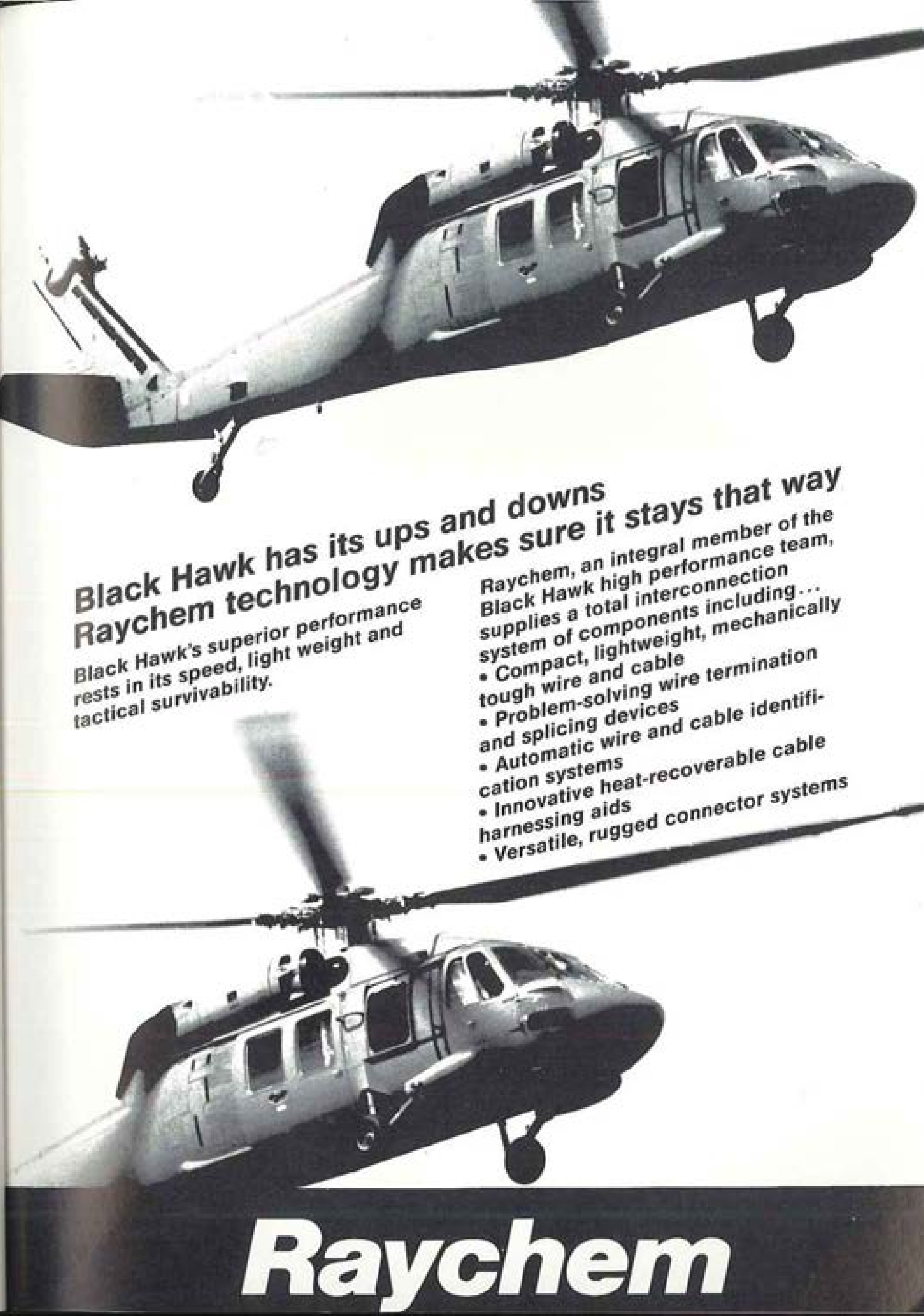
It has been said, "Rome wasn't built in a day". So too, helicopters are not designed, tested and built overnight. The maturity and production process of the **Black Hawk** is one portion of the big picture in the aircraft life cycle. While the testing and production of the helicopter takes place within established guidelines, and in accordance with prescribed procedures, it is necessary to maintain a flexible posture to "cushion the impact" o surprises that emanate from the test pro gram. It is sometime necessary to revis test schedules to perform other tests whil the problems identified in a previous tes are sorted out and solved. However, pro duction cannot stop and wait until all th unknowns are identified and resolved Production decisions must be based o the best analysis and test informatio available at the time.

A continual search

As the aircraft move down the produc tion line, both the Army and the contrac tor will continue looking for improve ments and new ways to make the pro gram more efficient and less costly. Th Army now owns more than 15 produc tion aircraft and will continue to receiv aircraft per the contract requirements Data generated from the **Black Haw** program can also be used by the decisio maker for cost estimates in the test an production of a future generation of ai craft.

Testing will be completed shortly however, history tells us that difficulties re quiring resolution will surface when th aircraft is in the field. These problems wi require additional analysis, test, resolu tion, and subsequent incorporation int the aircraft. By systematically incor porating changes, the user and the Arm stand to benefit from increased capabilit and performance, and improved reliabili ty, availability, and maintainability, wit minimal cost impact in this era of sky rocketing prices.

The **Black Hawk** aircraft when fielde will have been thoroughly tested by bot the Army and Sikorsky. It goes to the fiel "ready for duty" to be used with pride an confidence. ◄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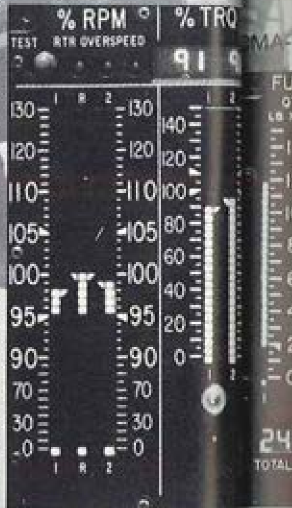

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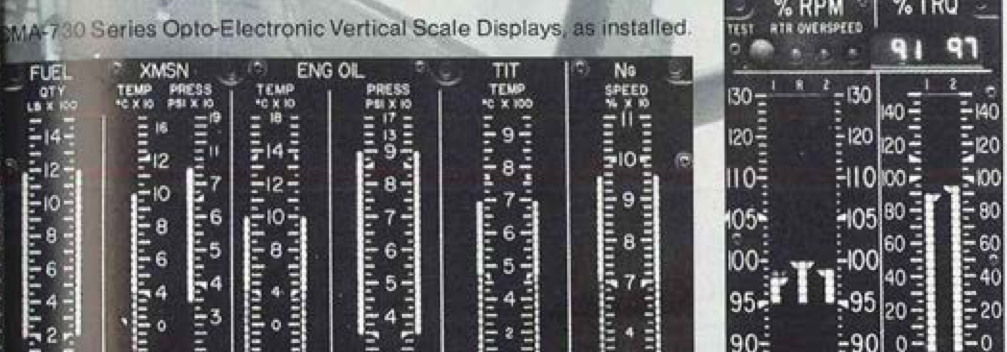

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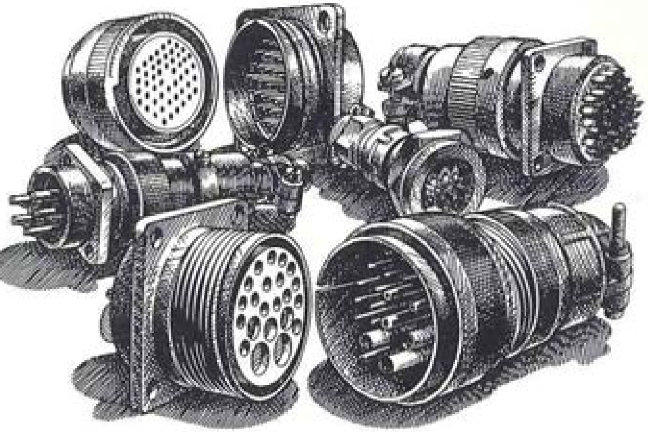

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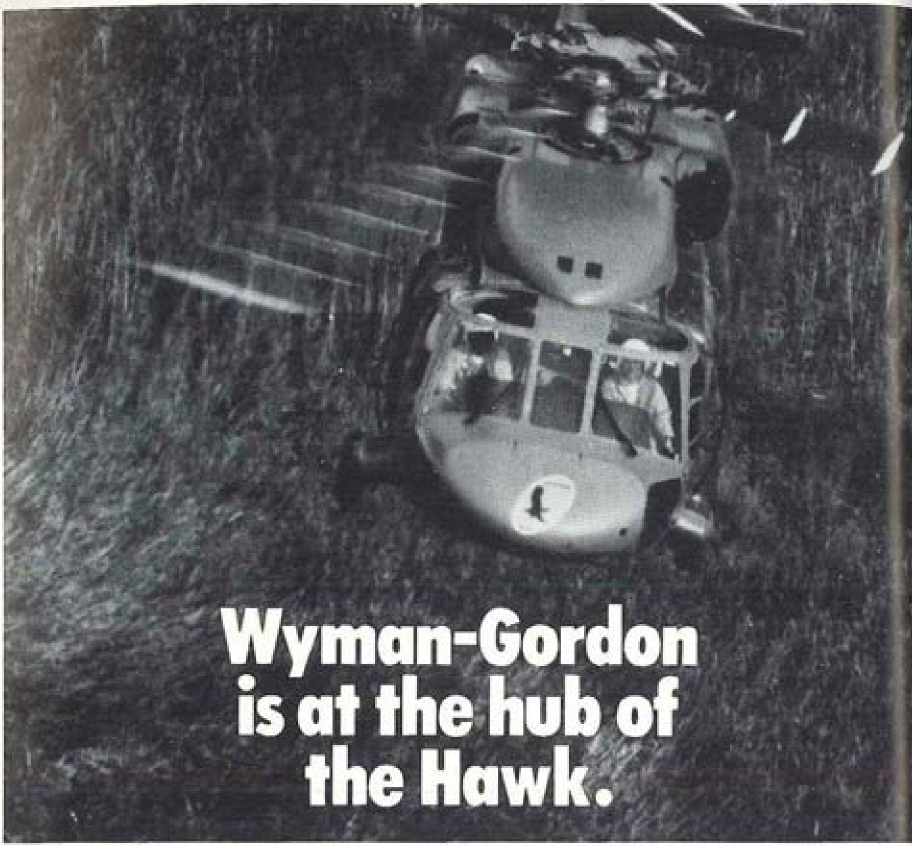

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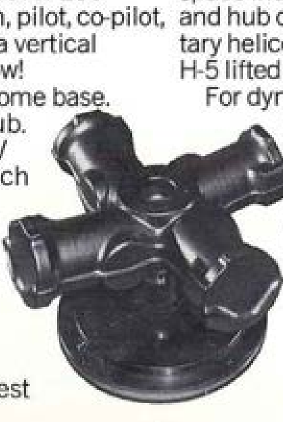

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The Army's Qualification Process

By CHARLES C. CRAWFORD, Chief, Systems Development and Qualification Div, AVRADCOM

TO formulate an Army aircraft qualification organization required a prolonged and arduous campaign. As Army expanded its needs for more air vehicles for a wider range of combat tasks (recognized as early as the Korean conflict) the need to qualify aircraft for specific Army requirements became more and more apparent.

By mid-1966, all administrative actions had been completed for the Army to establish its own capability to perform the military airworthiness qualification of Army air items. **Department of Defense (DOD)** directives were in order and Headquarters, **U.S. Army Materiel Development and Readiness Command (DARCOM),** then (AMC), issued regulatory procedures.

Initial agency in St. Louis

A separate engineering organization was established in St. Louis to provide this capability so that aircraft designed specifically for the Army's combat mission, rather than to civil requirements or the technical standards of our sister services, could become a reality.

Equally important was the definition of stringent test procedures to evaluate the combat-hardening that these helicopters need for victorious operations on the modern battlefield. To assist in this process, Army management transferred the aircraft engineering flight test capability of TECOM directly to the development agency (now AVRADCOM) in that an airworthiness flight test capability had to be an integral part of the team.

Quick fielding of the Huey

The initial efforts of the qualification process were directed toward the quick fielding of the **Cobra** so that Army forces in Southeast Asia could have the world's first dedicated attack helicopter configuration. The stringent requirements to have operational helicopters entering the battlefield only 18 months after a contract go-ahead did not permit much innovative technical design work, but did result in a very successful attack helicopter which has grown significantly in capability since the initial AH-1G configuration was fielded.

Subsequently, the **Black Hawk** is the Army's first attempt to develop and field a truly military helicopter combat-hardened to the ballistics threat. It has performance margins never before attempted by the helicopter industry, and it possesses drastically improved flight characteristics that enable its pilots to handle these performance margins. It has an instrument meteorological flight capability to include successful operation under moderate icing conditions. Further, it features reliability/maintainability attributes which unload the maintainance burden and decrease the cost of ownership of this advanced maneuver vehicle.

We can see the militarization of this modern helicopter in almost every aspect. Note the attention to detailed design in the flight control system so that total redundancy exists and no single ballistics round can disable the aircraft within the threats envisioned at the time of its design. Flight crew and troop seating accommodations with their crashworthy design features allow the maximum practical protection. Engine and other instruments are light-coded vertical displays.

Rugged design criteria

Rugged structural design criteria have been demonstrated on numerous occasions to withstand hard landings, emergency landings in wooded areas, and in the case of the competing UTTAS, an actual crash. Subsystem improvements include "third chance" hydraulic power capability, fully redundant electrical capability, suction engine fuel systems, and ½-hour flight capability with loss of gearbox lubrication.

The stringent Army specifications for enhanced survivability demanded that the **Black Hawk** withstand enemy ballistics to a degree far beyond any aircraft in the Army inventory during the Vietnam era. The demanding qualification tests assured that those specifications were met or exceeded. The design specifications and qualification tests were not only developed against the threats experienced in Vietnam, but against future threats by an enemy with far more lethal weapons.

A UH-60A Black Hawk is shown in Nap-of-the-Earth flight at Fort Campbell, Kentucky.

Postulated against those potential threats, the **Black Hawk** fleet will deploy our combat power within the battle area with recognized acceptable losses, whereas our combat forces in the older helicopter fleet would be destroyed. The difference: the **Black Hawk** fleet can mass our combat power at the decisive time and place to overcome an enemy's numerical and firepower superiority, whereas, with the older fleet, the battle would be lost simply because our combat power aboard would be destroyed before they could be landed.

The **Black Hawk** was qualified by test against advanced crashworthiness criteria. We recognized that the **Black Hawk** would sustain battle damage — and that a certain percentage would crash-land. We have provided for protection of the cabin area so that it will not collapse and break-up under some very severe conditions. Furthermore, as a result of our criteria, the likelihood for a destructive post-crash fire is minimized. Thus, even when crash-landing in the battle area, the **Black Hawk** will protect the all important combat power it's transporting into battle.

The military worth of the flight performance design conditions cannot go unnoticed. The **Black Hawk** has greater agility in terms of vertical rate of climb at the hot day conditions of 4,000 feet, 95ºF. This capability covers 95% of the potential combat environment and at partial power. No other helicopter has ever achieved these performance characteristics.

This partial power aspect (95% IRP) anticipates deterioration of engine power while the military situation may not permit immediate engine replacement. Also, this power margin allows future growth of aircraft capability with small improvements to overcome unforeseen operational or maintainability deficiencies.

A bonus capability

Through its emphasis on reduced empty weight, our military qualification system has provided us with a bonus **Black Hawk** capability to deliver an additional 500 lbs. of combat power into battle on every sortie. This 500 lb. reduction in the **Black Hawk's** empty weight is approximately the equivalent of the total OGE lift capability of a UH-1 under hot day criteria in the highlands of Vietnam.

CLOSE LOOK—MG George S. Beatty, Jr. AAAA's National President, is shown receiving a Black Hawk cockpit briefing during the AAAA National Board's recent business meeting at Fort Campbell, KY.

To give full credit to the weight reduction effort, it must be pointed out that production **Black Hawk** are 800 pounds lighter than the original prototypes.

A fleet of 1,000 combat **Black Hawks** performing four sorties per day, can thus deliver an extra 1,000 tons of combat power daily. That equates to 8,000 more combat-equipped infantrymen, or 50,000 more rounds of 105 mm artillery shells. During 30 days of sustained combat, we're talking about providing superior mobility for 240,000 more troops or delivering 1,500,000 more artillery rounds. Thus, the increased 500 lb. lift capability dramatically enhances the Army's combat posture, a truly remarkable achievement resulting from our our military qualification program.

Chinooks freed for heavier loads

In less exotic terms this reduced empty weight provides an added lift margin sufficient to permit the **Black Hawk** to carry external loads up to 7,700 lbs. This additional margin now lets the **Black Hawk** carry the **Gamma Goat** with a reasonable fuel load, thus freeing our **Chinooks** for greater lifting tasks. Two **Lance** missiles can now be deployed simultaneously by one **Black Hawk** in the battle arena. By freeing **Chinooks** for heavier loads, a combat power "multiplier" factor has re-sulted from the increased 500 lb. **Black Hawk** lift capability. Never underestimate the merits of reduced empty weight and increased payload.

Our military qualification systems also placed high priority on increased maintainability and reliability. Granted, we doubled the engines (for performance and survivability), doubled the rotor blades (for agility), added an APU (for enhanced maintainability), and in other ways drove the manufacturer to greater complexity. But the result of our effort has reduced the ratio of maintenance manhours to flight hours. For the combat commander, this reduced maintenance burden and higher system reliability means greater availability of his critical maneuver vehicles to mobilize his combat power.

For the pilot, our military qualification system has given him a **Black Hawk** with flight handling qualities and performance margins never before achieved. The pilot will respect the quick response time of the **Black Hawk's** flight control system and the ease of its maneuver; its exceptional agility, speed, rapid rate of climb, and remarkable stability.

The flight control system, instrumentation, de-icing capability, power available, and fuel reserve pro-vide the pilot with a real opportunity to complete his combat missions at night and under inclement weather conditions.

Asking the key question

What qualification testing gave us this superior aircraft? . . . One which included over 600 contractor flight hours in the basic engineering development phase and 575 flight hours in the maturity phase. This testing led to the final production configuration.

This flight time included the most stringent helicopter flight structural demonstration ever performed. It was done solely on the initial prototype, and revalidated on an aircraft incorporating all essential production structural features.

While the flight test efforts are the more glorified phase, the true success of the helicopter lies in the work accomplished during ground test, primarily that of testing individual components on the bench. By the time it is deployed, the **Black Hawk** will achieve the minimum service life objective of 5,000 hours on all but seven parts. The service life of these parts are close to 5,000 hours, but they are being redesigned to achieve this goal.

A significant improvement

This significant improvement over previous helicopters was achieved through over 325 individual fatigue tests. Each drive system component has undergone more than 3,600 hours of testing through the combination of bench and ground test vehicle work. More importantly, these components were tested to 25% in excess of their design ratings. Sufficient test was allowed to identify weak links and es-tablish durability characteristics which permit each component to be replaced via an "on condition" basis.

It has not always been easy. Most people would never know that the **Black Hawk's** main fuel cells had to be dropped seven times with design improvements made between each drop to meet the crashworthy requirements. Incidentally, the drop height was 65 feet with a simulated full load of fuel. It would not be possible within this article to point out all the special militarized features in terms of specific configuration requirements or more stringent design criteria. I have tried to highlight a few to give you a feel for our current qualification process, one designed to provide the most affordable combat air items for the Army Aviator.

The **Black Hawk** represented our sophomore year, and the attack helicopter will be our junior year. We long for the opportunity to be seniors and provide you with even better high-performing, survivable, durable, but affordable military aircraft.

Environmental Testing

By COLONEL WILLIAM E. CROUCH, JR.
Commander, US Army Aircraft Development Test Activity

THE **U.S. Army Test and Evaluation Command (TECOM)** tasked the **U.S. Army Aviation Development Test Activity (USAAVNDTA),** Cairns Army Airfield, Fort Rucker, Alabama, when the **Black Hawk** Project Manager requested environmental testing for the Army's new utility helicopter.

The objective of environmental testing is to provide a means of evaluating the the performance, safety, and human factors engineering characteristics of the of the UH-60A **Black Hawk** under diversified environmental conditions.

Environmental testing will be conducted to determine if the aircraft performs satisfactorily in the desert, tropic, arctic, and temperate wet winter (Northern CONUS) climatic environments. These tests are intended to supplement other development tests performed in the temperate zone on the **RAM-D (reliability, availability, maintainability, and durability)** aircraft.

The desert test, a 100-flight-hour effort, was scheduled to be conducted at **Yuma Proving Ground (YPG),** Arizona, in the June to July 1979 timeframe. Testing at YPG will determine the effects of temperature, solar radiation, humidity, and sand/dust on storage, ground handling, and operation of the **Black Hawk.** Maintenance will be performed outside in the desert environment to the maximum extent practicable. A hangar will be used only for the more complex and time-consuming maintenance operations.

Tropic environment tests

A **Black Hawk** will be taken to the Panama Canal Zone to begin an evaluation of the helicopter in a tropic environment. After arrival at the Tropic Test Center, the **Black Hawk** will be flown about 80 hours. Then, the helicopter will be maintained in a flyable storage condition.

The engines will be run three times each week during the storage period. Daily inspections will be made, and periodic oil samples will be taken throughout the tropic environment "soak" period. The inspections will determine whether or not deterioration has occurred from exposure to bacteria, fungi, and warm wet weather. The aircraft will then be flown 20 hours in the tropic environment to conclude the tropic test cycle.

The **Black Hawk** will be tested in Alaska for 100 flight hours. The test will assess operation and maintenance in an arctic winter environment. The test helicopter will be operated in as wide a range of temperatures as available. Attempts will be made to accumulate data and compare performance in ambient air temperatures between 0ºF and -25ºF to the lowest ambient air temperature available. It is anticipated that temperatures down to -40º will be experienced. The length of cold soak periods and ambient air temperatures during these periods will be recorded during each phase of testing.

Full data base sought

A temperate wet winter test will be conducted in northern CONUS. This test differs from an arctic test in that the environment approximates the northern European winter climate with extensive amounts of wet snow and freezing rain. This testing will expose problems which differ from those encountered in the extreme cold dry climate in Alaska. **USAAVNDTA** will investigate the UH-60A's operational characteristics, ground handling, effects of environmental exposure, human factors engineering, and safety on the aircraft's capability to perform its mission in this environment.

The **RAM-D** is a 1,500-hour effort primarily conducted under temperate climatic conditions for the purpose of establishing a comprehensive data base on the maintainability and supportability aspects of the aircraft. The 1,500-flight-hour effort began in March 1979 and is scheduled through March 1980, with most of the testing being conducted at Fort Rucker, Alabama.

A number of ancillary items will be evaluated using this aircraft as a testbed. These include **aircraft survivability equipment (ASE)** items; mission flexibility kits such as extended range, anti-ice/de-ice, blackout kit, and winterization kit; **test measurement and diagnostic equipment (TMDE)**; and **appropriate peculiar ground support equipment (PGSE)**.

The rigorous test schedule for the **RAM-D** aircraft consists of 1,500 flight hours in about one calendar year during which the aircraft will be subjected to desert, arctic, and northern CONUS winter conditions. The tropic exposure on the other UH-60A will round out the complete spectrum of environmental aircraft testing in a compressed timeframe. USAAVNDTA will publish the results of each environmental test.

USAAVNDTA's end product will be a comprehensive and in-depth analysis of the effects that the different environments have on the UH-60A **Black Hawk** and will complete the environmental test cycle.

This testing, in conjunction with other development and operational testing results, will verify the ability of the **Black Hawk** to perform its role in airmobility operations.

A UH-60A Black Hawk helicopter is shown in its final assembly phase on the Sikorsky Aircraft production line at Stratford, CT.

IOC FDTE: The final assessment

By COLONEL ROBERT A. BONIFACIO, President
U.S. Army Aviation Board, Fort Rucker, Alabama

PREVIOUS testing has proven the UH-60A **Black Hawk** acceptable to augment the UH-1 helicopter fleet.

Its infusion into the Army inventory reduces the related materiel acquisition process to a relatively simple question: Does the initial operational unit have the capability to operate and maintain the **Black Hawk** and accomplish its assigned mission?

Although simply stated, its answer has far-reaching implications and involves many assessments. **Operating the aircraft** assumes that all pilot training has been accomplished and deemed adequate. **Maintaining the aircraft**, to include maintenance training, implies that the entire logistics system is responsive to all supply and maintenance actions at each level of maintenance.

Mission performance concludes that the aircraft performance characteristics, configuration, reliability, availability and maintainability, combined with an acceptable **Table of Organization and Equipment (TOE)**, will permit the unit to respond to and accomplish all required missions.

The **Initial Operational Capability Force Development Test and Experimentation (IOC FDTE)** is the vehicle by which the U.S. Army Aviation Board will provide the Commander, **Training and Doctrine Command (TRADOC)** this "final assessment." While most operationally-oriented tests or evaluations are conducted to choose between two or more alternatives, the IOC FDTE is specifically designed to wring out the total integrated system while it is being sworn in to the regular Army.

A period of trial

As a soldier enters the Army he undergoes a period of trial — a time during which he learns what is expected of him and a time during which the Army determines his capacities. A parallel or analogy can be drawn between this new soldier and the new **Black Hawk** aircraft. Each has passed tests which measure the capability to perform required tasks; each has demonstrated against scientific standards that he or it meets specifications.

For the soldier we have basic and advanced individual training to measure capability. For the new **Black Hawk** a more concentrated and intensive assessment will concentrate on key issues developed by the U.S. Army Infantry School (proponent for **Black Hawk**), Health Sciences Command, the U.S. Army Aviation Center, the Transportation Center, and others who have a specific interest in the UH-60A.

This 13-week **IOC FDTE** began on 4

The portable maintenance crane has been designed to remove the Black Hawk's engines, its main rotor blade components, and its transmissions.

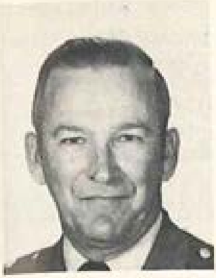
June 1979 at Fort Campbell, Kentucky, with three production model **Black Hawks** (five additional aircraft will be delivered during the **IOC FDTE**). Test Director, **Brigadier General W.C. Louisell,** Assistant Division Commander, 101st Abn Div (AASLT), and elements of "D" Company, 158th Avn Bn will fly a total of 1,536 sorties while accumulating 600 flight hours on the **Black Hawks** in support of the **IOC FDTE**.

Conditions will realistically approximate the field conditions in which the **Black Hawk** is expected to operate. The **IOC** unit manning and equipment tables realistically approximate the anticipated TO&E that will eventually be assigned 16 UH-60A helicopters.

The total involvement of the **IOC FDTE** is demonstrated by the inclusion for operational testing of the eight flexibility kits designed for the **Black Hawk.** The Medical Evacuation Kit, Blackout Curtain Kit, Air Transportability Kit, Hoist Kit, Rotor Deicing Kit, Winterization Kit, Infrared Suppression Kit, and Extended Range Kit that are designed to put the "U" into this utility helicopter will be assessed along with peculiar ground support equipment and test measurement and diagnostic equipment as they become available through production.

A critical issue in the **IOC FDTE** is the assessment of **reliability, availability, and maintainability (RAM)** of this new weapons system. Operational availability is the bottom line for the commander in the field. It is the entity that demands each element or subsystem be functioning as intended. This includes the quality of individuals and their state of training; availability of supplies and parts; quality and skill of maintenance personnel and adequacy of table of organization and equipment to support the fielded system.

We must determine the parameters of the **Black Hawk** that are associated with its operation and maintenance by soldiers trained in Army schools and flown by officers trained by civilian and military instructors. The U.S. Army Aviation Board takes great pride in accepting the responsibility of providing the "assessment" to ascertain the effectiveness of integration of the **Black Hawk** into the United States Army.



Performance Testing

By COLONEL DENNIS M. BOYLE, Commander
U.S. Army Aviation Engineering Flight Activity

WHEN the first caveman procurement officer contracted for his first delivery of **FFUMs (free flight unguided missiles,** i.e., rocks), he was faced with two problems:

a. Did the projectiles meet the specifications set forth in slate I of the contract **(Figure 1)**?

b. What were their actual performance characteristics **(Figure 2)**?

Without the answer to the first question our stone-age procurement officer would not have been able to insure that he was getting full value for his limited defense clams. Without the answers to the second question, his troops would not have the instructions to most effectively use their **FFUMs.**

And thus, it has been through the ages, until we come to the purpose of this article - to describe the way the **U.S. Army Aviation Engineering Flight Activity (USAAEFA)** is going to answer those questions for the UH-60A **Black Hawk** Procurement Officer.

Despite the fact that the **Black Hawk** has been intensively managed and exhaustively tested throughout its development, the final determination of the performance guarantees and capabilities of the production aircraft must complete the development cycle.

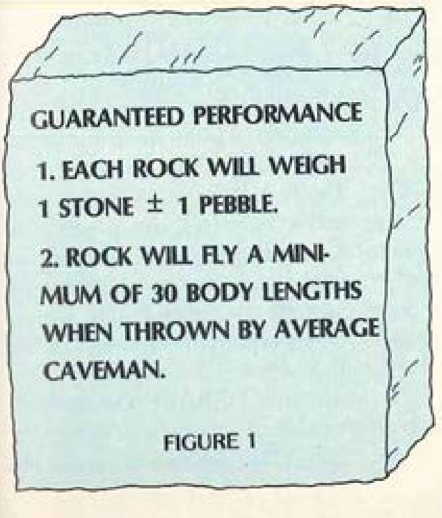


FIGURE 1

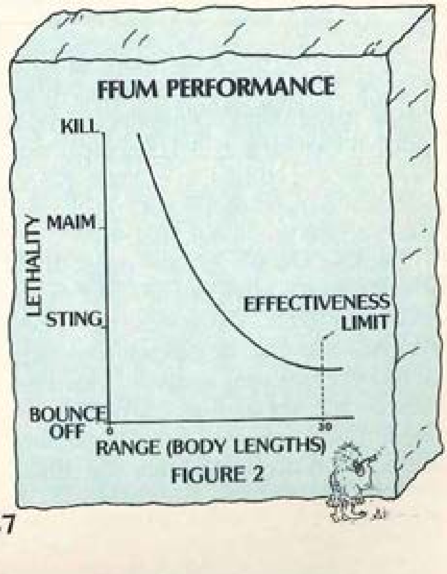


FIGURE 2

FIGURE 3 CONTRACT GUARANTEES

GUARANTEE	CONDITION	PRICE ADJUSTMENT
Empty weight will not exceed 10,900 pounds	Test production aircraft with all Gov't furnished equipment installed	Unit price times 3 times Guar. wt. divided by Actual weight minus 1
Hover gross weight will not be less than 16,450 pounds	Out-of-ground effect at 4,700 ft 95°F using 95% IRP (intermediate rated power)	Unit price times 4 times Hover GW divided by Guar. Hover wt minus 1
Cruise speed will be at least 145 knots	4,000 feet at 95°F, at design gross weight using maximum continuous power	Unit price times .5 times Cruise speed divided by Guar. speed minus 1

Right now, you're probably thinking I didn't know **Black Hawks came with** a one-year/12,000 mile guarantee." In a sense, they do, but that would be the subject of another article. However, the guarantees that interest the Procurement Officer refer to critical specific weight and performance objectives. If these objectives are exceeded, the contractor gets a bonus; if they are not met, he pays a penalty.

Consequently, these objectives are vital to the Army to insure that it gets the best possible aircraft for the tax dollar; and they are vital to the contractor, because he stands to gain (or lose) substantial amounts depending on his aircraft's performance.

The items guaranteed are listed in **Figure 3,** and include hover ceiling and cruise speed. These capabilities can provide a bonus (or penalty) of approximately $650 per pound of extra hover capacity and a penalty of $9,300 per knot of lower cruise speed per aircraft.

Because **USAAEFA** will establish the **Black Hawk's** actual performance (hover and level flight characteristics), **USAAEFA's** key roll in determining these items becomes very apparent. However, the test techniques that **USAAEFA** will use are well established and have been thoroughly coordinated with the **Black Hawk** Project Manager's office as well as with the contractor.

Hover performance will use the tethered hover technique pioneered by personnel from **USAAEFA** several years ago. The aircraft will be connected to a ground anchor by a cable of sufficient length to position the aircraft's wheels 100 feet above the ground. Gradual increases of power will then be used, each one exerting more pull on the cable.

Many factors affect results

By measuring the tension on the cable, and knowing the weight of the aircraft, the hover gross weight (aircraft weight added to cable tension) at the established power setting can be determined. Eventually, the maximum gross weight at the defined test conditions can be calculated from this data.

Unfortunately, it is not quite this simple as a number of factors can affect the results. The first of these is wind; as wind moves across the rotors, less power is required to hover at a given weight (just watch what happens as a helicopter passes through translational lift!). Consequently, winds during the test must be less than three knots.

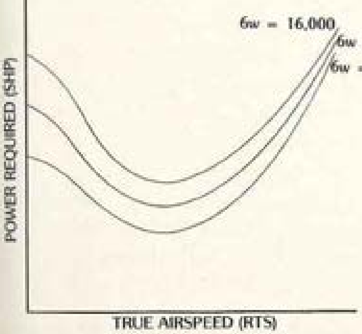
To insure this, **USAAEFA** recently obtained three wind towers with associated electronics to automatically read and record wind speeds. These towers will be set up in a triangular pattern around the hover point to insure coverage of the test area.

The second critical item is the cable angle. As angle increases, the apparent cable tension increases, producing a false hover weight for a given power setting. For the guarantee testing, the pilot will be required to achieve a cable angle of less than 2°.

He will be aided in this task by using a cable angle indicator similar to an ILS; and he will test data only when the two needles are joined in the center circle. Because of the large number of points required to verify hover performance, statistically the hover testing will be a lengthly, tedious, and time-consuming process.

Flight performance checked

The second major test item will be level flight performance. The aircraft is thoroughly instrumented to record fuel used, as well as precise rotor speed, airspeed, and altitude. By varying the altitude and rotor speed as fuel is burned, a constant thrust coefficient and referred rotor speed (related to tip mach number)



SPEED-POWER CURVE

can be maintained. By flying various forward airspeeds, a plot of power versus forward airspeed at different gross weights can be developed **(See chart on this page).** This eventually will lead to the **Black Hawk's** cruise performance at the specified test conditions.

To insure the accuracy of the results, two items are critical: Airspeed and Engine power. To precisely determine the power developed, the test aircraft's engines are calibrated by the engine manufacturer before and after testing. During the test, the performance of the engines will be monitored (fuel consumption, for example) to insure that there is no change. The data provided in this calibration will allow precise calibration of power delivered during hover and level flight tests.

Airspeed calibration

The airspeed will be calibrated in three separate ways. The first will use a ground course, where the time to travel a given distance will provide true airspeed. The second method will use a T-28 pace aircraft equipped with a calibrated precision airspeed indicator. The final method will use a multiple exposure automax camera.

Once the dollars and cents questions are settled, **USAAEFA** will move into the next area - developing performance and handling qualities data to use in the operator's manual. Have you ever wondered where the cruise charts, hover performance charts, height-velocity diagrams (dead man's curve) and such come from? They come from airworthiness and flight characteristics testing at **USAAEFA.** Exhaustive testing will define these as well as other performance capabilities, such as takeoff distance required to clear a fifty-foot obstacle, tail-rotor limitations in

The UH-60A Black Hawk is shown after an artificial icing flight

hover, cross-wind characteristics, and airspeed calibration.

One additional task performed by **USAAEFA** should be mentioned here. During all testing - performance verification testing, airworthiness testing, or any other program - the test pilots are constantly alert for any deficiencies or shortcomings which may affect the pilot or the aircraft. These faults can range from a door handle in an awkward location to the possiblity of tail rotor ineffectiveness under certain loading and wind conditions. These observations produce Notes, Cautions, and Warnings for the operator's manual; or, if severe enough, can lead to modifications of the aircraft.

One last test program currently scheduled for the UH-60A will go beyond performance into a relatively unknown area -helicopter flight in icing conditions. The **Black Hawk** is designed to operate in a moderate icing environment, thanks to blade deicing systems for main and tail rotor as well as numerous other anti-ice systems. However, the UH-60'A's capabiity remains to be proven. To accomplish this, the **Black Hawk** will undergo extensive flight in icing conditions.

The first phase will consist of flight in an artificial icing environment. The **Black Hawk** will be flown in close formation with a modified CH-47C (which sprays water to artificially form a cloud) to evaluate icing under controlled conditions of temperature and liquid water content **(See photo above).** Once the capabilities of the aircraft have been established, further flight into natural icing conditions will provide actual certification of the system.

Purpose remains the same

The whole process, from verifying the contract requirements to exploring the limits of performance, has changed considerably since our Neanderthal ancestor made his first buy of rocks. But the purpose remains the same today as it did in that long-ago time: To get the best value for one's defense clams, to buy a product that performs as advertised, and to provide that data to the user. **USAAEFA** will continue to perform this vital task for Army Aviation. ◄

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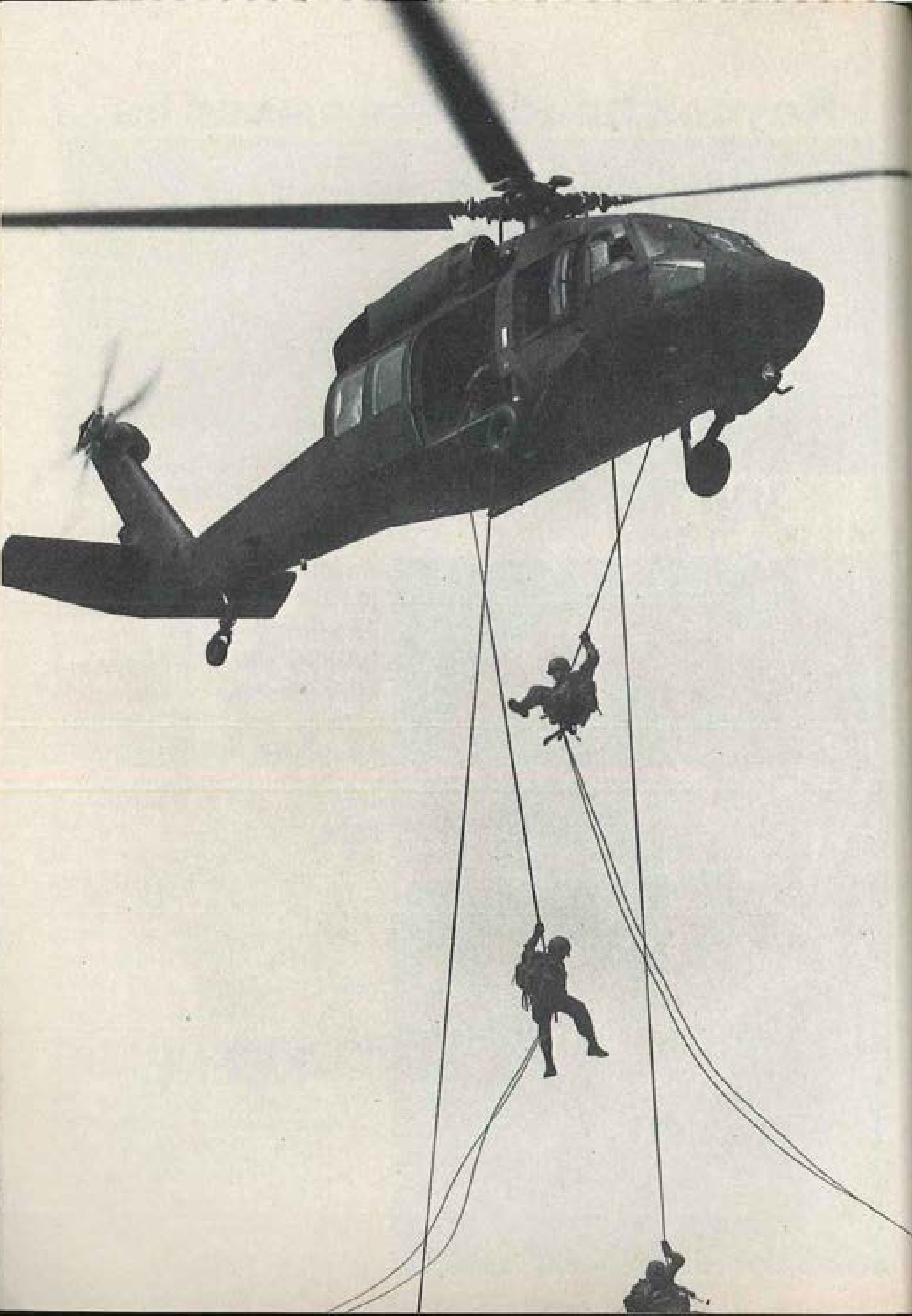

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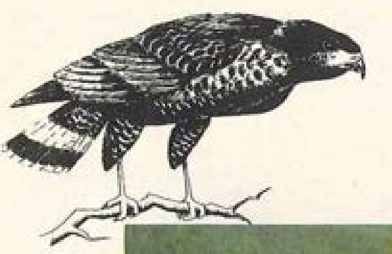

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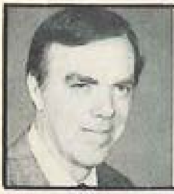

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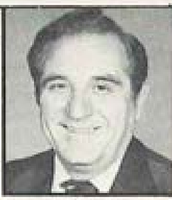

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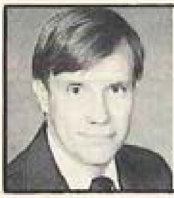

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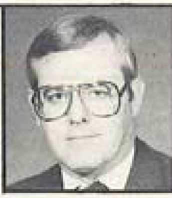

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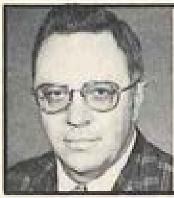

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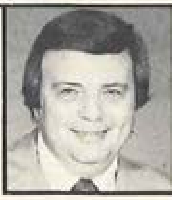

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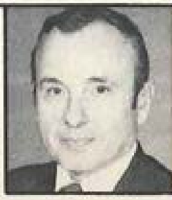

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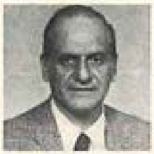

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The Army turned over four operational Black Hawks at July, 1979 ceremonies held at Fort Campbell.

BLACK HAWK MILESTONES

A 7-Page Photo Story on the Significant '73-'79 Black Hawk Events

UTTAS mock-up review conference. Sept. 1973.

UTTAS protot

First flight prototype rolls out, June 28, 1974.

MG W.J. Maddox visit

UTTAS flies October 17, 1974.

UTTAS pilots, J.J. Di

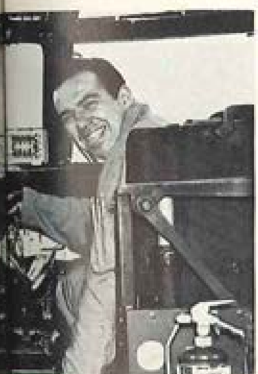
BLACK HAWK MILESTONES

nstruction. April, 1974.

Ground testing begins June 12, 1974.

th employee task team.

Employee involvement program begins, June, '74.



ight) and J.R. Wright.

Four prototypes in flight — June 2, 1975.

Army Preliminary Evaluation — October, 1975.

Tobias turns over prototypes, March 20, 1976.

Army troops fly UTTAS in competitive test phase.

C-141s take prototyp

Ft. Benning crowds a

Selection Advisory Co

BLACK HAWK MILESTONES

rmy competitive tests.

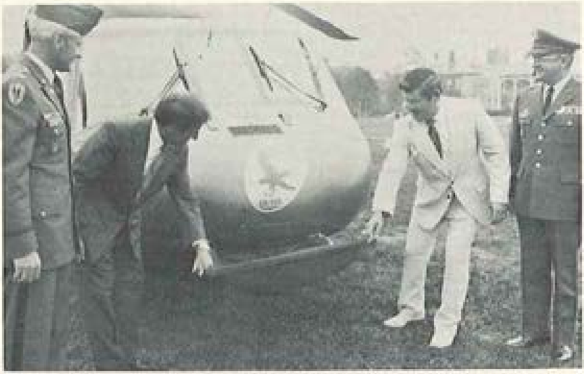
Tobias briefs crew during air transportability demo.

Sikorsky prototypes.

101st Abn crew tests UTAAS' lift capability.

hears production plan.

Tobias announces UTTAS win, Dec. 23, 1976.



Col Thorpe unveils Black Hawk emblem, Sept. '77.

First production UH-60 rolls out, Sept. 27, 1978.

Secretary Alexander gets April, 1979 plant briefing.

$129.4 million con

Cake-cutting at

Flag accompanies US

BLACK HAWK MILESTONES

signed, October, 1977.

MG Stevens lowers first fuselage onto final frame.

31 delivery to the Army.

C-5A loads UH-60 for California performance tests.

SANC deliveries, April, '79.

Army accepts oper'l Black Hawks at Ft. Campbell

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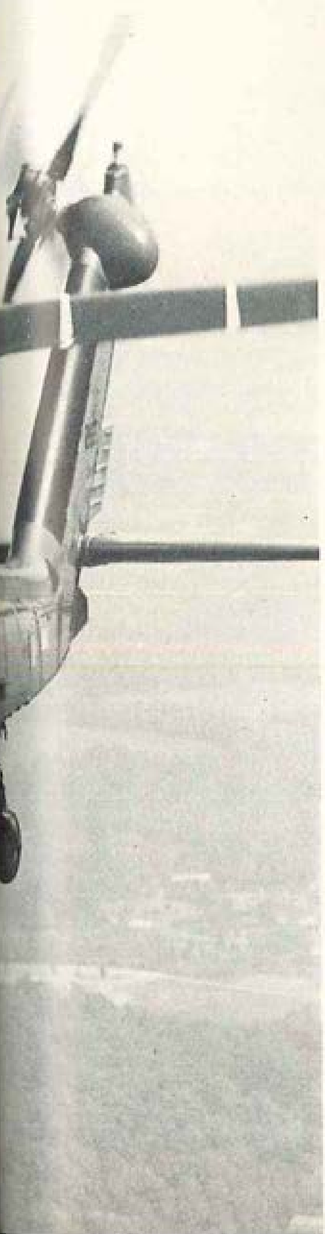

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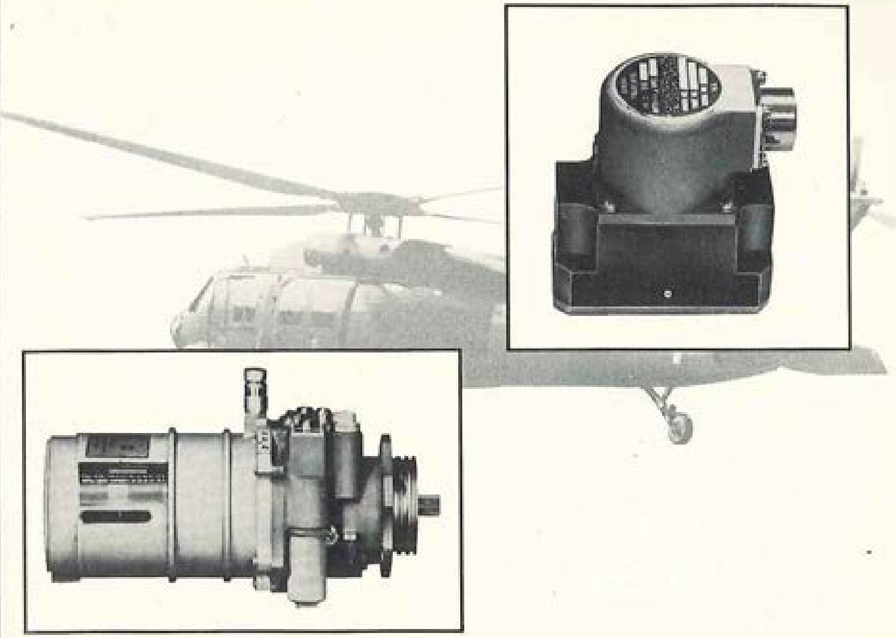

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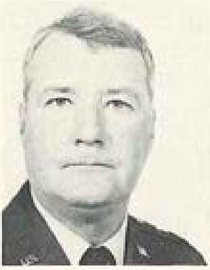


The TSM's role in fielding the UH-60A Black Hawk

By COLONEL CORNELIUS F. McGILLICUDDY, TRADOC System Manager—Black Hawk, USA TRADOC

SINCE reporting last to you in this magazine about 18 months ago, it's been an exciting and productive period for the **Black Hawk** and the relationship among TRADOC, DARCOM, and FORSCOM on fielding the system.

Let me cover a few areas briefly that highlight these inter-relationships not only between the major commands, but also Headquarters, Department of the Army.

Training

All important. The connections between development of training requirements, preparation of programs of instruction, and programming for resources are essential to training.

This has been accomplished in the last year and after the training of **Instructor and Key Personnel (IKTP)** the resident schools opened the door for mechanics training on 3 Jan 1979.

The training devices and publications to support this training were on hand and the graduation of MOS 67T (Helicopter Repairman) and the 68 series necessary to maintain the **Black Hawk** in the field has continued since that time without difficulty.

Pilot training began at Fort Rucker in April and consisted of a 15-hour transition accompanied by a ground school of 80 hours. This has also proceeded on schedule. Avionics training will begin at Fort Gordon later this year.

Combining the training at resident schools; getting delivery of training devices; using part task trainers, tools, and very, very extensive publications; and getting the people in place everywhere is a complex process but, in essence, all of this has been achieved by timely coordination among TRADOC, DARCOM, and FORSCOM.

A NETT is planned

As we point to the future we look for the formation of a joint TSARCOM/TRADOC **New Equipment Training Team (NETT).** This team will be used to train the enlisted mechanics of the 82d Airborne Division when they are issued the **Black Hawk,** and we think the same scheme will be followed when the aircraft is deployed to Europe.

As for pilots, unit Instructor Pilots will be trained at Fort Rucker, will be issued an **exportable training package** for ground school, and will then establish and conduct in-unit transition.

We're in the process of updating the **Individual and Collective Training Plan (ICTP).** The delivery of the **Instructional Systems Development (ISD)** material, which is being developed by Sikorsky Aircraft for Forts Rucker, Gordon, and Eustis, will be of great assistance in the process.

We are also in the process of developing long range training requirements to support the **Black Hawk** for the 1980's, and the initiation of a **Cost and Training Effectiveness Analysis (CTEA)** that will analyze how we're doing the TRADOC job. The **Army Readiness Training and Evaluation Program (ARTEP)** has been prepared and distributed to the field for coordination and comment.

Decision points

The **Black Hawk** still has some key decision dates, most of them surrounding an **Army Systems Acquisition Review Council (ARCSA IIIa)**, which will be held later this year.

The Project Manager for DARCOM will report on systems performance; the overall program; **Reliability, Availability, and Maintainability (RAM);** and costs. TRADOC will report on training, organization, air-transportability, the results of testing and supportability; and a sensing of user reception in the field.

Personnel

Good progress has been made here, thanks to the superb cooperation of MILPERCEN. The new MOS 67T is firmly established, and the near term requirements for the field have been announced by Department of the Army. We may have additional personnel changes when we use the **Black Hawk** to support the **Stand-Off Target Acquisition System (SOTAS)** and other requirements, and these are being studied now.

The TO&E for the **Combat Support Aviation Company (CSAC)** has been distributed in a test version to the 101st Airborne Division (Air Assault), and both TRADOC and FORSCOM will carefully scrutinize this organization to insure that the outfit has what it needs to operate in the field before finalizing the TO&E.

LOOK-SEE—LTG Harry W.O. Kinnard, Ret., a Past President of the AAAA and a previous CG of the 101st Abn Div, is briefed on the blade actuating system of the Black Hawk during the recent Nat'l Board briefings and business meetings held at Fort Campbell.

Air Assault Operations

The field manual, **FM 90-4, "Air Assault Operations,"** is now in final draft form and will be distributed to the field in January 1980. This manual provides doctrinal guidance for the training, planning, and tactical employment of all types of infantry units up through the battalion level in the execution of air assault operations.

FM 90-4 is intended as a guide for battalion commanders and staffs, and the commanders of supporting elements. It addresses the fundamentals of planning, preparation, and execution of the loading, air movement, and loading plans for air assault operations.

THE SIKORSKY AIRCRAFT PRODUCTION LINE AT STRATFORD FILLS WITH BLACK HAWKS

Testing

I'm sure this subject has been covered in other articles in this issue. Therefore, suffice it to say the Infantry School, as the test proponent, has prepared the Outline Test Plan and will submit the Individual Evaluation Report.

The cooperative coordination between the Aviation Board, the Operational Test and Evaluation Agency, FORSCOM (that provides the test unit), and DARCOM (that provides the equipment) has been excellent.

The future

Where do we go from here? . . The **Black Hawk** is a reality and hopefully the testing and decision forums will lead to production decisions that will provide the Army with a greatly improved capability to move, supply, and recover troops.

But new technology is abundantly available. This is especially true in flight control systems, information displays, power trains, and maintainability, and in our ability to reduce vulnerability and increase survivability.

The question remains as to how we can take advantage of these technologies and develop programs that integrate new systems as opposed to adding changes piecemeal without due regard to overall functions.

This is the new challenge to our TSM Office, and we intend to take the lead in this area of defining the new requirements as they pertain to the Army's airmobile capability.

The Materiel Fielding Effort

BY COLONEL JAMES R. BRIER, Asst Project Manager for Logistics, Off of the Project Manager, Black Hawk

IN the history of putting new weapon systems into the field, the record reflects some successes, some failures, and some systems that just edged through.

The basic problem with taking a system through research and development, into production, and then to the real user is that the development community lives in a different world from the real user. Certainly, we test the new system - everybody tests it, and in many locations as you'll read elsewhere in this issue.

Different employment

Though testing was an attempt to approximate an operational environment, the way the aircraft were employed was different from the missions and support posture used by the 101st Airborne (the first "real" user of the **Black Hawk**) and subsequent field units.

During all of this, we have been guided by two things: the **materiel need** document **(MN)** and the **TRADOC Systems Manager (TSM).** The MN was the Army's statement of requirements for this new aircraft and is very specific in saying exactly what the bird should be able to do and in what environment. This document was prepared by the combat developer (TRADOC) who is the "institutional user". (Standing in for all the "real users".) His voice is the TSM who gives us day-to-day guidance in how to implement the MN, e.g., what is meant by a particular requirement.

All of this testing and participation by the "institutional user" has one purpose - to provide the customer with the very best weapon systems consistent with the requirement. The requirement stated in the MN and by the TSM is a generic one, in that it is intended that the **BLACK HAWK** satisfy all of the requirements for a new utility helicopter for all Army units. The aircraft has not been tailored to fit the specific requirements for any one commander; however, it is capable of being tailored to suit those needs.

In the fielding of several past systems, there was a breakdown "where the rubber meets the road", where the commander is given new aircraft and must fit them into his operational structure to accomplish his mission. To bridge the gap between the test world and the real world for a newly-fielded system, DARCOM uses a materiel fielding concept to insure customer satisfaction. This program consists primarily of the **materiel fielding plan (MFP),** a management and control document, and the **materiel fielding team (MFT),** who are the operational executors of the MFP.

The **Black Hawk** MFP is the document which brings together all of the elements of support to show exactly how the bird will be supported when it hits the field. It explains the supply and maintenance concepts, requirements for peculiar tools and support equipment, publications, and all the other elements of logistics support which must be orchestrated to "make it all happen".

It also explains how the **Black Hawk** is different from other aircraft. Examples of this are: airframe, engine, and avionics warranties; use of the component record for intensive management in lieu of DA Form 2410, on condition vs TBO, modular concept; different oil sample requirements; and many other items.

Tailored support

Perhaps the most important part of the MFP is the **statement of quality and support (SOQAS)** which is DARCOM's guarantee to the customer stating exactly what support DARCOM will provide and what period that support will cover. The SOQAS is tailored for each deployment and must be agreed to in writing by the customer. In the SOQAS, a target date is established for all the logistic support to be operational on site before the aircraft arrive.

The customer should resonably expect that all of the repair parts, tools and support equipment, publications, technical assistance, and properly trained pilots and maintenance personnel will show up on site, at the proper time and in the proper quantities, and that a system will exist to support his future needs in all of these

LET US HEAR FROM YOU!
The "theme" issues of Army Aviation provide a comprehensive, in depth view of single subjects — in this instance, the Black Hawk. We'd be interested to know your thoughts on this editorial approach.

areas. The **Black Hawk** Project Manager and specifically the Assistant Project Manager for Logistics and the MFT are the ones responsible to bring this all together and be fully operational "as advertised". This is the culmination of many years of effort by a great team of people from DARCOM, TRADOC, FORSCOM, HQDA, and the contractors.

The true test

When we deliver the support package with the aircraft, it would be nice to think that they would operate together without any problems. Nice, but very naive! From all of the testing, we know a great deal about the aircraft and its support requirements, but we have not verified the production article in an operational environment.

The only way we will begin to find out how good or how poorly the system will perform is to deliver it to the 101st Airborne Division and let them use it. When problems arise, it will be the MFT that will provide on site assistance and will begin the cycle which will result in generic changes to the aircraft and its support system.

First, let's look at the MFT and see what resources are available. Presently, there are two teams, one for Fort Rucker to support **U.S. Army Aviation Center (USAAVNC),** and ADTA test aircraft, and another team at Fort Campbell to support the 101st Airborne Division. The team chiefs, maintenance technician and all of the contractor representatives have worked on the **Black Hawk** for an average of four years and matured with the system during the developmental and operational testing done in 1976.

The purpose of the MFT is not to fix the aircraft when it breaks - it is to identify the problems and "fix" the system. For example, when the mechanic finds that he cannot repair the aircraft by following the steps outlined in the maintenance manuals, the MFT will sort out what the problem is and assure DA 2028s are properly documented to make the required input to the publication system.

Hopefully, there will not be much of this as most of the tests in the maintenance manuals have been "verified" by the Army through previous demonstrations to confirm that the steps are called out correctly and that the required tools and support equipment are properly noted. What if there is a design problem? Maybe a door latch is not holding up under field use like it did during the tests. The MFT will document the problem and through the **Black Hawk** PMO channels get the contractor started immediatley in designing a hardware change to fix the problem. Maybe a requisition will be rejected by the supply system because of a superceded part number or because of improper coding of the requisition.

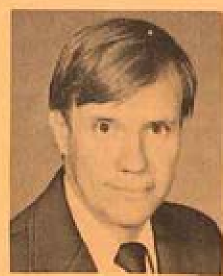
The contractor logistics representative will help sort out what the problem is so that the unit can get its part, but more important, he will recommend changes to **Black Hawk** PMO/TSARCOM to correct the system so that the other users will not experience this problem. The MFT will also provide additional training when necessary. For example, maintenance test pilots are being trained by the MFT until the course at **U.S. Army Transportation School (USATSCH)** become operational.

Non-skid walkways are provided on the forward crown area to facilitate maintenance for the hydraulic flight control, electrical, and heating systems. Hand-holds and steps are also provided to climb to the top of the BLACK HAWK safely.

PMO contact maintained

The team stays in constant contact with the Project Manager's Office, contractors and test sites to stay current on newly discovered problems and to find answers to the many questions which arise when a unit gets new equipment, especially a major system like the Black Hawk.

The objectives of all of this effort are, first, to insure that the system operates satisfactorily in the first unit; second, to tailor the system to meet the particular needs of that major unit. The third and most important objective is that after the MFT packs up and departs for thier next station, the **Black Hawk** will continue to perform well in the hands of the real user - "where the rubber meets the road".



Reliability, Availability Maintainability

By JOHN C. WALKENHORST, Chief, Product Assurance & Test Management Division, Office, PMO, Black Hawk

THE military, and especially the Army's **Black Hawk** PMO, has been placing a great deal of emphasis on the aircraft's ability to perform without failure; and should a failure occur, the ability to quickly and easily restore the aircraft to a flight status is a must.

With this in mind, the Army developed an in-depth plan early in the '60's to encourage the prime contractor and its vendors to develop the technology and technique required to improve the **Reliability, Availability, and Maintainability (RAM)** characteristics of the Army's new utility aircraft for the 1980's.

A relatively simple problem

At first glance, the idea to improve **RAM** appears to be a relatively simple problem. The prime contractor has at its disposal a host of reliable componentry that could achieve extended life, but they are either too costly, too heavy, too slow, or too difficult to produce. Immediately, the system planners were required to establish priorities, and as expected in today's environment, system design to cost received the highest priority.

Naturally, the performance of the new system to replace the existing UH-1 fleet would be the **Number One priority** from a technical viewpoint. After these two very important priorities were in place, the decision was made to make the **RAM** issue the **Number Two priority** technically. Because this was the highest priority ever assigned to a **RAM** program, it gave the **RAM** community a rare opportunity to influence the design on a new helicopter system.

Immediate action

Once this priority was established, immediate action was taken to develop the design concept and requirements that would then be imposed on the prime contractor. The maintenance concept and **RAM** requirements were developed by a diverse group of Army personnel experienced in field operations. Army Green Suiters, along with civilian counterparts, working with the existing aircraft were active in defining problems that could be avoided on the **Black Hawk** system.

The technical expertise from the Army's Laboratory, Development Command, Training and Doctrine Command, and the Depot were very active in quantifying the **RAM** improvements necessary to assure that the UH-60A was going to be truly reliable and easy to maintain. As a result, the **RAM** requirement issued to industry in late 1972 included a variety of **RAM** quantitative parameters.

Just to highlight a few, there was a system **mean-time-between-failure**

(MTBF) of four hours, mean-time for removal of major dynamic components of 1,500 hours, the total maintenance man-hours per flight hour of 2.8 hours for fault corrective, and the scheduled maintenance manhours per flight hour was not to exceed one hour. Another very important aspect of the **RAM** program was the qualitative requirements. Simply stated, these are the day-to-day maintenance problems that have plagued the mechanic working on current Army aircraft.

High on this list of desirable qualitative **RAM** characteristics were the elimination of safety wire, sight gauges that are easily read on all components that require routine servicing, the elimination of the need for maintenance stands and platforms, and Go-No-Go maintenance indicators on Safety-of-Flight equipment. This composite of quantitative and qualitative **RAM** requirements, if achieved, would represent a significant improvement over any existing aircraft in the Army's inventory in the **Black Hawk** class.

A greater challenge

These requirements became even moe of a challenge to industry, due to the improved performance requirements being requested by the Army tactical planners. They were requiring the aircraft to have an increased payload, improved crash survivability, improved vulnerability, not to mention being able to fly faster, higher, on hot days and in all weather conditions. All these requirements led to increased complexity in the design of the **Black Hawk.**

As the **Black Hawk** design evolved and the engineers, draftsmen, logisticians, and critics battled tooth and nail over the detail design, it became apparent that the need existed for an accurate accounting of the maintenance actions required for the fledgling aircraft. Although most experienced Army management personnel are very knowledgeable in the field of systems maintenance characteristics, very little accurate **RAM** data existed on previous development programs.

Along came RAM/LOG

With support from the Army-wide technical community, a dedicated data gathering and reporting system called **RAM/LOG** was developed. **RAM/LOG** uses data gathered by Green Suiter specialists, whose sole task is to observe and record all test and test-related activities. Special **RAM/LOG** forms are used. Data recorded includes skills, tools, echelon, elapsed time, man-minutes, and the support equipment utilized in performing the maintenance action. At the end of each day, the Team Chief and Shift Supervisors check the **RAM/LOG** forms to verify the data.

The data is then translated into key-punched computer cards. The **RAM/LOG** data is scored, using a very definitive set of scoring criteria, and then sent to TSARCOM in St. Louis. The data is again validated, using computer editing and validation routines prior to being added to the **RAM/LOG** Master Data Base. The data is then used to evaluate the achievement of the **Black Hawk** towards meeting the **RAM** requirements.

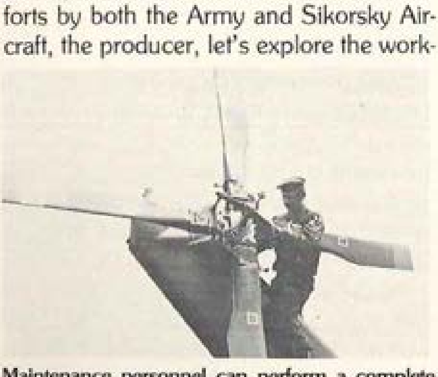
RAM shortcomings found during the Government Competitive Test and the Maturity Phase were analyzed by Sikorsky and Army personnel to ensure that corrective actions were incorporated into the production design. In support of the corrective actions, numerous design tools were used. These tools included failure analysis, maintenance demonstrations, special function and fatigue testing, mock-ups, and design reviews.

In addition, a quarterly technical review was conducted with Sikorsky's design team to review the problems identified and ensure that corrective actions were being taken.

As the production **Black Hawk** goes through the initial fielding and the final phase of user field testing, the accomplishment of the **RAM** effort will be fully evaluated. The main thrust of the early deployment test will be to ferret out any remaining **RAM** shortcomings, brought about by the transition from a prototype to production UH-60A **Black Hawk**. Although considerable emphasis has been placed on the **Black Hawk RAM** characteristics, it is a sure bet that problems will occur. These have been anticipated in the planning process of the production **RAM** program, along with the warranty program for the major dynamic components of the aircraft and the T700 engine.

To maximize the benefits of these efforts by both the Army and Sikorsky Aircraft, the producer, let's explore the workings of both efforts. First, the production **RAM** program will be a joint venture between the fielding team, the **Black Hawk** PMO, and Sikorsky. This effort amounts to flying the aircraft extensively to test the durability of the systems. As a component or subsystem fails, or maintenance is required to restore an aircraft to flight status, these actions will be recorded on **RAM/LOG** data by the same data collectors who performed the same function in the factory environment.

In addition, field commanders and maintenance personnel will be required to routinely provide the normal field reporting required on all fielded systems. Upon completion of the controlled **RAM/LOG** data collection, a comparative analysis will be performed by the **RAM** community to determine the optimum field reporting required to support the **Black Hawk** as the production run progresses.



Maintenance personnel can perform a complete inspection on the tail rotor without the aid of maintenance stands. Also, all components can be removed and replaced with the use of a special maintenance crane (See opp. page photo) which is part of the aircraft's fly-away equipment.

Taking corrective action

At the same time, Sikorsky will be monitoring and taking corrective action on all failures, especially those requiring improvement in the aircraft design. These improvements will be pursued via the engineering change proposal, correction of deficiency clause, or Warranty Program, depending on the type and nature of the failure.

Let's explore the second main thrust of the **RAM** production effort, the **Warranty Programs.** The **Black Hawk** Project Manager received direction from every echelon of the DOD, requiring the contractor provide a warranty to ensure achievement of the **RAM** goals. As a result, during the first three operational years of the **Black Hawk** fielding, a warranty will be in place on the major dynam-

SIKORSKY FAMILY DAY — On a brisk September day in 1974 Sikorsky employees took a close look at their UTTAS entry, the UH-60A, the eventual winner of the two-company UTTAS competition.

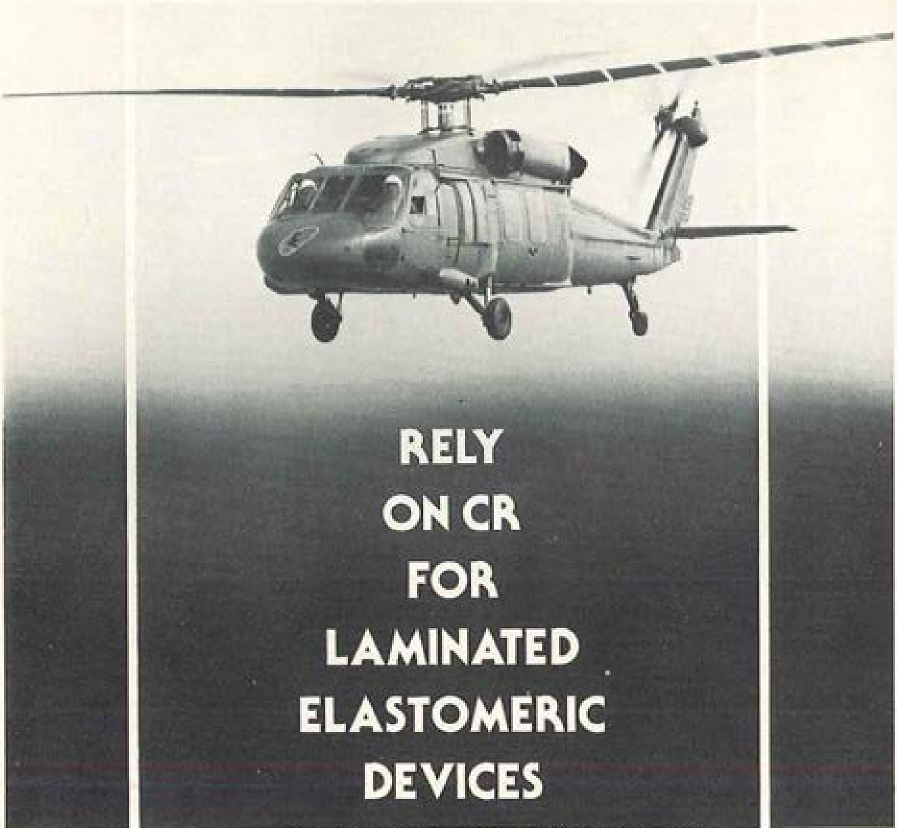
ic components of the aircraft, provided by Sikorsky, and T700 turbine engine, provided by General Electric.

These warranties will cover all maintenance required for depot repair, excluding those maintenance actions not directly under the control of the contractor. Exclusions include such items as battle damage, maintenance error, operation outside prescribed limits, etc., which are beyond the control of the producers. Via the use of the warranty clause and the contractor's requirment to perform the depot repair function, the stage is set to resolve any major fielding problem requiring depot maintenance on the **Black Hawk** system.

The production **RAM** program and warranty effort should ensure the Army of an early maturing of the **Black Hawk** system, thereby becoming a truly reliable and easily maintained aircraft. In summary, the **RAM** effort by the Army development community and industry will be directed toward meeting the challenge provided by the present and past **Black Hawk** Project Managers.

That challenge is, and will continue to be, to produce a weapons system that can effectively counter the potential enemy's numerical superiority, and to produce them at the lowest possible life-cycle costs as relates both to money and manpower. This challenge does not only apply to both contractors, it also applies to Army management, and to weapons system operational and support personnel.

Superior technology, **superior** skills, **superior** survivability, and **superior RAM** are, and must be, our front lines — and they must be vigorously pursued in the fielding of the **Black Hawk.**



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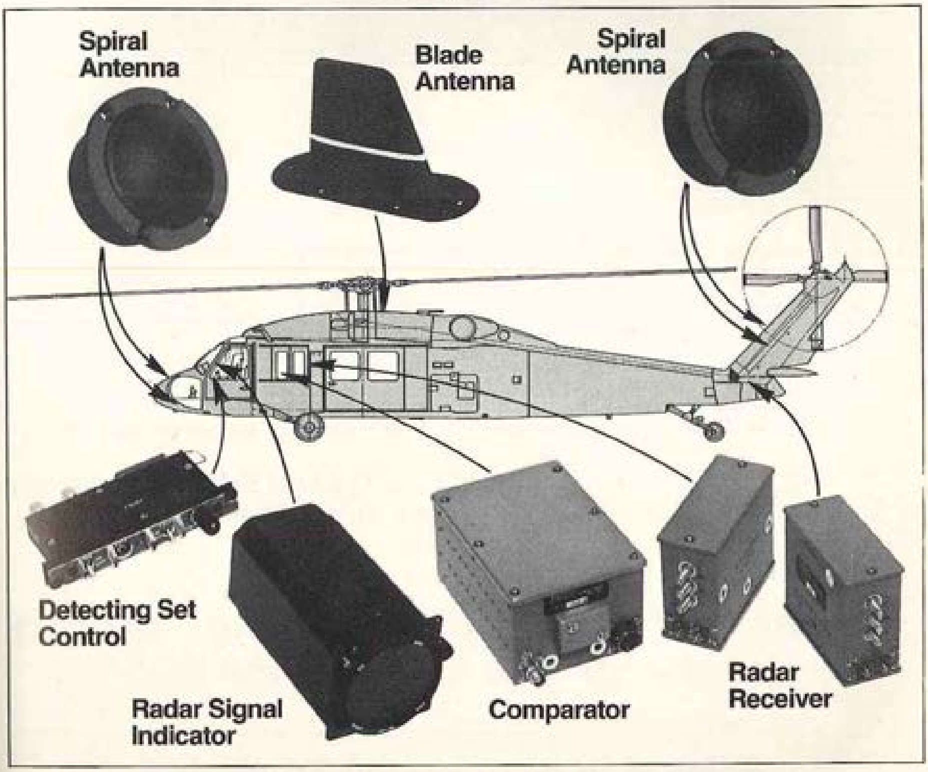

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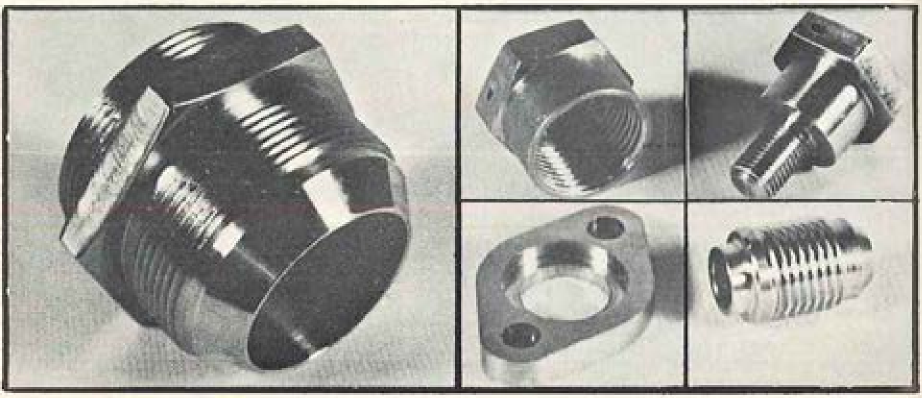

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Sikorsky's Black Hawk flies with Sperry's ASN-43 Compass System.

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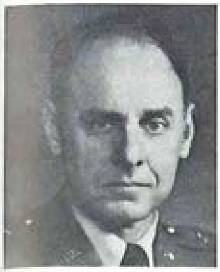


Black Hawk Flight Training

BY MAJ. GEN. JAMES H. MERRYMAN, Commander, U.S. Army Aviation Center and Fort Rucker, Alabama

THE **Black Hawk** is here, and we at the United States Army Aviation Center are proud to be training pilots and instructor pilots in the Army's newest helicopter.

Preparation for the **Black Hawk** flight training courses began several years ago. Since the UH-60A is a totally new aircraft with advanced systems, a completely new training program had to be developed. Over the past few years, much time and effort has been expended in developing a flight training program that will fully qualify pilots in flying the aircraft and understanding the systems that make up the UH-60A. On 26 April 1979, the culmination of those efforts was realized when the first UH-60A **Aviator Qualification Course (AQC)** began.

Black Hawk flight training is available to commissioned and warrant officers assigned or on orders to a TOE/TDA position requiring UH-60 qualification. These aviators must also meet the prerequisites of the course, as outlined in DA Pam 351-4. Two UH-60 courses are being taught at the Aviation Center: The AQC, and the **Instructor Pilot Course (IPC).** The annual training input for the AQC and IPC will be 255 and 35, respectively.

Aviator Qualification Course

The Aviator Qualification Course is four weeks in length with 15 hours of dual flight instruction consisting of transition flight training, instrument flying, and night operations.

The transition portion of the course consists of those tasks normally associated with transition flight training; such as hovering flight, take-offs, approaches, and airwork. An important part of any transition course is emergency procedures training. In the UH-60 Aviator Qualification Course, training in single engine operations, hydraulic system failure, automatic flight control system failure, stabilator failure, along with numerous other emergency procedures, is conducted.

Because the **Black Hawk** is a two-pilot aircraft and the co-pilot has specific responsibilities during normal operations and emergency procedures, training is conducted in both the right and left seats of the aircraft.

Training in carrying external loads up to 7,000 pounds and internal loads that bring the aircraft up to its maximum gross weight is performed to acquaint students with the different handling techniques of the aircraft.

The Doppler Navigation System is the **Black Hawk's** primary tactical navigation system. Therefore, in order to gain the maximum training time available on this system, use of the doppler is made daily concurrently with other training such as navigation between the basefield and training areas, terrain flight operations, external load operations, and confined area and pinnacle operations.

Instruction on the command instrument system is conducted in dedicated flight training periods and also, as with the doppler, concurrently with other training primarily upon return to the basefield from the training area.

Night operations include normal maneuvers, external loads, radio navigation, formation flying, and use of the doppler.

Academic training consists of 71 hours of instruction covering aircraft systems familiarization, the command instrument system, the doppler navigation system, and aircraft survivability equipment. The first seven days of the course are devoted solely to academics and then throughout the remainder of the course, half of the training day is spent in academic classes.

BELOW: The Army's UH-60A Black Hawk arrives at the USAAVNC, Fort Rucker, Ala.

Aircraft systems familiarization training provides the students with a working knowledge of those aspects of aircraft maintenance and systems operations that pertain to the safe operations of the aircraft. Beginning with a general overview, instruction is received on electrical systems, mission equipment, engines, fuel systems, powertrain, rotor system, hydraulic and flight control systems, automatic flight control systems, weight and balance, and malfunction analysis.

Instructor Pilot Course

The **Black Hawk** Instructor Pilot Course is four weeks and four days in duration, consisting of 20 hours of dual flight instruction. In actuality, the course is a four-day add on to the aviator qualification course, since sutdents in the IP course receive the same training as qualification course students during the first four weeks. The last four days and five flight hours are devoted to method of instruction training.

Because the UH-60 will replace UH-1's in designated units, the present unit IP's should continue to be IP's once the **Black Hawk** is received in order to capitalize on their knowledge and proven instructor abilities. Therefore, aviators attending the instructor pilot course must be current, school-trained rotary wing instructor pilots.

Training devices/simulators

To insure that our students receive the most effective training and understand completely the operation of the many systems, numerous training devices have been developed to support and enhance

101st Airborne Division Flight Instructor CW3 Mike Hutson explains Black Hawk engine preflight procedures to CPT Dickson.

Academic instructor, SSG Richard Christensen, briefs CWO's Williams and Hier of the 101st Airborne Division on operation of the T700 engine.

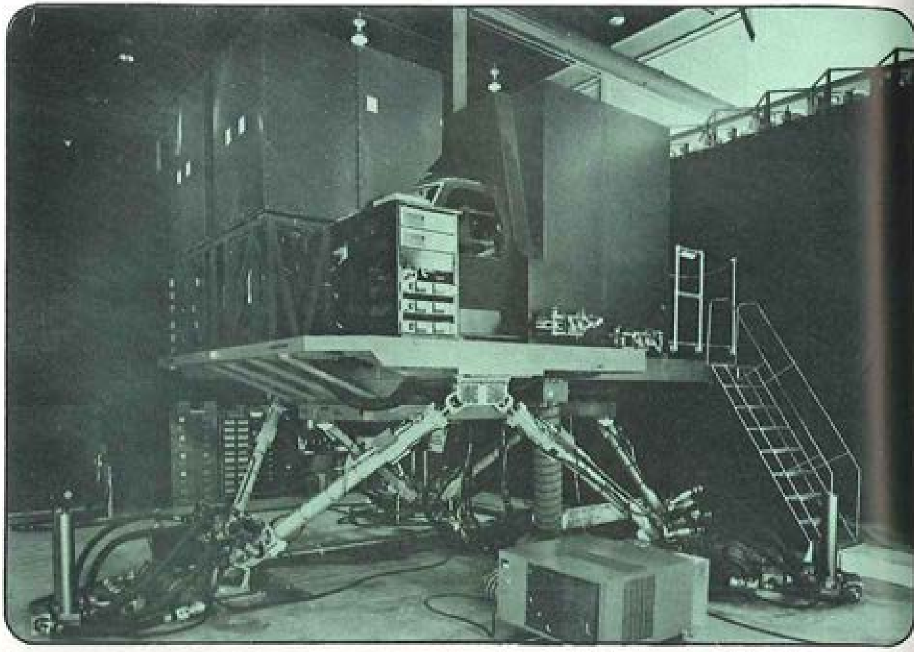
academic training. Some of these devices are on hand, while others are presently being constructed. All will be in operation by 1 October. The training devices are as follows:

- **T700 Engine Simulator:** A backlighted, programmable engine simulator trainer designed to teach engine operation, multiengine management, malfunction analysis, corrective actions, and emergency procedures.
- **Electrical Systems Trainer:** Backlighted, programmable trainer designed to teach operation, malfunctions and corrective actions pertaining to the AC and DC electrical systems.
- **Hydraulic System Trainer:** Backlighted, programmable trainer designed to teach operations, malfunctions, fault isolation analysis and emergency procedures pertaining to the aircraft's hydraulic system and related flight control/stability augmentation systems.
- **Fuel System Trainer:** A backlighted trainer designed to teach operatons, malfunctions, and corrective actions pertaining to the fuel system.
- **Composite Trainer:** A programmable composite trainer consisting of three separate display panels: a cockpit panel, flight control panel, and powertrain panel. The trainer is designed to teach operations, malfunction analysis, corrective actions, and emergency procedures pertaining to the powertrain and flight controls.
- **Flight Simulator:** A prototype flight simulator is being developed to support qualification and instructor pilot training. The simulator will have two cockpits with visual displays and will be capable of normal maneuvers and emergency procedures;. but, unlike the current UH-1 simulator, which is primarily an instrument trainer, it will also allow aviators to train in NOE flight and external load operations under the added realism of hostile fire directed at the aircraft.

The simulator is scheduled to be ready for training in October 1979. DT/OT II is scheduled to be conducted at the Aviation Center from October 1979 to April 1980. This will determine the optimum aircraft to flight simulator mix and which visual system should be procured for production flight simulators. Students attending qualification and instructor pilot training during DT/OT II will participate in the tests.

Training in the future

The Army's plan for conducting



Flight Training

(Continued from Page 113)

UH-60 training is contained in the TRADOC UH-60 Individual Collective Training Plan. This plan calls for all UH-60 aviator qualification training and instructor pilot training to be conducted initially at the Aviation Center.

However, when this plan was approved by Department of the Army, it was recommended that consideration be given to exporting UH-60 qualification training to the field as soon as possible. In keeping with this guidance from DA and the TRADOC philosophy of "training the trainers", plans are to conduct the qualification course at the Aviation Center until September 1980 when an exportable training package will be fielded.

With Aviation Center trained instructor pilots and the exportable training package, an institutional quality qualification course can be conducted in the unit. The fielding date of the exportable package is based on the need for USAAVNC to validate the courses and to make any refinements that may be needed.

At the same time qualification training is exported to the field, the instructor pilot course will be re-designed to permit UH-60 pilots to return to USAAVNC for instructor pilot qualification.

The Aviation Center is prepared to present the best flight instruction available to Army Aviators on this new aircraft. We welcome any inquiries or suggestions that you may have on our **Black Hawk** Training Program. The USAAVNC point of contact on the UH-60 is the Training Management Division, Directorate of Training, Autovon 558-3603/3217.

Black Hawk Aircraft Maintenance Training

BY MAJ. GEN. OREN E. DEHAVEN, Commanding General, U.S. Army Transportation Center and Fort Eustis, Va.

TO dream of the day when the Army aircraft inventory has the world's most sophisticated, reliable, and mobile utility helicopter and then building that sterling dream into reality is a tremendous engineering accomplishment. To make certain that such an aircraft stays in the air to perform its assigned missions is a comparable challenge!

The **Black Hawk** is the tremendous engineering accomplishment; performing the maintenance needed to keep the aircraft flying is the challenge.

The U.S. Army Transportation School is the TRADOC proponent for Army aviation maintenance training and doctrine. This responsibility includes training and educating the managers of aviation maintenance personnel and materiel. Appropriate members of the School faculty have been trained at the Sikorsky factory and are now engaged in working closely with contractor personnel in developing training programs.

Training aircraft maintenance soldiers to work on the UH-60A **Black Hawk** involves six **Military Occupational Specialties (MOS)** and eighteen skill levels. Transition training for helicopter repairers in the field will provide additional personnel in MOS 67T, Tactical Transport Helicopter Repairer.

Aircraft component repairers with the following MOS will be trained to maintain the **Black Hawk.**

68B, Aircraft Engineer Repairer (T-700 turbine engine).

68D, Aircraft Powertrain and Nondestructive Test Repairer.

68F, Aircraft Electrician.

68G, Aircraft Structural Repairer.

68H, Aircraft Pneudraulics Repairer.

All skills trained for the **Black Hawk** will be applicable for the three levels of aircraft maintenance; viz., **aviation unit maintenance (AVUM), aviation intermediate maintenance (AVIM),** and aviation depot maintenance.

During the timeframe of development and operational testing of the prototype helicopters, but before the Government selection of the **Black Hawk,** TRADOC was exploring new training techniques, systems designs, and the whole spectrum of educational technologies used in the private sector, universities and other Government agencies. Out of this scientific researching came a model for developing instructional systems that apply to institutional (resident) and exportable (nonresident) training sites. This means that soldiers performing **Black Hawk** maintenance will have been trained under a scientifically constructed model; that model is known as instructional systems development (ISD). It consists of five phases: I-Analyze, II-Design, III-Develop, IV-Implement, and V-Control or Evaluate.

Phase I is concerned with identifying jobs and tasks which make up those jobs. For example, what tasks must a 68B repairer perform to adequately carry out the requirements of maintaining an aircraft engine? Phase I explores the entire area of engine maintenance and identifies all tasks.

As a further assist to training management, Phase I compiles tasks into two groups: tasks not selected for instruction and tasks selected for instruction. Performance standards are established for instruction-selected tasks and the most suitable instructional setting for each task is determined.

Since authoring this article, General DeHaven has been assigned as CG of the Army's Logistics Center. BG (P) Harold I. Small, a veteran Army Aviator, has replaced General DeHaven as CG, US Army Transportation Center & Fort Eustis.

Phase II concerns design of the instruction; i.e., conversion of each selected task into a terminal learning objective. These objectives are then analyzed to determine subelement learning objectives and the learning steps needed to master the objectives. Tests are designed to match learning objectives, student samplings are tested to insure that entry behaviors match the level of learning analysis.

Developing the instruction

Finally, a sequence of instruction is designed for the learning objectives. Developing the instruction (Phase III) entails how the instruction is to be packaged and presented to students; selection and development of instructional materials including a try-out of these media (validated); and considerations of training setting criteria, costs, and media characteristics.

Phases IV and V follow typical procedures for presenting the instruction and then obtaining feedback from the users of the product (commanders of students approximately one year after course completion). Feedback includes an analysis of selected tasks to discover omissions or inclusions of tasks deemed essential to the job or are not really essential to job perfor-

mance. Phase I and II require enormous amounts of time. In order to get the **Black Hawk** maintenance training program moving, Sikorsky Aircraft personnel provided technical expertise in assisting the Transportation School's efforts to apply the ISD model to the **Black Hawk,** and developing an appropriate course of instruction.

They accomplished a blueprint of Phases I and II at a time when the Transportation School was initiating efforts to use the ISD model. This action will aid the School for a two-year period while it develops Soldier's Manuals, **Skill Qualification Tests (SQT),** and Commander's Manuals. In addition, Sikorsky provided initial key personnel training (IKPT) of the teaching and managing cadre.

Preparing training for personel assigned to **Black Hawk** units, aviation intermediate maintenance units, and depots is proving to be an exciting program. Initial classes for 67T began 3 January 1979 using a composite trainer which features easy access to actual aircraft hardware. These classes are for personnel assigned, or to be assigned, to units programmed to receive the **Black Hawk** in the near future. The first self-paced course for MOS 67T10 (mechanic's helper) is programmed to start during April-June 1980.

All of these actions are ties into a remarkable period of Army aviation; aeronautical and mechanical technology when married to technological advances in the fields of education and training produce products that strengthen our fighting posture and reinforce our logistical support programs.

HILSMAN

GRACEY

UH-60A Avionics Maintenance Training

By MAJ. GEN. WILLIAM J. HILSMAN, CG, and BOWDRE T. GRACEY, Avionics-SATCOM Dept. U.S. Army Signal Center & Ft. Gordon, Georgia

IMAGINE yourself looking over the shoulder of a helicopter pilot on a combat mission. A fault indicator lamp flashes on the cockpit panel, telling the pilot a malfunction is about to degrade the performance of the helicopter.

Surprisingly, the aviator watches calmly as other fault indicators light up. This aviator knows how to select backup systems and limit the progress of the condition, allowing the mission to continue.

This pilot's aircraft, the UH-60A **Black Hawk** helicopter, is equipped with a fault isolation feature which identifies potential failures and allows corrective action. This new aircraft, with its five avionics systems, has changed avionics instrumentation, and it is now changing our avionics maintenance training as well.

First, let's identify the five avionic systems in the **Black Hawk.** Flight stabilization is provided by the **Automatic Flight Control System (AFCS).**

For standard navigation, the **Black Hawk** has a common-user civil airways instrument flying system consisting of a very high frequency omnidirectional ranging, localizer, glideslope, and marker beacon.

For special navigation, the helicopter is equipped with a doppler tactical navigation system incorporating position fixing (continuous present position digital map position readouts), range, and leading to destination. Also available are **automatic direction finding (ADF)** and VHF/FM homing.

Flight identification is provided by a crypto-secure selective identification friend-or-foe system.

Three-radio arrangement

The helicopter's communications system is made up of three radios: one VHF/AM radio to net with armed escort helicopters; one UHF/AM radio to net with other aircraft in airmobile operations and with **air traffic control (ATC)** facilities; and one VHF/FM radio and provisions for a second radio to net with ground units and command frequencies simultaneously (a command instrument system). The aircraft also has intercommunications for the crew.

Additionally, the helicopter is wired for the interconnection of all on-board radio sets for retransmission of incoming messages. It is also equipped with preinstalled ducting to accommodate cable runs, should an aircraft be required to carry unique avionics circuitry.

At the U.S. Army Signal Center we are adapting our avionics maintenance training to meet the challenge of the advanced design of the **Black Hawk.** The tables which follow show at a glance the equipment currently being taught and the additional equipment which will be added to our avionic courses.

Our basic course (14-week's duration) is **Avionic Mechanic,** MOS 35K10, which trains the soldier to perform **Aviation Unit Maintenance (AVUM)** on tactical aircraft communications, navigation and flight control equipment installed in Army aircraft.

Simulator maintenance

For soldiers with assignments to **Black Hawk** units, a three-week functional course, **UH-60A Black Hawk Avionic Mechanic,** 102-F44, will be given to provide maintenance training on the AFCS. This course will use the A11H75 and A11H76 training simulators.

The simulators will allow the student to perform step-by-step fault isolation procedures on the components and wiring harness of the AFCS. Graduates of the 102-F44 Course will be awarded a skill identifier to the 35K10 MOS. **Black Hawk** field units can send their MOS 35K10 personnel to the Signal Center for functional training on the AFCS as required.

The **Avionic Communications Equipment Repairer Course,** MOS 35L20, a 22-week course, trains the repairer to perform **Aviation Intermediate Maintenance (AVIM)** on aircraft communications equipment. No adjustments are required to this course since all **Black Hawk** communications systems are currently taught. Many aircraft, both fixed-wing and rotary, use the same avionic systems for communications.

PV1 Charlie Roberts tests the radio set AN/ARC-164A, the UHF transciever in the UH-60A.

The **Avionic Navigation and Flight Control Equipment Repairer Course,** MOS 35M10, A 24-week course, trains the repairer to perform **Aviation Intermediate Maintenance (AVIM)** on aircraft navigation and flight control systems.

The **Black Hawk** equipment that will be added to this training program in 1981, when the Army will take over the maintenance responsibility from the manufacturer, includes training on the Radio Receiver AN/ARN-123(V) and the Automatic Flight Control System.

AVIM training

AVIM training will be provided in a six-week functional course known as the **UH-60A Black Hawk Automatic Flight Control System Repairer Course,** 102-F45. The AFCS training simulators will be used to teach the tasks of operating and troubleshooting the AFCS, and a bench test set or a composite trainer will be used to train AFCS alignment. A skill identifier will be awarded to the 35M10 MOS holder upon completion of the additional training on the AFCS, which will be given to students with **Black Hawk** assignments. **Black Hawk** field units can send MOS 35M10 personnel to the Signal Center for this functional training.

The **Avionic Special Equipment**

Repairer Course, MOS 35R10, a 25-week course, trains the repairer at the AVIM level on avionic navigation and radar systems.

Transponder Set AN/APX-100 used in **Black Hawk** will be added to the current 35R10 training program. No immediate resident training is planned for the other **Black Hawk** special avionic systems. The manufacturers of the Altimeter Set AN/APN-209 and the Radar Doppler Set AN/ASN-128 have been awarded **reliability improvement warranty (RIW)** contracts to repair these systems for the next four years. If the contracts are not cost-effective, then resident training in MOS 35R10 will commence on these systems.

A new look in manuals!

The new look of **Black Hawk** avionics has led to a corresponding new look in technical manuals. The new maintenance manuals contain data on how to troubleshoot the helicopter's avionic systems broken down into task format:

The procedure for each system includes the following parts:

A step-by-step operational check; a logically sequenced troubleshooting chart; a component location diagram; an expanded wiring schematic; a listing of personnel required; a list of supplies, test equipment, and test conditions.

The **Fault Isolation Procedure (FIP)** Manual describes normal system operation and desired results of the operational check. The troubleshooting chart lists various problems that can occur and directs the repairer to the component of the system that has failed. The location diagram shows where each component is installed in the **Black Hawk.** The schematic diagrams are well organized with test points, values, and data all on the same page.

Commander's and Soldier's Manuals will be developed from the job tasks that were used to develop the new manuals. The **Skill Qualification Tests (SQT)** will sample these same tasks.

The initial training on the AFCS was conducted in April 1979 by the contractor at Fort Campbell, KY, for the Airmobile Division. **Instructor Key Personnel (IKP)** from the Signal Center received four weeks of factory instruction on the AFCS at the Sikorsky facility in Norwalk, CT, (Norden) in May 1979, followed by an additional two weeks of practical exercises on the aircraft itself at Fort Eustis, Va. Those individuals who received factory instruction have stabilized tours at the Signal Center and are developing training programs for the 102-F44 and 102-F45 Courses. Resident training is scheduled to begin during the next fiscal year.

A level of cohesion

Formal training, on-the-job training, and actual experience lead to the development of fully qualified personnel. In this regard, the unit commander has a threefold responsibility: he must insure that OJT programs are established to enhance the soldier's formal training; he must evaluate the proficiency of trained personnel with appropriate SQTs; and he must insure that deficiencies which can be attributed to training are reported to the appropriate service school so that corrective actions can be initiated.

The Staff and Faculty of the Signal Center are proud to take the lead in the ongoing process of training the maintenance team that will support the **Black Hawk.**

Black Hawk Flight Simulator Training

By COLONEL BORIS POGOLOFF, Project Manager for Training Devices, Naval Training Equip Center (Orlando)

WHEN the **Black Hawk** helicopter simulator joins the inventory later this year, it will mark a number of **firsts** for the Army's **Synthetic Flight Training System (SFTS)** program.

It will be the **first** time that a new Army helicopter and its flight simulator become operational concurrently.

It's the **first** time that the Army contracted for a simulator before selecting the aircraft manufacturer.

It's the **first** helicopter simulator with two types of visual systems.

And it's the **first** helicopter simulator with the full capability of nap-of-the-earth flight.

Many technological advances

The **Black Hawk** flight simulator, designed by PM TRADE and produced by the Link Division of the Singer Company, incorporates many advances in simulation technology which will further enhance the **SFTS** program.

The simulator actually is two independent trainers. Each training station cockpit is mounted on a motion system that moves in all six directions, with seat shakers for buffet and vibration effects and aural cues to simulate aircraft sounds. Each has its own computers and instructor station.

The big difference between the two systems is in visual simulation. One cockpit is furnished with **computer-generated images (CGI)**; the other has scenes from an advanced type television camera terrain model system. Both systems provide full-color displays for day, dusk, and night flying operations. Visual cues are synchronized with cockpit instrument cues, motion cues, and audio cues, giving trainees the feel, sight, and sound that simulate the actual environment.

Unprecedented realism

The camera/model board visual system furnishes an unprecedented variety of realistic scenic details, enabling aviators to simulate VFR operations ranging from ground taxi through nap-of-the-earth flight.

Two forward-looking visual displays are provided, one for the pilot and one for the copilot. The pilot also has a side-looking display. There are two model boards, identical in content with forward and side displays coordinated. This provides the pilot with a total horizontal field-of-view of approximately 100 degrees.

The visual world is contained on two identical three dimensional scale models of the terrain. The 1:1000 scale provides a 19 km by 7 km visual flying area over the 64 by 24 foot model. A movable gantry transports the high resolution TV

SIMULATOR TRAINING
(Continued from Page 121)

camera over the model board, keeping it always at the computed location and altitude of the simulated aircraft. The TV camera views the model through an optical probe whose lenses, mirrors, and prisms move to provide the correct attitude and viewing angle, as well as dynamic focus for the scene.

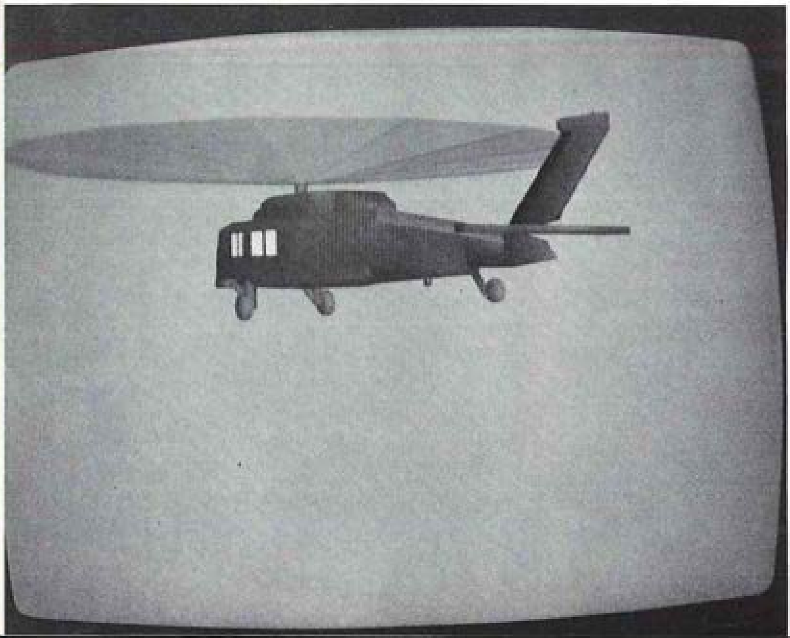
Laser height sensor

One of the most distinctive features of the new simulator is a laser Probe Height Sensor which continuously measures the clearance between the model board and the tip of each optical probe. A laser beam is reflected from the surface, providing clearance measurements accurate to within a few hundredths of an inch. If a probe gets too close it is retracted automatically by the computer to avoid impact and possible damage. The laser also provides height data to the simulator's radar altimeter.

The model boards are finely detailed with roads, buildings, ponds, streams, fences, utility poles, water towers, high-voltage transmission lines, and 800,000 individually placed trees. Architectural features of buildings include doors, windows, chimneys, porches, and walkways.

Many operational "views"

The **CGI** visual sysem also provides a wide variety of operational views, with forward and side displays for both the pilot and copilot. This variety makes the system particularly suited for cross-country flight instrument approach and breakout, nap-of-the-earth flight, and flight over unfamiliar terrain. It even permits formation flying, with the lead ship flying outside the aviator's cockpit window. The lead ship's flight path and maneuvers are fully programmable by the IP. **(See illustration.)**



◄LEFT: The lead ship that is employed in practicing formation flying is shown in the SFTS's computer-generated projection.

OPP. PAGE: A view from the left side of the camera-model board cockpit.

The **CGI** system works from data bases containing the locations of edges of objects to be displayed. The system constructs scenes in full color and in true perspective as the eyepoint moves through the scene.

Sun and moon shadowing used

Although all objects are described by straight lines, controlled shading gives surfaces appropriately rounded contours. Objects also respond to illumination by the sun or moon, brightening on sides toward the light and darkening on opposite sides.

The **CGI** system shows not only solid objects, but also point lights which can be made to flash, rotate, strobe, or be seen from only one direction. It also displays two-dimentional ground patterns, such as landing field markings.

Realistic visibility effects are introduced under instructor control. The scene can be immersed in fog or haze of variable densities which make the scene fade as the range increases. Cloud tops and bottoms can be simulated, along with the breakout the pilot experiences as he drops beneath the cloud bottom. Flying into clouds produces appropriate white-out effects.

Built-in Anti-aircraft fire

Both visual systems provide special electronic effects, such as tank and small arms fire which instructors can order up to test aviators' skill at evasive tactics.

This all adds up to the most modern and sophisticated helicopter simulator yet attempted, and marks another plateau in the developing growth of PM TRADE's Synthetic Flight Training System.

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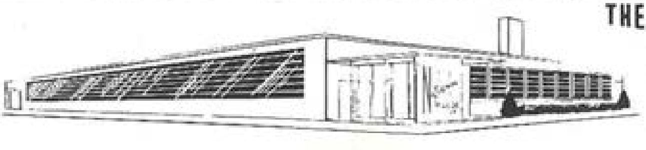

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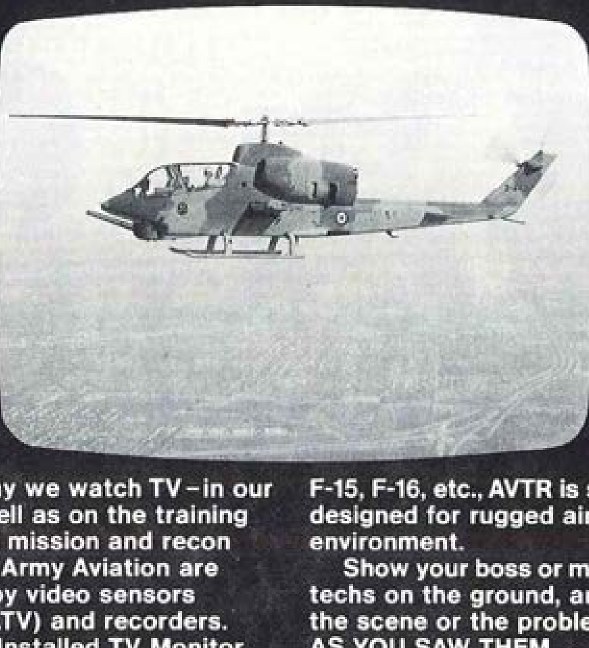

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A New Look in Manuals

BY MAJ. GEN. RICHARD H. THOMPSON, Commander, USA Troop Support & Avn Materiel Readiness Command

THE **Black Hawk** can boast of many "firsts" for the Army in terms of design, mission capability, and survivability.

These "firsts" resulted from the application of innovative approaches in the design and development stages of the aircraft. The **Black Hawk** represents the latest in the state-of-the-art and is being deployed to update our aging fleet of utility helicopters.

Innovative approaches were also taken in the development of certain elements of the logistics, such as the publications.

The **maintenance manuals** represent a major breakthrough in addressing the target audience, the mechanic. The manuals have been made easy to read and understand using simplified illustrations keyed to the location of the parts/components on the aircraft and instructions directed toward the specific task being performed.

Surveys taken by both government and industry have indicated a need to simplify the maintenance instructions of the Army's equipment. Reading levels of the many people being graduated from high school are less than adequate.

While the academic community attempts to solve this problem, we in the Army must solve ours, which is to make our maintenance manuals easier to understand. Army equipment is becoming more complex, thus it is imperative these manuals reflect this academic realism.

Mirroring the complexity

Many of the current maintenance manuals describing complex equipment mirror the problem. Systems theory and descriptions are often integrated into the procedures; illustrations are too complex, with numerous callouts placed in no logical sequence; the instructions address only the part/component being removed or disassembled, with little consideration given to the mechanic performing the task; consumables are called out by a reference and the mechanic must consult other parts of the manual to identify these materials.

Current manuals do **not** describe exactly where the component is located, what consumable materials will be required, how many people will be required to do the task, what tools will be needed and, finally, to really compound the problem, how to perform the task by understandable step by step instructions.

The **Black Hawk** manuals are a significant step forward toward improving the old system. First, the operator's manual, the checklist, and the maintenance test flight manual have been prepared using **relatively new formats** which have undergone extensive rework including user's review and acceptance. The effort to simplify maintenance and troubleshooting instructions is the real innovation in the **Black Hawk** program.

The **Black Hawk** maintenance tasks are written in **simple step by step instructions** keyed to **simplified illustrations** usually placed on the facing page. The manuals are task-oriented and are prepared for each of the major **Black Hawk** systems.

Each manual contains all of the information the mechanic needs to successfully complete the task, including the instructions, tools, consumables, MOS and number of people required to perform the task.

For the first time, the Army has a **separate troubleshooting manual** for a complex aircraft system. In the past, troubleshooting data was scattered throughout the manuals with little or no systems interface. TM 55-1520-237-23-3 contains all the troubleshooting procedures

for each system in the UH-60A aircraft. The manual is indexed by both system and by malfunction.

It also contains a matrix, which lists all the troubleshooting tasks, the MOS required, the maintenance level that can perform the task, and references to other applicable publications that may be required. There are 66 troubleshooting procedures in all, starting with simple operational checks keyed to "Yes" - "No" logic tree procedures.

The approach taken in preparing these procedures promises a great return in the areas of **decreased equipment downtime** and reduction in the unnecessary replacement of parts.

Quality is a major factor

While quality is always a major consideration in the preparation of any set of manuals, it became a key factor in the **Black Hawk** manuals for two reasons: they are a new set of manuals and they introduce a new format to the user. To insure the quality of the manuals, a 100% verification was performed. Conducted at both the contractor's and Army's facilities, most of the tasks were actually performed on production aircraft. This enabled the publications personnel to produce the **most accurate manuals possible.**

Army mechanics were used in the verification wherever and whenever possible to assure that the troops in the field could use the manuals and to acquaint them with the new format. This verification and physical teardown evaluation were a test of both the technical accuracy and the format of the **Black Hawk** manuals.

The benefits of the "new look" manuals can be identified in many areas. If the mechanic can perform more accurately, use parts only when actually required, perform with less complex training, and increase **OR** rates for the aircraft, then the benefits are easily identified.

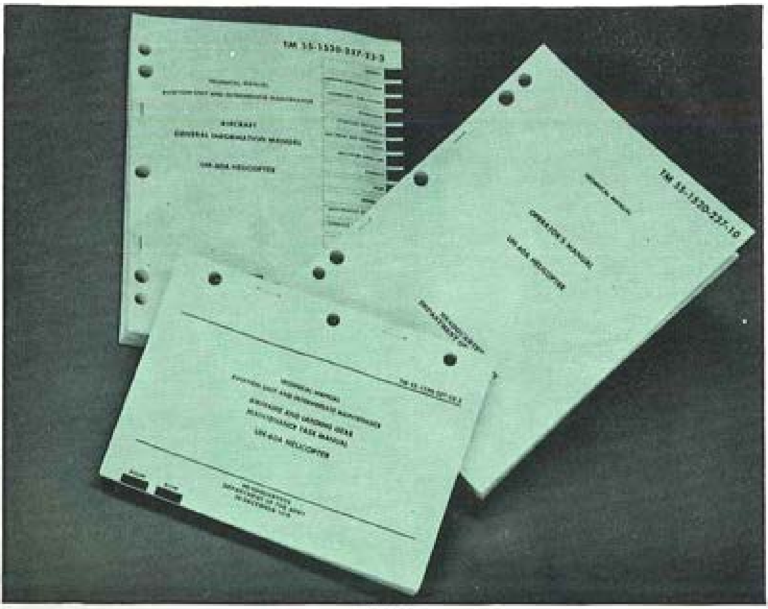
We must also consider that, because of the "hands on" verification of the manuals, the accuracy was substantially increased, which means less manual modification because of inadequacies of errors and increased user confidence.

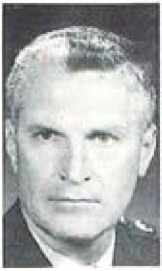
The **Black Hawk** publications program has received intensive management to assure the manuals fulfill their intended purpose. They represent a new philosophy and concept in simplified maintenance instructions, enabling the user to perform complete and safe maintenance.

To monitor the publications for acceptability and usability remains our task. We are maintaining contact with the initial users for their recommendations on further improvement. **Formal manual reviews** will be conducted periodically with the users for the purpose of providing comments or technical update.

Feedback from the field, thus far, indicates the new approach is an improvement over the present system. However, some fine tuning adjustments will have to be made in coordination with the user to assure the program remains on the right track.

The **Black Hawk** manuals have taught us much in the areas of maintenance support, verification planning/execution, and coordination with the users. These lessons, when applied to future systems, such as the AH-64, will further assure more complete, accurate, and usable set of maintenance manuals for a major weapons system than ever before.





WHITE PETERSEN

Talking to and with the Black Hawk

By COL ROY WHITE, PM, NAVCON Systems & COL DARWIN A. PETERSEN, Cdr, AVRADA

THE UH-60A **Black Hawk,** the newest of the Army's helicopter fleet, was designed to fulfill the needs of the Army's air mobile forces. Testing has proven that the **Black Hawk** will not only meet but exceed the Army's requirements.

The **Black Hawk** has the high maneuverability and immediate control response required for effective NOE and low level operations as well as enhanced maintainability features necessary in present and future combat environments.

The application of new avionics subsystems within the **Black Hawk** cockpit was designed to accommodate both the pilot and copilot to further enhance the operational effectiveness of the aircraft.

On the battlefield, in almost any weather condition, the **Black Hawk** can operate because of the full compliment of tactical and IFR equipment installed. The pilot and copilot panels are identical which simplify in-flight control transition and the center console controls are within easy reach of both pilot and copilot so that the **Black Hawk** can be operated by a single aviator.

Total commitment

The **Avionics Research and Development Activity (AVRADA)** and **PM Navigation/Control Systems (PM NAVCON),** Fort Monmouth, NJ are totally committed to the support of the avionics systems used in the **Black Hawk.** Communication and navigation equipment have been redesigned to be

Pilot and co-pilot's view of the instrument panel of the UH-60A Black Hawk.

smaller, lighter, and more efficient than the equipment previously used in utility transport aircraft.

Figure 1 provides an overall view of the **Black Hawk** instrumentation and electronics of the cockpit panel and center console.

Communications capabilities

In the area of communications, the VHF/FM, VHF/AM, and UHF/AM capability is provided by the AN/ARC-114A, the AN/ARC-115A, and the AN/ARC-164 transceivers. The C-6533/ARC intercom provides an intercommunication capability and the means by which the operator(s) may select and control associated radio equipment for voice transmission and reception.

Also installed is a Troop Unit Commander VHF/FM antenna. This antenna is used with the Troop Unit Commander's organic radio (AN/PRC-25 or AN/PRC-77) and permits the Troop Unit Commander, during transport, to maintain contact with his ground forces without using the aircraft radios and intercoms.

Within the next two years, it is anticipated that the AN/ARC-186(V) multiband radio will replace the AN/ARC-115A. The AN/ARC-186(V) provides the communications capability of the AN/ARC-114A and the AN/ARC-115A in a single package that is form fit and function interchangeable with the AN/ARC-115A. This radio will be used primarily for worldwide air traffic control communications from aircraft to tower and other appropriate facilities using VHF/AM and for tactical air-air and air-ground communications using VHF/FM. The operator will have twenty preset channels to reduce workload during the mission.

For navigation, the **Black Hawk** is equipped with the AN/ARN-123 radio receiver. This receiver provides manual and automatic **VHF omnirange (VOR)** bearing, **marker beacon (MB)** position, **localizer (LOC)**, and **glideslope (GS)** information for enroute and terminal navigation and **instrument landing system (ILS)** approach and landing.

Additional navigation equipment are the AN/ARN-89 **automatic direction finder (ADF)** which provides automatic or manual compass bearing on any radio signal within the frequency range of 100 to 3,000 kHz and the AN/ASN-43, heading reference system, which provides heading reference information to the pilot and to the AN/ASN-128 Doppler. The AN/APN-209 radar altimeter provides accurate indication of the aircraft's relative height above the terrain.

There's new equipment!

New equipment used in the **Black Hawk** includes the AN/APX-100(V) transponder and the AN/ASN-128 Doppler Navigation System. The dual diversity transponder, AN/APX-100(V), is capable of providing identification to all suitably equipped challenging aircraft, surface ships and ground interrogators within the operational range of the system. The AN/APX-100(V) provides full spherical coverage around the aircraft.

The AN/ASN-128 Light Weight Doppler Navigation System provides the **Black Hawk** navigation capability for use in the tactical airspace. With inputs from the heading reference system and the vertical gyro, the Doppler provides accurate aircraft three dimensional velocity, present position, range, bearing and time to destination or target area, and steering information either in digital or analog form.

The **Computer Display Unit (CDU)** as shown in **Figure 2,** permits programming of the computer and selection of the desired data display. The system is designed to operate from ground level to an excess of 10,000 feet. The Doppler is completely self-contained and requires no ground based signals.

Something new: CIS!

Used for the first time in an Army helicopter is the three-cue **Command Instrument System (CIS).** This navigational aid displays the horizontal and vertical attitude of the aircraft, and, by means of a visual display, provides steering commands for the pilot/copilot. These commands enable the pilot to fly a desired heading; pursue a selected course; perform approaches via FM/homing, ADF, VOR, and ILS; maintain fixed altitude; maintain a constant airspeed on approach and home on a broadcasting station.

The CIS consists of a **Vertical Situation Indicator (VSI), Horizontal Situation Indicator (HSI),** a **Command Instrument System Processor (CISP),** a CIS Mode Select panel and a Mode

Figure 2—The Computer Display Unit (CDU) permits full programming of the computer

Figure 3—The Black Hawk's Command Instrument System (CIS) Mode Select Panel.

Select panel. The CIS Mode Select panel is shown in **Figure 3.**

In addition to providing R&D and production capabilities in support of **Black Hawk,** AVRADA and OPM NAVCON are currently providing full time support to **Black Hawk** at Fort Campbell, KY during the conduct of the **Initial Operational Capability (IOC)** and **Force Development and Test Evaluation (FDTE).**

With the emergence of the **Black Hawk,** a new era in Army Aviation has begun. Designed with the pilot and crew in mind, the **Black Hawk** gives the pilot and crew more ease of control and power.

Effective transport

In the words of **Major General "Jim" Merryman,** Commander, U.S. Army Aviation Center, Fort Rucker, AL, "Now for the first time, on any day, just about anywhere, we can lift an entire squad and more in this helicopter. In addition, it is designed to operate and survive on the battlefields of today and tomorrow."

The electronic package on the **Black Hawk** vastly contributes to the aircraft's ability to effectively transport troops, to perform its missions, and to survive.

What is ballistic survivability all about?

The **Black Hawk** must operate in the high-threat environment, and it has been designed to achieve small arms survivability and much, much more.

IF your main blades take a hit, especially a 23mm HEI hit, you'll still fly. **Why?** The **Black Hawk** has a ballistically tolerant specially processed titanium spar, a spar that suffers the least damage and is most tolerant when hit by a 23mm HEI — regardless of projectile fuze type.

IF

IF the UH-60A tail rotor drive shaft is hit many times — even by 23mm API — your helicopter still flies. **Why?** Drive shaft material/wall thickness/diameter — all are optimized for survivability — and demonstrated and documented in ballistic and laboratory tests.

IF the UH-60A loses its primary tail rotor controls, your helicopter still flies. **Why?** A fully redundant system. Back-up controls — widely separated from the primary system — take over.

IF the UH-60A tail boom is hit by 23mm HEI — your helicopter still flies. **Why?** Large volume, crack-resistant ductile-skin, multi-stringer/spar construction.

IF the UH-60A tail rotor head is hit — your helicopter still flies. **Why?** Integral dual-stage tail rotor servo protected by gearbox. Patented redundant-pivot input linkage. Demonstrated tail rotor head stability after loss of blade pitch linkage.

IF the UH-60A's primary controls and primary hydraulics are shot out, you'll still fly home. **Why?** The **Black Hawk's** tail rotor servo centering spring immediately causes all blades to reach a pre-selected angle — and remain there.

fly home. **Why?** The **Black Hawk's** tail rotor servo centering spring immediately causes all blades to reach a pre-selected angle — and remain there.

IF you take a hit in your fuel tank, no sweat! **Why?** With one tank out after a high-threat hit, **Black Hawk** cross-feeding maintains a fuel supply to both engines. In an emergency, the UH-60A is still available for missions even with one tank out.

IF your transmission lubrication system receives combat fire, you're not necessarily out of business. The **Black Hawk's** simplified transmission lube system reduces the number of vulnerable soft oil lines and components, and input shafts are fully enclosed.

IF your rotor head is hit, there's a good chance you'll fly on. **Why?** It's a titanium hub, capable of taking 23mm hits. It has excellent ballistic resistance. Clean coring. No cracking. What's more it uses elastomeric bearings which have demonstrated tolerance to 23mm. No lube means no chance to lose oil.

IF a hit is taken in the cockpit, the survivability chances are excellent. **Why?** The **Black Hawk's** fiberglass cockpit and instrument panel protects pilots against the secondary effects of spall and debris. And boron-carbine armored bucket seats also protect them. Widely separated, redundant pilot/co-pilot controls reduce the possibility of single-hit control loss and enhance rear-view visibility.

With its redundant systems and ballistically tolerant features, the **UH-60A** is designed for battlefield staying power.

What if you take a hit in the Black Hawk? Will you be able to survive?

Aircraft Survivability! Hard at Work!

By COLONEL DANIEL DELANEY, Project Manager, Aircraft Survivability Equipment (ASE), AVRADCOM

SURVIVABILITY, a watchword for Army aircraft, has been an actuality for the **Black Hawk** since the beginning of the development program.

A full suite of **Aircraft Survivability Equipment (ASE)** was specified, spanning the electromagnetic spectrum and vulnerability reduction (ballistic hardening).

Accordingly, the maturity/production phases are proceeding to implement a progressive survivability program.

Growth requirements met

New missions now being formally assigned to **Black Hawk** were considered in the early phases and the **ASE** programs were adjusted to insure that the growth requirements could be accomplished with a minimum impact to the respective programs. The individual equipments/aircraft were designed such that only minimum aircraft provisions would be provided as needed.

For example, the production **Black Hawk** aircraft are painted with IR paint and provisioned for IR suppression and will be afforded other IR protection as might be needed depending upon the threat or mission at the time and the prerogative of the field commander.

Likewise, **radar warning** and other radar protection is also provided. For Medevac and special electronic-type missions the respective aircraft are going to be capable of being tailored to give the protection desired.

Many dimensions considered

Present day **ASE** have been developed, or are being developed, to incorporate the added capability which might be needed, and in almost all cases, the space, weight, and power budgets have been those previously established early in the **Black Hawk** development program.

Reliability and **availability** are two other **"-ilities"** or dimensions being continually stressed for **Black Hawk** survivability.

Battle is payoff!

Each **ASE** must demonstrate its effectiveness and reliability under threat conditions. The programs are being expedited to insure that the equipment's fieldworthy and producible before fielding.

The future for **Black Hawk** promises that we'll have an aircraft with the versatility to meet the changing needs of the Army. The future also promises that the aircraft survivability equipments on board are designed to insure that the field and combat effectiveness are maintained at an affordable cost.

UH-60A Mission Flexibility Kits

By CHARLES D. MUSGRAVE, Chief, Technical Management Division, Ofc, Project Manager, Black Hawk

THE **Black Hawk** helicopter is designed to transport 11 fully equipped troops, plus a three-man crew and cruise at speeds in excess of 145 knots.

However, there are many other **special secondary missions** it can perform by installation of various mission flexibility kits. Some existing helicopter parts may have to be relocated or removed to install a kit. When the mission is completed, the kit is removed and any parts removed or relocated are reinstalled.

These kits are available: **Blackout Devices, Infrared Radiation (IR) Suppression, Winterization, Main and Tail Rotor Blade De-Ice, Air Transportability, Aeromedical Evacuation (Medevac), Range Extension** and **Rescue Hoist.**

Blackout Devices Kit—This kit consists of seven blackout curtains which are installed over the windows and the opening between the cabin and pilots compartments.

One curtain is installed over each of the four cargo door windows and the two gunners' windows. The seventh curtain is installed between the cabin compartment and the pilots' area. This curtain also has a zippered access panel.

They are held in place by Velcro tape which is bonded to the cabin structure and the curtain panels.

This kit allows the cabin lights to be on without being detected from the outside. It enables medical attendants to care for patients under blackout conditions.

IR Suppression Kit—This kit is a hostile environment kit used solely for the purpose of improving survivability against heat-seeking missiles. This is accomplished by a reduction in **IR** signature and line-of-sight view of hot metal engine parts.

The kit consists of engine cooling air inlet baffles, suppressor assembly, a support strut and fittings, a support fairing, and an aft contour fairing. The **IR** suppressor routes hot exhaust gases from the engine through the suppressor core, which is mounted in a fiberglass honeycomb nacelle.

Prior to installation of each **IR** suppressor, the standard engine exhaust module and aft faring must be removed. However, the engine and cowling remain in place.

Range Extension Kit—This kit essentially consists of two fuel tanks that are installed in the cargo compartment area. They are secured to the floor tiedown fittings. With this kit installed an additional 780 usable gallons of fuel is available.

The two tanks are crashworthy but not

self-sealing. When this kit is installed, there is no cargo or seating space available in the cargo compartment.

Rescue Hoist System Kit—The rescue hoist is post-mounted in the cabin on the right side of the helicopter when installed. It is a high performance, two-speed system with the capability of hoisting 300 pounds at 0-250 feet per minute or 600 pounds at 0-125 feet per minute. Six hundred pounds is the maximum weight that may be hoisted. The hoist cable is 250 feet long.

The **Rescue Hoist Control** panel is mounted in the lower console in the cockpit. It contains all the necessary controls for operating the hoist from the cockpit.

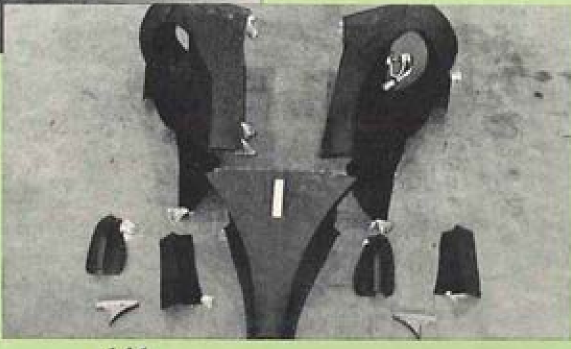
There is also a Crewman's Control Pendant Grip which is a hand held control for operations from the cabin. This pendant grip also has two caution/warning lights, namely, a 10-foot CAUTION light and a red OVERTEMP light. The 10-foot CAUTION light warns the crewman whenever the cable is 10 feet or less from the stop limits. The red OVERTEMP light warns the crewman of an overtemperature condition in hoist motor or its lubrication system.

A cable shear system does just what its name implies, it shears the cable in an emergency. The cutter may be actuated by the pilot or copilot or the crewman.

Winterization Kit—This kit consists of hydraulic components to provide increased engine start capability in cold weather. This is accomplished by installing a second accumulator in the APU start system to provide increased APU capability at low ambient air temperature.

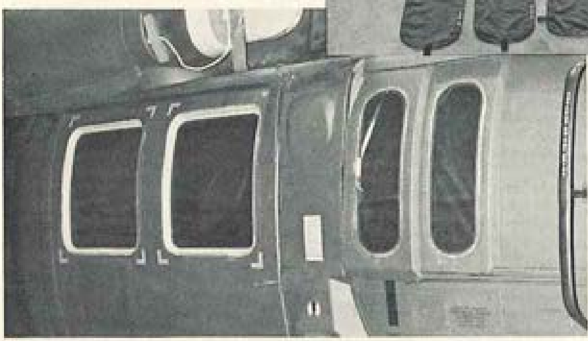
Main and Tail Rotor Blade De-Icing Kit—This kit consists of electrical

LEFT: The mounting of an IR suppressor kit increases survivability against heat-seeking missiles by reducing the IR signature and the line-of-sight view of hot metal engine parts.



RIGHT: The parts of the kit consist of engine cooling air inlet baffles, suppressor assembly, a support strut and fittings, a support fairing, and an after contour fairing.

RIGHT: The Blackout Devices Kit conists of seven blackout curtains which are installed over the windows and the opening between the cabin and pilots' compartment.



LEFT: A side view of the Black Hawk shows blackout curtains installed in each of the two cargo door windows (left) and the two gunner's windows at the right.

components which provide power and system control for electrothermal de-icing of the main and tail rotor blades. An aircraft power systems modification sub-kit contains the components and wiring required to interface the aircraft and kit power systems.

Electrical power is provided to main and tail rotors by the installation of the de-ice control system, slip ring assemblies, a de-ice system junction box, and wiring harnesses. The de-ice control system consists of a system controller, a main rotor power distributor, an ice detector, outside ambient air temperature sensors, an icing rate meter, and control wiring harnesses.

Air Transportability Kit—This kit permits air transport of the **Black Hawk** in the C-141 and C-5A aircraft. The kit consists of an air transport set and an air transport loading set. The air transport set consists of all common equipment required for preparation and reassembly of one **Black Hawk** for transport in a C-141 or C-5A aircraft. The air transport loading set contains the necessary equipment for loading and unloading of a **Black Hawk.** Two **Black Hawk's** can be transported in a C-141 and six in a C-5A.

Aeromedical Evacuation (Medevac) Kit—This kit sometimes simply referred to as the "litter kit" is designed to facilitate quick, easy loading of patients. It consists of a pedestal mounted in the center of the cargo compartment, which contains four litter supports.

A 115 volt A.C. electrical power pack is also available to operate standard hospital equipment. The litters may be rotated 90° to the longitudinal axis of the helicopter to allow rapid loading and unloading from both sides of the helicopter.

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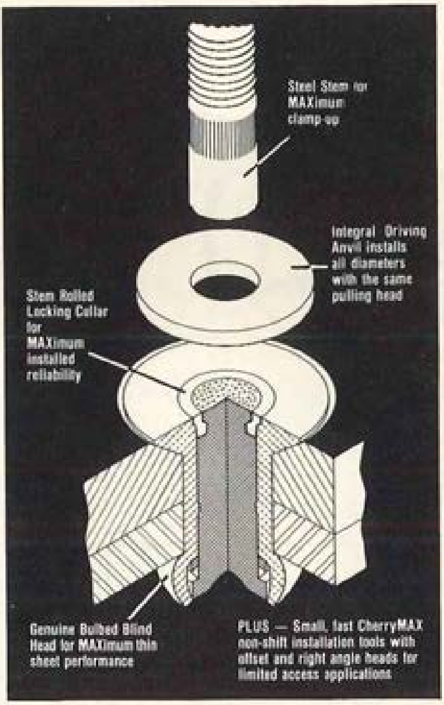

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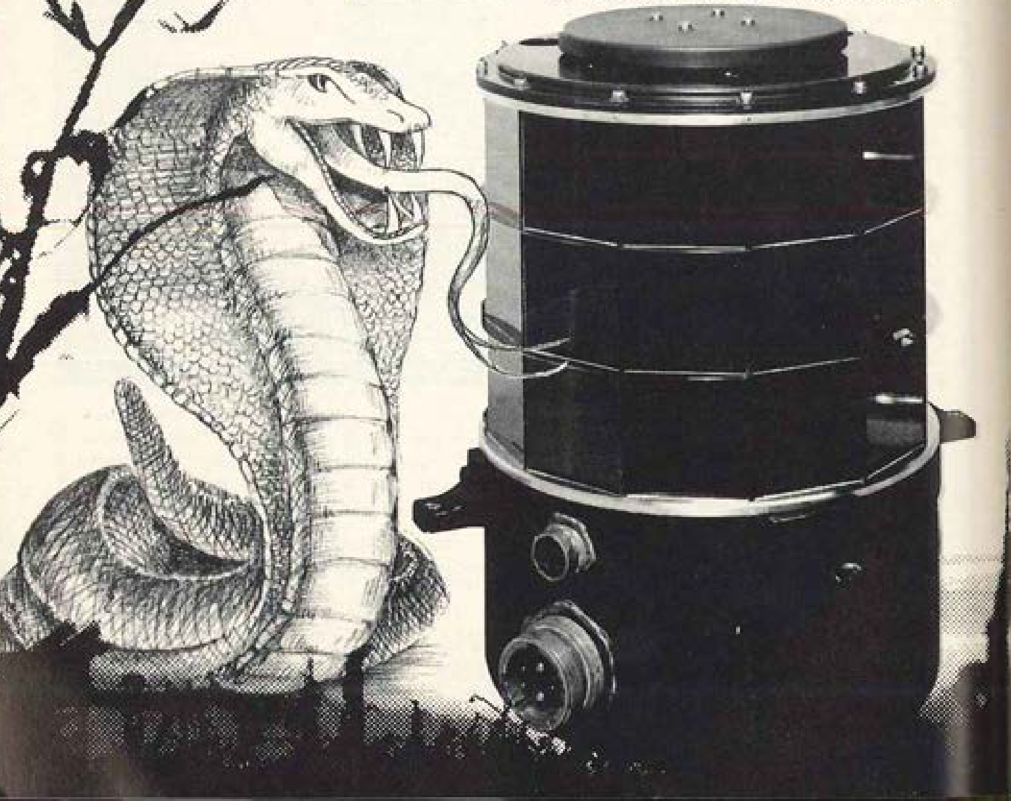


Testing the Parachuting and Rappelling Capability

By COLONEL G.G. THOMAS, JR., President,
U.S. Army Airborne Board, Fort Bragg, North Carolina

IT'S 0630 hours, 21 May 1979, a busy Monday morning at the **US Army Airborne Board (USAABNBD),** and word has been received that the UH-60A **Black Hawk** is enroute from Simmons Army Airfield for the first day of testing activities to establish jumping and rappelling procedures.

The day's test schedule is to find a suitable location for an anchor line cable and to install the cable; work out aircraft approach procedures; design seating arrangment for as many jumpers as possible; check trail position of **deployment bags (D-bags)** in flight; and to airdrop dummies. All the above must be satisfactorily accomplished to set the stage for live personnel airdrops.

Rappelling actions studied

Another group in charge of rappelling will begin working to answer questions as to how the aircraft should be approached, how many rappellers can be seated, how many rappellers can be safely placed in each door at one time, what type and how much new equipment will be needed, what effect will the increased prop wash (as compared to the UH-1H) have on the rappelling ropes, and so on until sufficient answers have been found to safely allow rappelling operations to begin.

Popular demand and general curiousity will require public access to the aircraft so static displays are arranged at Simmons AAF and Pope AFB with crews available to answer questions. (Many personnel turned out at both locations from the Air Force and the Army, making the effort very worthwhile.)

The first test flight

When groundwork is completed, preparations are made for the first test flight. At an altitude of 1,000 feet **above ground level (AGL),** the first **D-bag** attached to an overhead-mounted anchor line cable is tossed out the aircraft compartment door. Slightly starboard, photographing the activity, is an USAABNBD Board UH-1H photographic chase aircraft with a safety observer aboard.

Word comes immediately over the **Black Hawk** radio that the bag is trailing high on the fuselage, dangerously close to the main rotor head. The bag is pulled in quickly and testing is suspended with the overhead anchor line configuration. Subsequent **D-bag** tow tests with a floor-mounted anchor line cable were acceptable and recommended for use.

The second test flight of the day will require airdropping 16 dummies of various weights rigged with standard MC1-1B and T-10B parachutes. This operation goes without incident, setting the stage for the first live personnel airdrop from the **Black Hawk,** which is scheduled for the following morning.

At **Nijmegen Drop Zone (DZ),** Ft. Bragg, NC, early the morning of 22 May 1979, an unusual helicopter approaches the **DZ** marking panels and eight parachute canopies are open underneath. The first lift of eight US Army paratroopers, led by **COL G.G. Thomas,** has been successfully airdropped from the UH-60A **Black Hawk** helicopter.

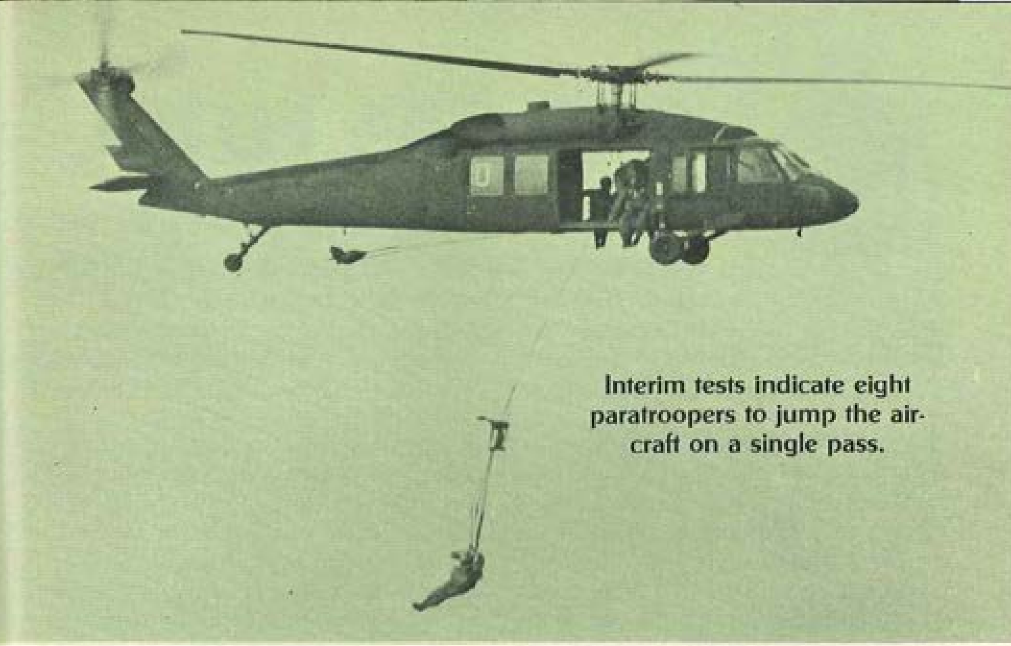
The paratroopers are highly-experienced test jumpers from the US Army Airborne Board. The aircraft circles, lands on the **DZ,** picks up the second lift of eight test jumpers, and the procedure is then repeated for the remainder of the morning with the objective of making as many parachute jumps as possible during the nine days allotted for testing the **Black Hawk.**

When all available parachutes for the day's operations have been expended, the UH-60A aircraft heads due east to the USAABNBD hangar, located adjacent to Ft. Bragg at Pope AFB. The remainder of the day for the Airborne Board's test personnel is programmed for the development of rappelling procedures under the supervision of an instructor from the US Army Infantry School's Pathfinder Committee.

Various configurations tested

With the development of basic procedures for personnel airdrop and rappelling operations, further testing is needed using jumpers/rappellers rigged in the various approved configurations for carrying combat equipment. In some cases, the basic procedures required revision to accommodate unforeseen problems with particular rigging configurations.

Left: Two USAABNBD soldiers are pictured rappelling from a UH-60 Black Hawk aircraft at Ft. Bragg, NC. The tests indicated four rappelers can exit the aircraft at one time, two per door.



Interim tests indicate eight paratroopers to jump the aircraft on a single pass.

Upon development and thorough testing of procedures, personnel from various XVIII Airborne Corps user units begin participating in personnel airdrop and rappelling operations under the supervision of a **USAABNBD** jumpmaster, rappellmaster, and other test personnel.

Although not officialy tasked to develop procedures, **USAABNBD** personnel conducted successful **military free fall (MFF)** operations at altitudes up to 10,000 feet **above ground level (AGL).**

A busy "test period"

Thus ends a busy - but rewarding - eight days of test jumping and rappelling, resulting in interim US Army procedures for the UH-60A **Black Hawk** helicopter.

A total of 615 static-line jumps, twelve **MFF** jumps and 150 rappels were made during the test period with one T-10B parachute malfunction and two personnel injuries. None of these incidents were attribuatble to aircraft performance.

The **Black Hawk** is more powerful than the UH-1H and has a larger cargo compartment which will facilitate the air transport of 11 combat-equipped troops. However, door size requires some limitations for parachutists and rappellers.

Interim procedures developed by the Airborne Board permit only eight parachutists to jump the aircraft on a single pass — three jumpers in each door at one time with an additional two inside the cargo compartment. Eleven jumpers required too much movement inside the aircraft — around and over the static lines — for positive jumpmaster control and safety.

A maximum load of ten rappellers can be seated safely in each lift with four rappellers exiting at one time, two per door. When scheduling permits, the Board will continue work to further refine procedures for special operations using the Army's new and powerful **Black Hawk** helicopter.

A UH-60A FDTE Progress Report

By MAJOR MICHAEL R. DEVLIN, Commander,
D Company, 158th Aviation Bn, 101st Airborne Division

IN the subsequent two articles written by four members of the 158th Aviation Battalion, you'll receive a firsthand **Pilot's Report** and **Maintenance Report** on the **Black Hawk**.

I would like to preface their articles with a short update on what has happened thus far in the **Force Development Test and Experimentation (FDTE)**, and the impact it has had on D Company, 158th Aviation Battalion **(Ghost Riders)** here at Fort Campbell, Kentucky.

D Company completed the turn-in of their UH-1 fleet and received their first UH-60A on 30 May 1979. We now have four of the fifteen **Black Hawks** required by TO&E.

The **FDTE** began on 4 June 1979. Thus far we have:

- Flown 175 hours.
- Completed 160 of the 181 critical maintenance tasks.
- Successfully accomplished loading the UH-60A aboard C-141 and C-5A aircraft.
- Evaluated the blackout kit and the winterization kit.
- Performed a 500 hour PMS inspection.

During these test events, the members of D Company were "tracked" completely by Data Collectors. The latter recorded all actions and the time required to complete a task. Credit is due both the members of D Company and the UH-60A for although some procedural and technical faults have been found and recorded, the aircraft were proven to be of high quality and the personnel highly professional.

The experience gained by all personnel because of the test events has been phenomenal. The maintenance personnel have virtually removed and reinstalled everything on the UH-60A from troop seats to the main transmission and tail rotor transmission. Without the test, this type of invaluable experience could not have been gained for many months, perhaps years.

We're very impressed!

The flight time flown thus far has included virtually every type of load that D Company would be expected to carry, except for medical evacuation (which will be tested at a later time).

The pilots of D Company have been very impressed by the handling characteristics of the UH-60A as well as its quantum increase in power over the UH-1. The performance of the aircraft and the GE T700 engine have met all expectations.

Particularly important thus far has been a successful air movement exercise. After several practice sessions, the UH-60A was loaded onto and off of C-141 and C-5A aircraft well within the time limits prescribed. The **"Ghost Rider"** personnel have played a big role in reconfiguring the original load plans, and have submitted numerous suggestions to facilitate loading in future operations.

The FDTE will continue well into October of 1979, as we gain more confidence with each successive test event. In September, the majority of our time will be spent operating from a field location. This will place both crew and helicopter under as realistic a combat environment as can be simulated.

I'd be remiss if I didn't mention that the success of the **FDTE** to date is due to the great team effort that has developed within the Test Directorate and among the principal participants. The members of the Aviation Board, the Materiel Fielding Team personnel, and the members of D Company, 158th Aviation Battalion, have generated a truly professional and cooperative effort.

I am positive that this team spirit will continue throughout the remainder of the test.

BROWN

LORD

Two 101st Abn IP's cite greater efficiency

By CW3 Carl Brown, SIP, D Co, 158th Avn Bn and CW3 Emory S. Lord, IP, D Co, 158th Avn Bn

ON its arrival at Fort Campbell on 30 May 1979, the UH-60A **Black Hawk** found a home with Company D, 158th Aviation Battalion of the 101st Airborne Division.

As of 1 July 1979, 11 pilots and three instructor pilots from Company D have completed qualification training at Fort Rucker, Alabama. The four UH-60A's at Fort Campbell were flown for a total of 104 hours by 22 June 1979.

During that time 76 sorties of troop movement, 12 sorties of internal loads with weights in excess of 2,600 pounds, and 38 sorties of external loads (to include a **Gamma Goat** of 7,300 pounds, and one 105mm howitzer with gun crew and basic load (5,800 pounds) were completed.

On 11 July 1979, two UH-60A's were successfully loaded on an Air Force C-141 **Starlifter.** Breakdown time was five hours with a loading time of 38 minutes for the first aircraft and 19 minutes for the second. Off-loading was completed in 53 minutes. The major problem encountered was the inexperience of our personnel. However, after a practice session, the loading was accomplished most efficiently.

The maintenance personnel of the company are performing critical maintenance tasks in order to validate the requirements specified in the technical manuals. A real benefit of these tasks is the valuable "hands on" training. Included in the test evaluation of maintenance tasks will be the areas of NBC decontamination, door gun firing, airborne rappelling procedures, camouflage techniques, rough terrain ground handling, and a battalion-size field training exercise.

A challenging experience

From the pilots' point of view, flight in the UH-60A is a challenging and rewarding experience. The capabilities of the aircraft have been greatly enhanced through the use of such systems as the **Automatic Flight Control System (AFCS)** which improves the stability and handling qualities of the aircraft.

The **Command Instrument System (CIS)**, which provides visual displays and command signals on the **Vertical Situation Indicator (VSI)** and a **Horizontal Situation Indicator (HSI)** for the pilot and co-pilot, has greatly reduced the crew workload during instrument flight.

The pilots continue to review the systems associated with the UH-60A, and have been providing feedback and recommendations on the problem areas that have been encountered.

The doppler Navigation System (AN/ASN - 128) built by Singer, is going to be a real asset to the aircraft and the aviator. We feel the potential of the system hasn't been fully realized yet.

An area in which we have found the system to be useful is as an aid to navigation along with the good old 1:50,000 map. We're finding that the 90 knot finger we've developed isn't fast enough to navigate at speeds of 145 knots, making it easy to get mis-oriented on the map.

With the doppler we can get an eight digit coordinate of our location in **Universal Transverse Mercator (UTM)** or in latitude and longitude to help confirm our location or reestablish our position. Along with the constant position read out, we can retrieve distance to the destination (in kilometers), time to destination, and a heading to the destination by the most direct means.

A technique we've initiated to update the doppler in flight by use of a map and terrain features. Using this method, the pilot doesn't have to be guided verbally by the navigator continuously. With the use of the **CIS** and the number one pointer on the **HSI**, which is similar to the number one needle on the **RMI** in the UH-1, the pilot can fly using terrain flight techniques to stay masked, and have a visual indication of the landing zone location as well as a **DME** distance readout all the time. By cutting down these communications, crew members are free to concentrate on other areas.

Tactical instrument flight

Another feature of the doppler is its capability of storing enemy target locations as you fly over them. It can store up to nine target locations in eight-digit coordinates if needed, and this information can be retrieved by simply pushing a button.

There's a possibility in the near future we'll be able to use the doppler for tactical instrument flight. With very little experience to date, a few of us have made successful tactical instrument flights from takeoff to approach. If the reliability and the accuracy of the crews are determined to be within standards and the system dependable, we might be using doppler for instrument flight in the future.

The Radar Signal Detector Set (AN/APR-39B-1) provides the pilots a visual display of the quadrant from which a radar signal is being emitted, and an audio signal to aid in identifying the type of radar that has been detected.

This feature will be invaluable in pinpointing enemy radar. Coupled with doppler target storage, we believe that we will be able to keep enemy ADA intelligence updated to a far greater degree than has been possible in the past.

The UH-60A **Black Hawk** with its truly advanced flight stabilization and Command Instrument Systems, coupled with doppler navigation and the Radar Signal Detector, has opened new vistas in the areas of terrain flight and tactical instruments. Once all of the system's capabilities have been mastered by the aircrews, they will greatly enhance both survivability and efficiency on the battlefield.

AUSTIN

SARRI

101st crewchiefs say, 'We're learning daily'

By SSG Frank Austin, C Co, 158th Aviation Bn and SGT Jerry Sarri, D Co, 158th Aviation Bn

THE first UH-60A **Black Hawk** helicopter was greeted with great enthusiasm when it made its debut at Fort Campbell on 30 May.

The members of Company D, 158th Aviation Battalion were elated to see the helicopter arrive, and were prepared to begin the Force Development Test and Experimentation.

Pilots, crewchiefs, and maintenance personnel had all previously completed UH-60A training at Fort Rucker and Fort Eustis. Despite this, the **Ghost Riders** quickly discovered that there were a great many tasks that could only be learned by daily experience.

"Maintenance Free" is a term long associated with the **Black Hawk** and indeed, in comparison with the daily services required on the UH-1, the term is very correct. However, once the second aircraft arrived and five to seven hours per aircraft per day were flown, maintenance personnel began to get a real workout on the new helicopter.

The ease of access to most of the work areas on the **Black Hawk** is as promised. However, some areas were difficult to work on, particularly due to the new manuals. Some steps are out of sequence or missing. In several instances, certain items of common hardware were not stocked in tech supply. Therefore, simple tasks caused work stoppages for parts.

Problems such as these are bound to happen whenever a new aircraft system enters the inventory, and we accept this fact. These problems are diligently noted by a team of Data Collectors provided by TSARCOM and the 101st Airborne Division.

The Data Collectors are carefully trained in collection of both **RAM (reliability, availability, and maintainability)** and other field data pertinent to safety, organization, and human factors. Information overlooked or lost can be of vital consequence, as this is the basis of future maintenance manuals and publications.

Maintenance efforts thus far in the **FDTE** are a learning experience and have been recorded by the Data Collectors so that the total system can be improved as a result of our experience.

So far in the **FDTE** we've been busy with both re-torques (required during the break-in period) and the removal and installation of numerous modules and components so that task times can be verified. The performance of 181 identified critical maintenance tasks insures rapid learning of all possible maintenance that may be performed by **AVUM** personnel.

Two special tools have had to be fabricated by **AVIM** personnel of the 5th Transportation Battalion to facilitate specified re-torque and tasks on the main rotor flap stop. These special tools were created through concentrated efforts of both user and Tech Rep personnel.

We're very proud of our loading exercises both on the C-141 and C-5A. In both cases, we feel that we met the requirement, achieved boarding in under the required time, and have the distinction of being the first unit to satisfactorily complete UH-60A air movement loading.

The maintenance personnel and crew-

PLAN AHEAD!

The 1980
AAAA National Convention
will be held at the Sheraton Atlanta Hotel during Thursday, April 10, to Sunday, April 13

★ ★ ★ ★ ★

General Robert M. Shoemaker, Army Aviation's most senior aviator, will again serve as Chairman of the Convention's Presentations Committee.

★ ★ ★ ★ ★

The AAAA Convention's Friday, April 11 Luncheon will serve as the 1980 site for the triennial inductions to the "Army Aviation Hall of Fame."

chiefs of Company D, 158th Aviation are becoming more confident with their UH-60A each day. No aircraft will ever be without the need of some maintenance action and we continue to insure that the UH-60A will be the finest troop carrier in the Army inventory.

In meeting the challenge of the sky, Sikorsky Aircraft has provided the U.S. Army's only air assault division with a promising aircraft with some great potential yet to materialize. As the **Black Hawk** and **Screaming Eagles** take to the sky, the new horizon shows potential and promise.

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Colonel Charles F. Drenz assigned in August 1979 as the PMO-Black Hawk

Born in Erie, Pennsylvania, on 12 August 1930, Charles F. Drenz attended both high school and college in Erie, Pennsylvania, graduating from Cathedral Preparatory School in 1948 and Gannon College in 1953 with a BS degree in Business Administration. He was commissioned a 2d Lieutenant from ROTC upon graduation from college and entered active duty on 5 April 1953.

He served in the Military Police Corps from 1953 until 1958 with assignments during this time at Camp Gordon, Georgia, Korea, Japan, and St. Louis, Missouri. In 1958 Colonel Drenz accepted a Regular Army Commission and served in the infantry with the 2d Infantry Division at Fort Benning, Georgia. In 1959 he received Army flight training at Fort Rucker, Alabama.

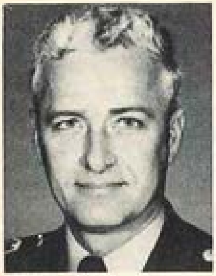
In 1960 he was transferred to the Trans-portation Corps and attended transportation and aircraft maintenance training at Fort Eustis, Virginia. Colonel Drenz at-tended rotary wing flight training at Camp Wolters, Texas, in 1961. From 1962 to 1965 he was assigned to the Seventh Army in USAREUR as a Commander of an Aviation Maintenance Company and also as S4, Seventh Army Aviation Group. In 1965 he attended Command & General Staff College at Fort Leavenworth, Kansas, for one year.

Colonel Drenz served in Vietnam with the 34th General Support Group during the period July 1966 through July 1967. Upon reassignment from Vietnam, Colonel Drenz was assigned to the Office of the Deputy Chief of Staff for Logistics, DA, primarily as an Aviation Logistics Staff Officer. In 1971 he returned to Vietnam to command the 520th Aviation Maintenance Battalion for a period of eleven months.

Upon return from Vietnam in 1972, he attended the Florida Institute of Technology where he received a Master of Science degree in Contract and Procurement Management.

Colonel Drenz attended the Air War College at Maxwell AFB during the period August 1973 through May 1974. He served as Special Assistant to the Advanced Attack Helicopter (AAH) Project Manager from August through November 1974. He then served as Project Manager, — Cobra from 13 December 1974 to 20 June 1977.

Colonel Drenz is a Master Army Aviator rated in both fixed and rotary wing aircraft. He is married to the former Lillian P. Martin of Newport News, Virginia. They have one son, Michael, and two daughters, Susan and Sandra.



WE'VE MET THE CHALLENGES!

By BRIGADIER GENERAL RICHARD D. KENYON
Black Hawk Project Manager, U.S. Army DARCOM

IT has been my good fortune to work almost three years as a member of the combined U.S. Army and industry team which transfigured the **Black Hawk** from a developmental prototype helicopter to a production system in the hands of the soldiers in the field.

This period has not been without challenges, but these were always met with professional competence and a positive attitude by the **Black Hawk** team.

A productive team

Personnel from my immediate office, from the U.S. Army Aviation Research and Development Command, from the U.S. Army Troop Support and Aviation Materiel Readiness Command, from the TRADOC System Manager's office, from the Army Development Test Activity, from the airframe prime contractor, Sikorsky Aircraft Division, from the engine prime contractor, General Electric, and many other organizations joined together in a productive team effort to analyze the challenges, define corrective measures and implement coordinated actions.

As a result of this management process, the U.S. Army has been able to field the first helicopter defined and developed to meet our unique combat requirements. Each and every member of the **Black Hawk** team should be justly proud of his or her achievements.

No time to stack arms

However, not a one can now "stack arms" because system changes will be required as the helicopter "matures" and as we implement the complex program of logistical support. Much work lies ahead!

As I depart from my project manager position, I sincerely thank the many individuals whose hard work and application of personal skills made possible the progress in the **Black Hawk** program.

I wish all of you the best of luck in future endeavors and hope our paths cross again.

month's takeoffs

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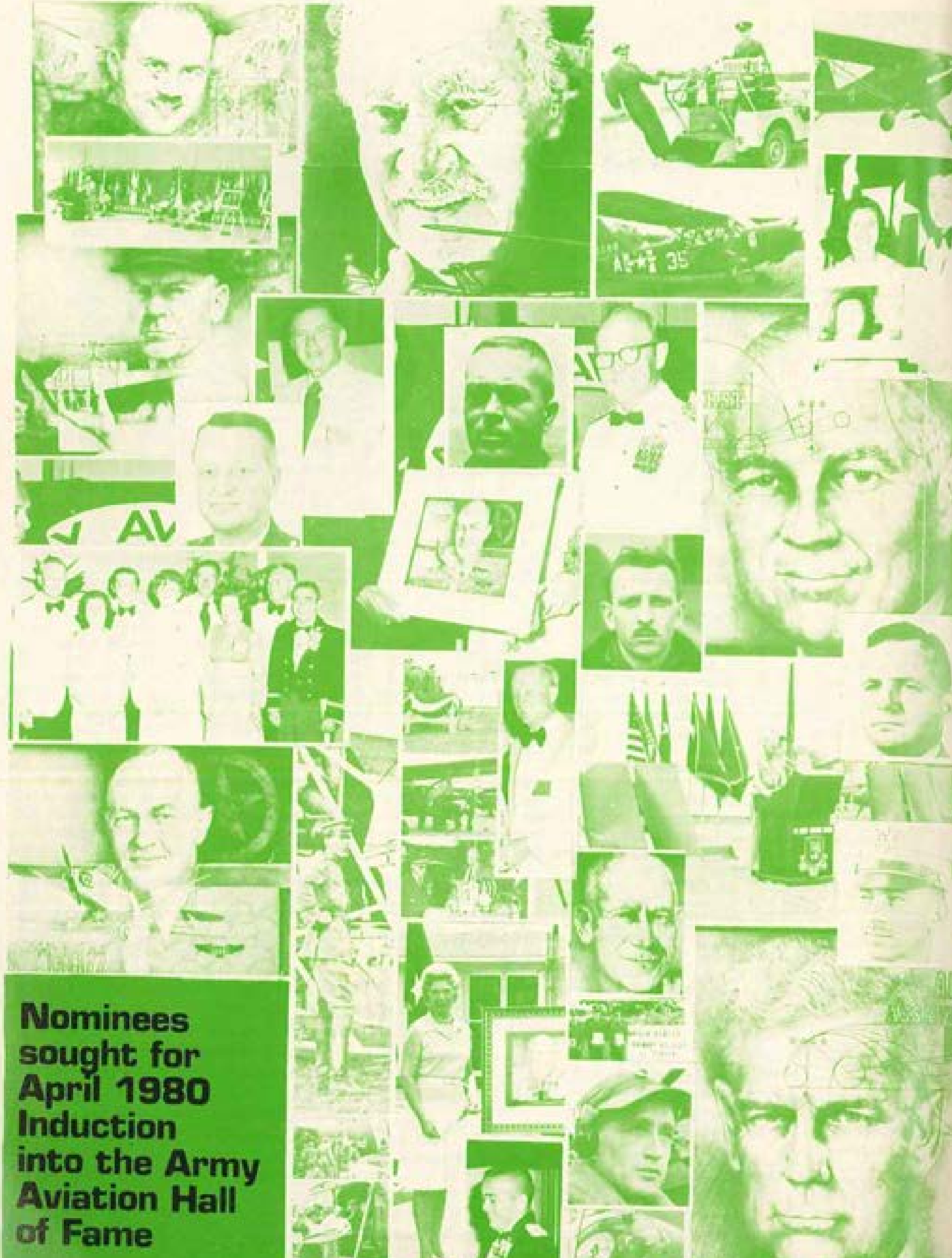
1979 Who's Who in Army Aviation

The first update of AAAA's "Who's Who in Army Aviation," the professional-social roster of the Association's active duty aviation warrant officer members, will be published as the centerfold insert in the December, 1979 issue. A "Personal-Professional Data Form "is to be mailed to each AWO association member this coming September 1 for October 1 return to the AAAA. ◄

 NOT RECEIVING YOUR ISSUES? DID YOU SEND IN A CHANGE OF ADDRESS?



Nominees sought for April 1980 Induction into the Army Aviation Hall of Fame

Nominees sought for 1980 induction to the "Army Aviation Hall of Fame"

BACKGROUND: An AAAA-sponsored "Army Aviation Hall of Fame" honors those persons who have made an outstanding contribution to Army Aviation, and records the excellence of their achievements for posterity. The "Hall of Fame" is located at Fort Rucker in the Army Aviation Museum where the portraits and narratives of the Inductees are displayed in a distinctive location. The costs of the program — selection, induction, portraiture, etc. are underwritten by the AAAA. ELIGIBILITY: Anyone may nominate a candidate for the "Hall of Fame." All persons are eligible for induction, except AD military personnel Civilian personnel are eligible prior to their retirement.

* * * * *

Nominations should be submitted on or before 1 December 1979 to AAAA, 1 Crestwood Road, Westport, CT 06880, and should include:

(1) The nominee's full name and address.

(2) A 40-50 word summary of the achievement(s) for which the candidate is being nominated to the "Army Aviation Hall of Fame."

(3) A current photograph of the nominee, if living, or information as to where such a photo or photos may be obtained.

TO: AAAA, 1 Crestwood Road, Westport, CT 06880

I'd like to nominate the following persons as candidates for induction into the "Army Aviation Hall of Fame" in April, 1980. On separate sheets, I've enclosed their full names and addresses (where known), a brief 40-50 word description of each of their accomplishments, and a photograph of each, where available. (Please print).

Nominee...

Nominee...

Nominee...

Your signature.................................

Volume 28 — Aug.-Sept, 1979 — Numbers 8 & 9

BLACK HAWK, 1979 — A SPECIAL ISSUE

(Continued from Page 4)

Applicants for 1980 AAAA Scholarship Aid Are Sought

The AAAA Scholarship Foundation, a separate non-profit educational activity created to provide scholarship aid to the sons and daughters of AAAA members and deceased members, announces the availability of assistance funds for the 1980 college-entry year. Program participation is limited to the children of members with an effective date of membership on or before March 31, 1979.

APPLICATION PROCEDURE

Student-applicants are asked to request the appropriate application forms by writing to the AAAA Scholarship Foundation at 1 Crestwood Road, Westport, CT 06880. Requests for applications must be received on or before December 15, 1979. Grades and test scores must be submitted by February 15, 1980. All forms, together with other supporting data, must be returned to the Foundation on or before February 1, 1980 to receive Awards Committee consideration. The student-prepared application should state the full name of the applicant's father-member and address of student if different.

ELIGIBILITY CRITERIA

The AAAA applicant must also be: (1) a high school senior who has applied to an accredited college or university for Fall, 1980 entry as a freshman; and (2) unmarried.

SELECTION & NOTIFICATION

Selection of winners will be made during the month of March 1980 with each applicant to receive a list of the winners not later than 1 April 1980.

BACKGROUND DATA

Incorporated in December 1963, the AAAA Scholarship Foundation provided 11 scholarships in 1979, and has furnished more than $64,100 in direct aid.

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