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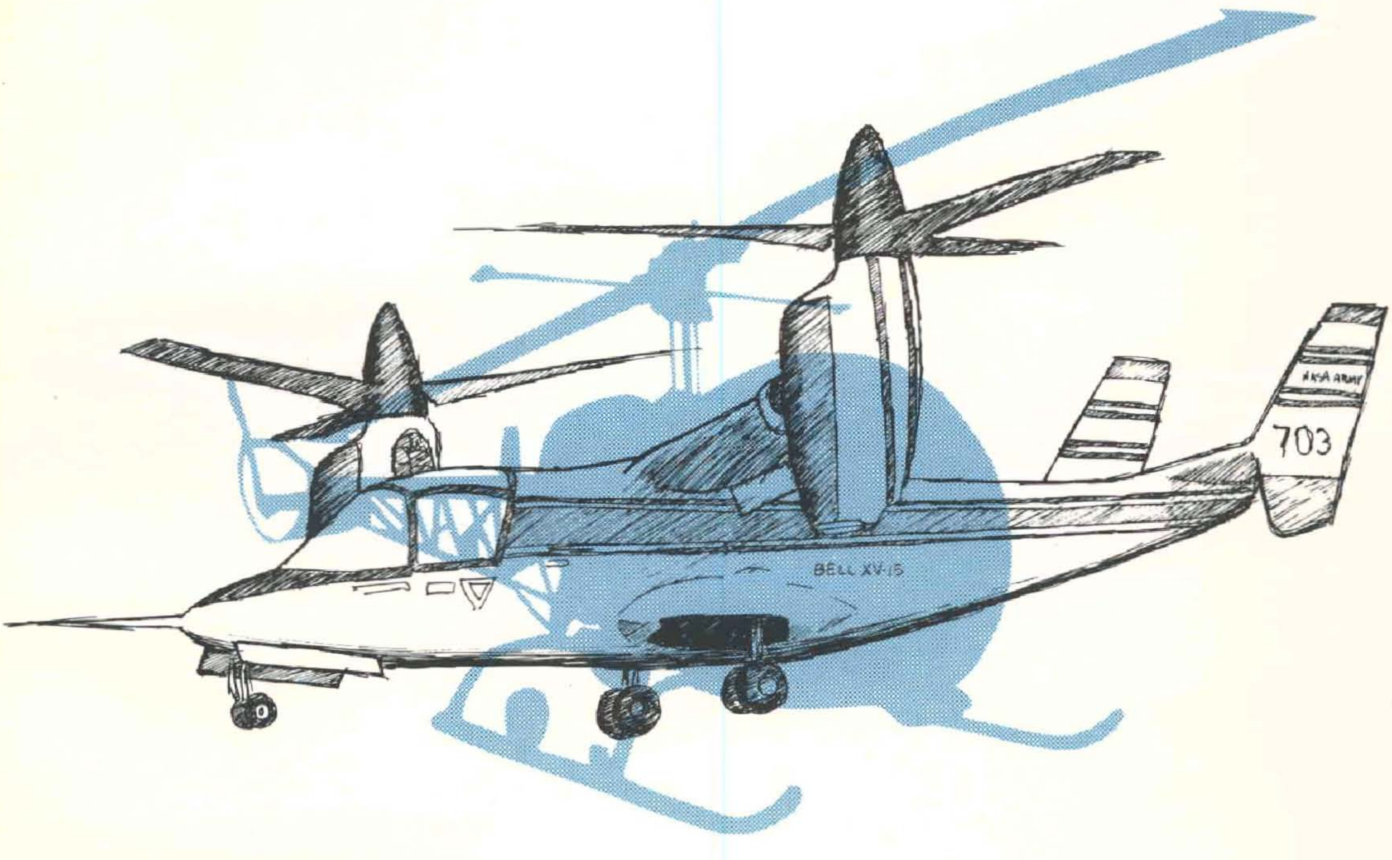

Focus on Army Aviation Technology

ARMY R,D&A

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ABOUT THE COVER:

Front cover shows a small sampling of past and future Army aircraft. A 1950-era OH13 and the Army/NASA-sponsored tilt rotor aircraft are depicted. Back cover shows a UH1B armed with a lashup of M60 machineguns and 2.75 rockets. Below is shown the Army's first designed armed helicopter, the YAH-64.

FEATURES

DEPARTMENTS

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Purpose: To improve informal communication among all segments of the Army scientific community and other government R,D&A agencies; to further understanding of Army R,D&A progress, problem areas and program planning, to stimulate more closely integrated and coordinated effort among Army R,D&A activities; to express views of leaders, as pertinent to their responsibilities, and to keep personnel informed on matters germane to their welfare and pride of service.

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TILT ROTOR AIRCRAFT

By Martin D. Maisel
and
LTC Clifford M. McKeithan

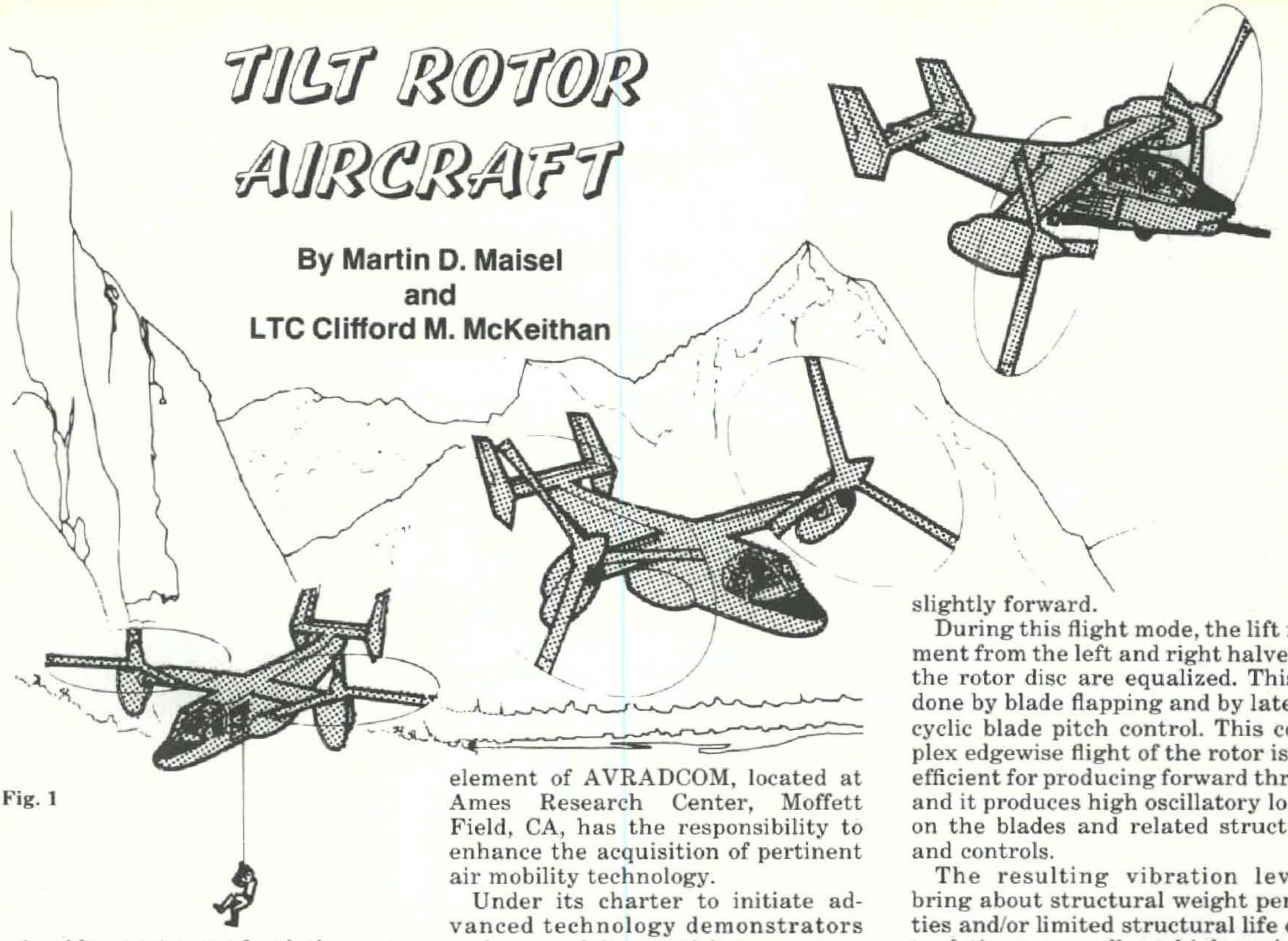


Fig. 1

A wide spectrum of aviation support is currently available to the Army ground commander. From the attack helicopter, with its tank-killing capabilities to the high flying reconnaissance airplane with its electronic surveillance systems, a variety of aircraft (both fixed wing and helicopter) are required for the total mission.

Now a new type of aircraft is emerging which will combine into one vehicle the favorable qualities of both the fixed-wing aircraft and the helicopter. The technology for this aircraft—called the Tilt Rotor concept—was developed in research programs conducted by the Army with other government agencies.

Tilt rotor technology is now approaching a degree of maturity which makes the concept a viable candidate for the next generation of military or civil vertical/short takeoff and landing (V/STOL) aircraft.

In recognition of the growing value of Army aviation and the importance of vertical lift capability, the Army assumed primary cognizance of its rotary-wing aircraft in a mid 1960s interservice agreement.

The U.S. Army Aviation Research and Technology Laboratories (RTL) element of AVRADCOM, located at Ames Research Center, Moffett Field, CA, has the responsibility to enhance the acquisition of pertinent air mobility technology.

Under its charter to initiate advanced technology demonstrators and to exploit promising new concepts and technology, RTL-AVRADCOM, in a joint effort with the National Aeronautics and Space Administration (NASA), and now with Navy participation, is verifying, through a full scale test program, the characteristics of the XV-15 Tilt Rotor Research Aircraft. This flight test program may be the introduction of a new chapter in Army aviation.

The helicopter has become a basic and integral part of the Army air mobility system. This is chiefly because of its unique ability to hover efficiently and its low speed maneuverability. This special hover and low speed capability is achieved by use of a large diameter rotor (or rotors) which provides the principal lift.

Although the helicopter has been able to perform the Army's VTOL missions effectively, some inherent characteristics have restricted expansion of the helicopter's domain.

In cruise flight, the helicopter must get both its lift and propulsive (forward) force from the main rotor. This is accomplished by altering the angle of each blade as it rotates around the disc (fore/aft cyclic pitch) such that the resulting force vector is tilted slightly forward.

During this flight mode, the lift moment from the left and right halves of the rotor disc are equalized. This is done by blade flapping and by lateral cyclic blade pitch control. This complex edgewise flight of the rotor is inefficient for producing forward thrust and it produces high oscillatory loads on the blades and related structure and controls.

The resulting vibration levels bring about structural weight penalties and/or limited structural life due to fatigue as well as high maintenance costs and crew discomfort.

Additional performance problems are caused by the high aerodynamic drag of the rotor hub assembly. The near sonic speed of the blade tip advancing into the free air stream increases drag (and hence the power required) and produces high noise levels. The stalled and negative flow on the blade retreating from the free air stream is, in addition, a source of the vibration and oscillatory loads.

The net result is that helicopters are currently limited to moderate speed (generally 130 to 170 knots) and moderate range (usually less than 300 nautical miles) applications. While these problems are being investigated, most solutions will only partially overcome the problems of the edgewise flight of the rotor.

One aircraft concept shows exceptional promise in minimizing or eliminating these problems. This concept provides that the large diameter rotor which produces the hover lift can be tilted fully forward for high speed flight. In this configuration the rotor serves as a conventional propeller while lift is produced by a conventional wing (Figure 1).

This "tilt rotor" concept has been under investigation for many years. The first successful tilt rotor aircraft, the XV-3, was developed by the Bell Helicopter Co. for the Army and the Air Force in the early 1950s. Flight and wind tunnel tests were conducted by the government, and the manufacturer verified the principles of the concept. The tests revealed problems in rotor/pylon/wing aeroelastic stability, stability and control, and handling qualities. The future of the tilt rotor concept, therefore, depended on the ability to satisfactorily resolve these technical issues.

During the late 1960s and early 1970s, the Army, NASA, the Air Force, and industry actively sought a basic understanding of and resolutions to these problems of the tilt rotor concept. The effort included analytical, wind tunnel, and flight simulator investigations.

When this technology base was completed, the Army and NASA jointly established a tilt rotor research aircraft project to demonstrate by flight tests that the key tilt rotor issues had been resolved.

Under this new program, two research aircraft (designated the XV-15) were fabricated by Bell Helicopter Textron. Preliminary hover and air taxi tests were conducted with aircraft No. 1 in May 1977 (Figure 2).

Following that initial hover period, the aircraft was transported to Ames Research Center, Moffett Field, CA, where, in May 1978, it was placed in the 40 × 80-foot wind tunnel. It underwent extensive tests of loads, performance, and stability. Aircraft No. 1 is currently being refurbished to the flight configuration and is scheduled flight status during 1980.

Aircraft No. 2 began the flight envelope expansion phase at Bell's Flight Research Center, Arlington, TX, in April 1979. By January 1980 approximately 30 hours of flight testing were accumulated. This included exploration of the helicopter mode, the conversion corridor, and the low speed portion of the airplane mode flight envelope (Figure 3).

Pilot comments have been favorable for all flight modes and conditions. Correlation of XV-15 flying qualities with prior flight simulations at the Ames Research Center Flight Simulator for Advanced Aircraft has been excellent.

Testing to higher airplane mode speeds will continue in CY80 at the contractor's facilities. Aircraft No. 2 will then be transferred to NASA's Dryden Flight Research Center, Edwards AFB, CA, where flight envelope expansion and proof-of-concept testing will be completed.

A concept evaluation flight test program will then be conducted. Both aircraft will be used to examine flight characteristics pertinent to potential civilian and military mission applications. These tests will include terminal area operations, environmental (noise and downwash) evaluations, and mission simulations.

After the concept evaluation phase, the XV-15 Tilt Rotor Research Aircraft will be utilized to conduct experiments in advanced tilt rotor and general V/STOL technology. XV-15 design characteristics are presented in Table 1.

TABLE 1
XV-15 TILT ROTOR RESEARCH AIRCRAFT CHARACTERISTICS

• WEIGHTS	
DESIGN GROSS WEIGHT (DGW)	13,000 lb
EMPTY WEIGHT	9,670 lb
MAXIMUM USEFUL FUEL	1,471 lb
• SIZE	
WING SPAN (BETWEEN ROTOR AXES)	32.2 ft
OVERALL LENGTH (INCLUDES INSTR BOOM)	46.3 ft
WING AREA	169 ft^2
• LOADINGS	
WING LOADING (@ DGW)	77ft^2
DISK LOADING (@ DGW)	13.2 ft^2
• PROPULSION SYSTEM	
ENGINES (2)	LYCOMING LTC1K-4K (T-53 MOD)
NORMAL RATED POWER	1,250 SHP
ROTOR DIAMETER	25.0 ft
ROTOR TIP SPEED (HELICOPTER/AIRPLANE)	740/600 ft/sec

Although mission requirements are determined by user agencies, it is hoped that this discussion will stimulate the imagination of the user when he recognizes that air mobility may no longer be limited to the capabilities of existing helicopter or fixed-wing aircraft. The tilt rotor concept will provide a new dimension of flexibility in the strategy and tactics available to the military commander.

The introduction of any new aircraft into the Army inventory requires extensive evaluations of all pertinent factors. A newly developed *concept* receives an even more stringent examination, making the "selling" process a formidable task.

The mission flexibility and potential life cycle cost advantages offered by the increased flight envelope of the tilt rotor aircraft cannot be ignored. This is particularly true in light of the historical patterns observed following the introduction of the helicopter. Roles and missions eventually developed well beyond the scope envisioned by the originators.

Although it was originally developed for the Army medical evacuation missions, the UH-1 aircraft has become ubiquitous. It is meeting a wider range of missions in the military and civil sectors than any aircraft in history.

Army aviation performs a broad spectrum of missions which require a range of performance characteristics not currently possessed by a single type of aircraft. Some missions require the ability to take off and land vertically. These applications usually require the aircraft to spend extensive time in hover and to exercise a high degree of agility in the nap-of-the-earth environment.

Other missions emphasize good high altitude performance, high

Fig. 2. XV-15 in hover configuration.

Fig. 3. XV-15 in airplane configuration.

cruise speed, long loiter times, and high payload capabilities. Neither the helicopter nor the airplane is able to meet all of these requirements. Therefore, a mix of helicopters and airplanes is required.

Even within those categories, compromises are necessary between aircraft capabilities and mission requirements. Having accepted those compromises, the tactical doctrine for the employment of aviation assets becomes constrained by the operational limits of the aircraft selected.

The advent of a practical tilt rotor aircraft provides the opportunity to minimize the constraints imposed by the operating envelope limitations of current aircraft. The capabilities of tilt rotor aircraft combine the most desirable characteristics of both categories: the vertical takeoff, hover and agility of the helicopter with the high speed cruise, range, payload, efficiency, and low vibration of the airplane.

The broad capability of the tilt rotor aircraft permits the tactician to consider options not previously available to him. The speed and range of such aircraft allows maintenance and staging areas to be placed further behind the forward edge of the battle area (FEBA). The commander has the flexibility of rapid lateral redeployment to critical locations.

High speed penetrations deep into the enemy's rear to attack key logistical and command, control, and communications (C^3) facilities become feasible with the large performance envelope of the tilt rotor.

Given the increasing lethality of the "threat" air defenses, survivability of aviation systems is of deepening concern. Four factors important to survivability are agility in the nap-of-the-earth (NOE) environment, maneuverability at high g-loading, high dash speeds, and low aural signature. Agility in the NOE environment is critical to minimize detectability. Maneuverability at high g-loading is necessary to "break-lock" of threat weapons systems. High speed dash is necessary for survival when the terrain cannot provide masking. With increased emphasis on acoustical detection and targeting, aural signature assumes higher levels of importance. The tilt rotor aircraft shows promise of excelling in all four areas.

The tilt rotor aircraft possesses other characteristics significant to military applications. Loiter time is important for many military aircraft. Minimum fuel flow can be obtained over a wide band of speeds by varying the tilt of the nacelles. Thus, a single type of aircraft can be used for many missions ranging from high altitude stand-off EW missions to low level, low speed visual reconnaissance.

Another characteristic of tilt rotor aircraft, the low vibration levels experienced in the airplane mode, can produce benefits in aircrew proficiency and endurance, aircraft structural fatigue levels, maintenance factors and the design parameters for avionics and mission equipment. High-speed fuel-efficient cruise mode also provides the tilt rotor with the ability to be readily self-deployed to the European theater.

A number of applications can be readily visualized to utilize the capabilities of tilt rotor aircraft. Some of these include special electronics missions, reconnaissance and surveillance, medical evacuation, command and control, utility, medium lift, penetration raids and insertions, as well as rear area security.

The appearance of the Hind-D attack helicopter has made us aware of the need to field a defensive air-to-air capability. With its speed, range, and superior maneuverability in the tilt rotor mode, this aircraft appears to be ideally suited to intercept, maneuver against, and defeat the Hind-D. The XV-15 research aircraft has already demonstrated that the tilt rotor could exceed the Hind-D's climb, descent, and speed capabilities.

Possible tilt rotor applications are not confined to the Army. All the Services have possible uses for its capabilities. In the Marine Corps, there are a number of applications similar in nature to Army missions.

In the Navy, the tilt rotor might serve in antisubmarine warfare, antiair warfare, antisurface warfare, airborne early warning, search and rescue, carrier and vertical onboard delivery/vertical replenishment, and possibly the remoting of active sensors away from ships.

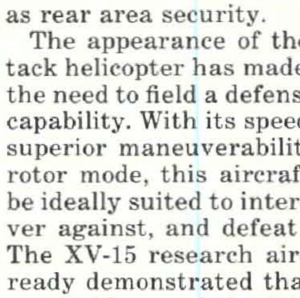
The Air Force could use the tilt rotor for short-haul transport, search and rescue, and forward air controller duties. The Coast Guard has some missions similar to the Navy's as well as the unique missions of coastal patrol and environmental pollution monitoring.

Evidence that the tilt rotor aircraft is being seriously considered is provided by the Navy's investment of over $4 million to accelerate the concept evaluation flight test program. This acceleration will enable the tilt rotor to be evaluated as a possible replacement for the Marine Corps' aging CH-46 fleet or the next Navy subsonic V/STOL aircraft.

The development of new military aircraft has often resulted in spin-offs to the civil sector. In the XV-15, there is a unique opportunity to evaluate civil mission capabilities simultaneously with military applications development. A wide variety of civil tasks readily come to mind: off-shore oil rig support, interurban travel, executive transport, pipeline/powerline surveillance, border patrol and air ambulance service.

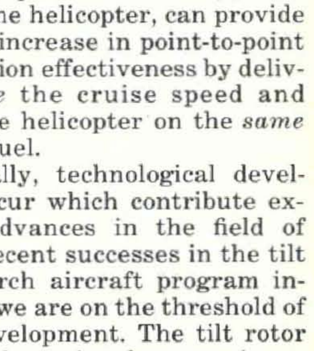
The tilt rotor aircraft, with its capability to operate out of confined areas like the helicopter, can provide a dramatic increase in point-to-point transportation effectiveness by delivering *twice* the cruise speed and range of the helicopter on the *same* amount of fuel.

Occasionally, technological developments occur which contribute exceptional advances in the field of aviation. Recent successes in the tilt rotor research aircraft program indicate that we are on the threshold of another development. The tilt rotor is an idea whose time has come!



MARTIN MAISEL joined the Army Aeronautical Research Laboratory (now the Aeromechanics Laboratory), Research and Technology Laboratories (AVRADCOM) in 1970. He has been involved in tilt rotor aircraft research since 1967. He has a BS degree from Polytechnic Institute of Brooklyn and has done graduate work at the Rensselaer Polytechnic Institute.

LTC CLIFFORD M. McKEITHAN joined the Tilt Rotor Aircraft Program at the Aeromechanics Laboratory, U.S. Army Research and Technology Laboratories (AVRADCOM) in June 1979 as the deputy program manager (Army Liaison). Prior to this, he was the R&D coordinator for the Directorate for Development and Engineering, AVRADCOM. He graduated from the United States Military Academy in 1962 and has a master's degree from the Georgia Institute of Technology.



Rotor Systems Research Aircraft

By LTC Robert K. Merrill

The term "flying wind tunnel" has been coined to describe the newest, and perhaps most sophisticated aircraft to join the Army inventory. Two Rotor Systems Research Aircraft (RSRA), developed by Sikorsky Aircraft Division of United Technologies Corp., have been delivered to NASA Ames Research Center, Moffett Field, CA.

The RSRA was developed under a joint Army/NASA contract, and will begin a long range research program in future helicopter rotor systems. Designed purely as a research aircraft, the RSRA is a rotor test vehicle that will add a new dimension to the field of rotary wing research.

In the late 60s, efforts to advance the state-of-the-art in rotor systems technology, while meaningful in their own right, indicated a significant gap in our predictive techniques and an accurate, repeatable correlation between the theoretical approach and the resultant flight verification. Even full scale wind tunnel efforts proved inaccurate because of the complex nature of a rotating, maneuvering rotor system.

The missing key element which prevented significant advances was our inability to precisely measure the exact rotor state as a function of time and flight condition. The "trial and error" method proved costly, both from the fiscal considerations and the extreme risk to flight crews.

Each candidate rotor system required the development or modification of an airframe to match the system under study. Every rotor system research effort, in fact, became a total aircraft development program. There was a general reluctance to depart very far from proven, successful concepts to investigate innovative, yet unproven rotor systems.

The RSRA provides the platform to test a wide range of different rotor system configurations without the associated costs and risks, both fiscal and personal, of developing the matching airframe. In addition, the RSRA will provide accurate data on rotor states which will enable us to modify and refine our predictive and analytical methodology.

A research vehicle, in order to be useful, must have certain basic capabilities. A flight test envelope must exist which will encompass the expected envelopes of future rotor systems under all flight conditions. Versatility must be provided within the flight control system to exploit this envelope and to allow accurate, repeatable test results.

Finally, a measurement and data acquisition system must be provided to accurately record desired flight parameters so that useful data analysis can be performed in a comprehensive manner.

To provide these capabilities, a compound helicopter concept was used (Figure 1). In this configuration, fixed wing control surfaces and auxiliary propulsion engines are used to provide reactive forces and moments against the rotor system. This allows for the investigation of the complete rotor envelope during flight.

An added advantage is realized in that the airframe is not dependent upon the rotor to provide the required lift or thrust for flight. This will play an important role in safety considerations, to be described later.

The 45-foot wing installed on the aircraft may be varied between +15 and −9 degrees of incidence, which in turn can vary the required rotor thrust from zero to that which would be required for a much heavier aircraft. The wing has conventional flaps and ailerons, which can provide drag or a rolling moment re-

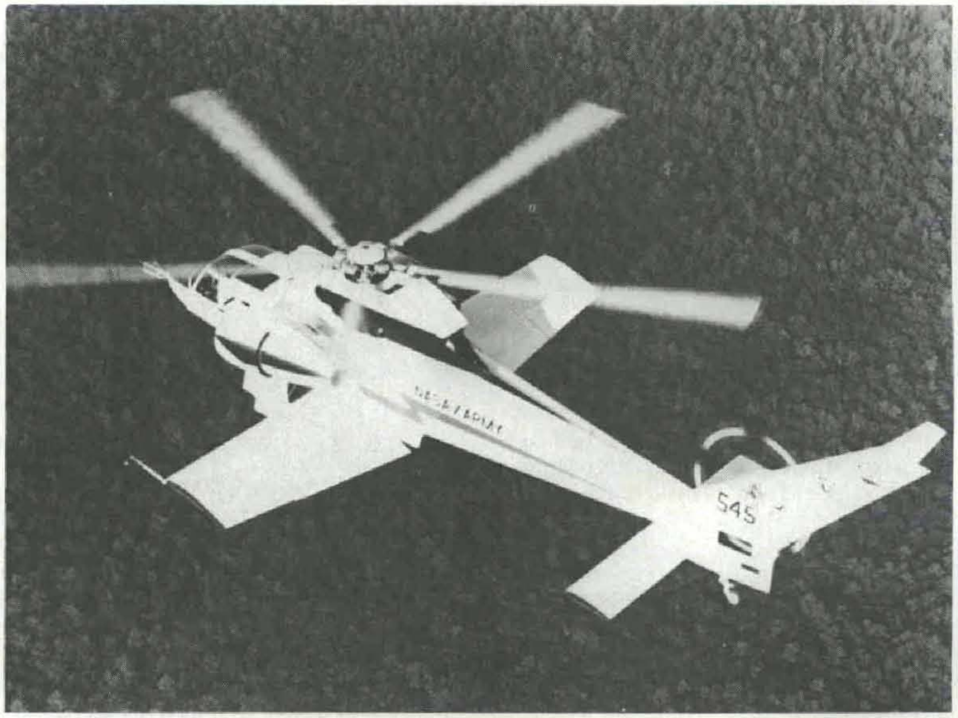


Fig. 1. RSRA compound helicopter configuration with fixed-wing control, lower tail, and auxiliary propulsion engines.

action to the rotor system under study.

The tail section of the RSRA contains a conventional helicopter tail rotor, a lower variable incidence stabilizer with fixed wing elevator controls, a rudder, and a drag brake. These controls provide further reactive forces and moments about various axes, and are fully controllable from the cockpit or by the electronic flight control system.

Auxiliary engines are General Electric TF-34-400A high bypass turbofan engines, the same type that are installed on the Navy S-3A "Viking" antisubmarine aircraft and the Air Force A-10 close support aircraft. These engines are thrust-rated at 9,275 pounds each and are used to offset the drag effects of the candidate rotor system.

The wing, auxiliary engines, lower tail, and rudder can be removed from the RSRA compound helicopter, resulting in an alternate flight configuration, that of a pure helicopter, which is actually the standard configuration of the second aircraft currently flying (Figure 2).

Common to both the compound and helicopter configurations are the rotor system dynamic components, rotary wing engines, fuel, electrical, and three of the four hydraulic systems. The design philosophy was to use as many proven components as possible to reduce technical risks and provide easier maintenance of the two aircraft during initial operations.

The H-3, or S-61 helicopter rotor system, GE T-58 engines, transmission, drive train and tail rotor were selected for initial installation to provide a well documented, proven system for the initial envelope expansion conducted by the contractor.

This rotor system has an adequate performance envelope and capability to allow a thorough systems integration flight investigation of the RSRA. It will also allow a baseline data acquisition

Fig. 2. RSRA compound helicopter, with wings, lower tail and auxiliary engines removed to provide flight configuration of a pure helicopter.

program to be conducted by the government.

The RSRA flight control system designed to provide versatility to the flight research task is truly unique. Safety dictated one crewmember must have direct positive override control capability of the aircraft at all times, thus an essentially standard hydromechanical control system is installed.

With the increased control surfaces available in the compound configuration, a means of "control sharing" had to be incorporated. This was accomplished by providing a pilot selected control phasing unit (CPU) referenced to the axes of the aircraft.

The CPU allows the pilot to select the proportion of control inputs to be made by the fixed or rotary wing control surfaces. For example, if a bank angle is desired, the aircraft can be banked by either the wing mounted ailerons or by tilting the main rotor.

With a 50 percent-50 percent sharing selected on the CPU, both the aileron and rotor contribute equally to the resultant bank angle. With a 100 percent fixed wing CPU selection, the entire bank is caused by ailerons. The CPU is available for the three primary aircraft axes and this capability becomes even more important during the research flight control system tasks.

The flight control system provided specifically for the research task is an electronic "fly-by-wire" system. The left seat, or evaluation pilot flys the aircraft through electrical signals which are ultimately summed into the primary mechanical control system. This summing can be either directly, through a force feel system, or through a digital computer.

The heart of the electronic flight control system is the Teledyne TDY-43 general purpose, flight qualified, digital computer that can be programed in numerous ways to provide changes in stability and control or force feel system gains.

The computer also can be programed to make various control inputs in a predetermined direction and magnitude. A third flight crewman, the research engineer, has direct access to the computer through his Program Monitor and Control Unit so that software may be monitored and gains changed in flight.

Three selectable research control modes of operation of the EFCS provide for maximum flexibility. These modes are manual, automatic, and auto/manual. In the manual mode, all of the control surfaces are under the control of the evaluation pilot who flies the aircraft through the computer using the programed control gains. This allows the RSRA to be used as a 5-degree-of-freedom in flight simulator in studying the aircraft handling qualities associated with a research rotor.

In the auto/manual mode, several control surfaces are under control of the evaluation pilot, while the remaining surfaces are under direct control of the computer. For example, the evaluation pilot could exercise manual control of the rotor under test, while the computer used the fixed wing controls to simulate a fuselage with different mass or inertia characteristics. In this case, a given rotor could be placed on a specified range of "simulated" fuselages in a short period of time, and performance recorded.

In the automatic mode, the computer has complete control of all surfaces. This mode could be used in the compound configuration, for example, to map rotor performance rapidly and precisely. A series of collective pitch inputs over a predetermined range could be made while holding all other rotary wing controls constant.

At the same time, the fixed wing controls would be used to offset the step increases in main rotor thrust, and maintain a constant altitude and airspeed. We therefore can accurately measure a single variable while holding all other variables and test conditions constant.

The third basic capability in any research vehicle is an effective and complete data acquisition and measurement system. In the RSRA, the knowledge that the aircraft would be used solely for research allowed the designers to incorporate many sensors during initial construction, usually an after-the-fact, time consuming effort in flight investigations.

An extensive on-board magnetic tape recording system provides a total record of flight test data which can later be computer processed to provide thorough analysis. In addition, a real time, telemetry capability allows ground based engineers to monitor any critical flight parameters and limits using strip charts and recently developed on-line computer conditioned data display system.

Design efforts to provide accurate force and moment measurements of the rotor system and all control surfaces were extensive. Load cells are used to measure individual component contributions to the total force and moment results. These must be calibrated so that total readings may be properly interpreted. The method of accomplishing this will be the use of a ground calibration rig, currently under construction.

The rig will place calibrated representative flight loads on all surfaces and exercise the complete data acquisition and force/moment systems interface. The compound helicopter entered the calibration rig in April of this year for a 2-month period.

Another system requiring extensive design effort is the Active Isolation/Balance System (AIBS), used to minimize the transmission of rotor system vibrations to the fuselage. During helicopter design, a rotor system/fuselage combination is normally matched so the vibration level is minimized over a very narrow frequency range based on the normal operating RPM.

Special devices may be used to further reduce the levels within the frequency spectrum generated by a particular rotor system.

In the case of the RSRA, it was anticipated that a much wider range of vibration magnitudes and frequencies would require attenuation since the capability to test any size or number of blade system was required. In view of this, the transmission is mounted on a rigid frame which in turn is separated from the fuselage by four hydropneumatic isolators. These isolators, through a pneumatic precharge and oil metering system, provide attenuation of high frequency vibrations.

A feedback system provides an automatic centering of the transmission over a wide range of forces and moments generated by a research rotor system. Compensation over a wide frequency spectrum can be made by adjusting the air precharge so each isolator acts as a "shock absorber." This system is extremely effective and has been flight demonstrated during the RSRA development program.

Perhaps the most innovative system developed for the RSRA is the Emergency Escape System (EES). It is the only system that will not be flight tested, but nonetheless, complete confidence in its success, if used, must exist.

During the initial design considerations, it was deemed necessary to provide the flight crew with an escape system based on risk analyses of the hazards associated with rotor system testing over the 15-year design life of the RSRA. This was especially true in the compound configuration where the proximity of the auxiliary engines, wing, and tail to the normal escape windows would preclude a manual bail-out at even moderate airspeeds.

While studies and limited experimentation with helicopter escape systems had been conducted, no complete system had been designed, fabricated, tested, and declared qualified and operational. Technology was available from many different sources, and the tremendous systems design and integration task was undertaken by the RSRA project team.

The resulting escape system is truly an engineering masterpiece. It is a modification of the Stanley "Yankee" extraction system, used successfully in the T-28 and A-1 aircraft in Southeast Asia.

The "full escape" system consists of a dual, completely redundant network of pyrotechnic transfer lines to various components which: sever the main rotor blades near the hub; fracture the overhead canopies; launch the tractor type main escape rockets to extract the three crewmembers and; provide for a fully automatic parachute deployment and seat separation.

An alternate mode of operation in the compound helicopter allows for initiating only that portion of the network that severs the main rotor blades. Since the aircraft does not rely on the rotor system for lift, the third flight configuration results, that of a pure fixed wing airplane.

This option allows the crew, in the event of stability problems with a research rotor, to jettison that rotor, and fly the airplane home using the fixed wing controls and auxiliary engines for thrust. The remainder of the network remains available in the event a full escape is required from the fixed wing airplane.

The escape system is strictly a self-contained pyrotechnic and mechanical system requiring no external electrical power sources for operation. It has been fully qualified in extensive component testing and in entire system testing conducted with dummies on a high speed rocket sled at Holloman AFB, NM. In five sled tests at 0, 134, 166, 209, and 210 knots from ground level, thirteen full extractions of the crew resulted in a 100 percent success rate.

Based on extensive simulations of initial aircraft reactions following the severence of the main rotor blades, and considering a worst case situation, the minimum escape altitude has been established at 250 feet in any aircraft attitude.

During preflight briefings for RSRA flights, a complete review of the escape envelope is conducted for the flight conditions to be flown. The system is an example of an overriding design concern on the entire RSRA program, that of crew safety.

To date, the RSRA has flown in two configurations, pure helicopter and compound helicopter. First flight of the helicopter occurred on 12 October 1976, at the Sikorsky facility in Stratford, CT. The contractor has demonstrated basic structural airworthiness and has flown the helicopter to 120 knots at a gross weight of 18,200 pounds.

The compound helicopter first flew at the NASA Wallops Flight Center, Wallops Island, VA, on 10 April 1978. All systems in this configuration have been demonstrated and the airspeed envelope expanded to 190 knots at 26,200 pounds gross weight by contractor pilots. Further flight testing and system qualification work will be conducted on this configuration by the government after calibration of the measurement system at Ames Research Center.

While the fixed wing configuration has not flown yet, plans are to remove the rotor and flight qualify the airplane in the 1982 time frame. Simulation studies indicate the airplane will be the most stable configuration of the three, and no major flight problems are anticipated.

The entire RSRA program was initially managed at Langley Research Center, VA, by a joint Army/NASA Project Office under the auspices of the Structures Laboratory of the U.S. Army Research and Technology Laboratories (AVRADCOM).

A NASA Center mission realignment in 1978 assigned all helicopter responsibility to Ames Research Center, CA. Upon acceptance of the two aircraft from the contractor, they were transferred to ARC, where they are now managed by a joint government team consisting of personnel from NASA's Helicopter Technology Division and the Aeromechanics Laboratory of USARTL.

The next several years will be devoted to fully developing system capabilities and gathering baseline data for future research efforts.

The RSRA will provide a national facility for rotor system and supporting technology development. Future generations of Army helicopters will benefit greatly by the knowledge gained from the "flying wind tunnel," the Rotor Systems Research Aircraft.

LTG Baer Retiring

As the magazine went to press official notification was received that LTG Robert J. Baer, DARCOM's deputy commander for Materiel Development, will retire effective 30 June 1980. LTG Baer has held this position since September 1977. No successor has been announced as of press time.

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Advancing Blade Concept Flight Research Program

By Harvey R. Young

The Advancing Blade Concept (ABC) a coaxial, counterrotating, hingeless helicopter rotor system, has been flight tested up to level flight speeds of 160 knots as a pure helicopter and up to 227 knots with auxiliary propulsion.

Test results have verified the feasibility of this type of rotor system, and many of the original concerns, or technical risk areas, have been laid to rest. Lessons learned during the flight test program have been of great value although, on occasion, painful.

For example, a hard landing in 1973 created a new respect for "low-speed aerodynamic phenomena" and resulted in more cautious program management when it became clear that only one ABC aircraft would be available for the remainder of the flight program.

The ABC flight research program began December 1971 with a contract between the U.S. Army Research and Technology Laboratories (AVRADCOM) Applied Technology Laboratory (ATL), Fort Eustis, VA, and Sikorsky Aircraft Division of United Technologies. The contract called for the design, fabrication and flight test of two ABC configured research aircraft.

By July 1973, two ABC aircraft, designated XH-59A, had been constructed and were ready for testing. Shortly, one aircraft was extensively damaged leaving only one flightworthy vehicle.

By March 1977, flight testing of the XH-59A, as a pure helicopter, i.e., without auxiliary propulsion engines, had been completed. Up until 1977, ATL had contractual and technical responsibility for the program and all funding came from the Army's budget.

In June 1977, a joint Army/Navy/NASA funded program was approved to investigate high-speed characteristics of the ABC rotor. Since that time, efforts have focused on high-speed tests.

The U.S. Navy has established a Program Coordinator and since October 1979 has solely supplied funds, while ATL continues contractual and technical program execution.

The ABC differs from other coaxial helicopter rotors in both physical construction and operational capability. ABC rotor blades are extremely stiff and are rigidly attached to the rotor hub. Stiff blades preclude excessive deflections under high loads. Their rigid retention to the rotor hub also prevents flapping excursions associated with conventional rotors.

XH-59A in test configuration, with J-60 turbojet engines.

Rotor blade pitch is controlled by swashplates in the same manner as conventional rotors. Unique to this concept, however, is the ability to intentionally vary the loading on the advancing side of the rotor as compared to the retreating side.

This feature, made possible by the stiff and counterrotating, rigidly attached blade, largely eliminates classical retreating blade stall and permits operation at high thrust coefficients and advance ratios.

Advantages of this rotor are: rapid control response/high damping; superior maneuverability, particularly at high speeds and high altitudes; deletion of the requirement for a tail rotor, with attendant benefits in safety, simplicity, vulnerability, compactness, noise signature, and performance; high-speed capability without wings when provided with a source of horizontal thrust; low disc loading compared to other high-speed VTOL concepts; and rugged rotor.

How do these advantages relate to existing or proposed missions? What new missions may now be possible with an aircraft that combines these advantages? What price is paid for these advantages? These are questions that have now been, at least partially, answered.

Missions requiring nap-of-the-earth (NOE) flight are obviously best performed by compact helicopters that are not encumbered with a tail rotor. Crisp control response, low noise signature, and a rugged rotor are additional features of high importance for NOE type missions.

It's interesting to note that the rugged ABC rotor is a by-product of the blade stiffness requirement. No "extra price" is paid for this rotor which should be able to withstand tree limb strikes and small-arms fire better than conventional rotors. The first, second, and fourth advantages listed above are of value for missions involving air-to-air combat.

An ABC aircraft with auxiliary propulsion seems uniquely qualified for air-to-air engagements throughout a broad airspeed range. Other high-speed VTOL aircraft that must observe "conversion corridors" while transitioning from one flight mode to another become vulnerable or lose effectiveness through these speed ranges.

A production version of an ABC helicopter with auxiliary propulsion would use an integrated lift/thrust propulsion system. This sytem would selectively power the rotors for lift or power the fans (or propellers) for thrust or distribute power as desired between the rotors and fans.

This type of system does not require a configuration change throughout the entire flight envelope, and a conversion corridor, as such, does not exist. Power management between rotors and fans and a reduction in rotor RPM at high speeds are required.

Low disc loading, advantage number five, above, is of crucial importance for missions involving considerable hover time or for aircraft operations from unprepared fields.

Where speed is not a factor, and the mission is primarily logistical in nature, a conventional helicopter with a disc loading of less than 8 pounds per square foot is the proper choice. However, for missions that include speeds above 170 knots, in addition to considerable hover time, an ABC helicopter with auxiliary propulsion is a logical candidate.

The accompanying photograph shows the XH-59A aircraft flying in its test configuration with J-60 turbojet engines installed for auxiliary propulsion. The cylindrical "can" between rotors contains slip rings essential for transmitting rotor blade strain gauge information.

The first flight of the XH-59A aircraft occurred on 26 July 1973, 19 months after the contract was awarded. On 24 August 1973, after the aircraft had been flown less than four hours, a low-speed accident occurred. While flying at 25 to 30 knots at an altitude of about 50 feet, the aircraft pitched nose up, lost altitude, and was extensively damaged in a hard, tail-first landing.

A detailed accident investigation, involving wind tunnel tests of 1/5 Froude scale model XH-59A aircraft, was conducted. Results of the wind tunnel tests, projected to the full-scale XH-59A aircraft, disclosed a significant difference between analytically assumed fore-and-aft variation of inflow through the rotors and the actual inflow.

The actual induced velocity through the rear of the lower rotor was estimated to be more than double that assumed in the analysis. The "fix" consisted of modifying the flight control system in the remaining XH-59A.

Longitudinal and lateral cyclic control ranges were doubled, a simple stability augmentation system (SAS) was added, and an in-flight adjustable cyclic phase angle changer was installed.

In retrospect, the accident may have been fortuitous even though the program was derailed for two years. It gave birth to a new emphasis on analytical accuracy. New rules were drawn up that demanded acceptable correlation between preflight predictions and actual flight data as a requisite for continuation of flight testing.

This same philosophy continues to be used. Although frustrating at times for "schedule makers," it is seen as a device that not only fosters safety but produces a technical consensus by forcing confrontation between analysts who make predictions and test personnel who obtain actual data.

From July 1975 until March 1977, the XH-59A was flown an additional 64 hours as a pure helicopter. Flight results confirmed several important advantages of the concept and identified some shortcomings. Some of the more important finds were:

• Classical retreating blade stall was substantially delayed. This result was expected from previous full-scale wind tunnel tests of an ABC rotor, but it was significant to confirm this advantage in actual flight where maneuverability and general handling qualities were simultaneously assessed. It was demonstrated that the ABC rotor sustains lift under conditions where conventional rotors stall out, and the rotor lift distribution needed to achieve this result is easily obtained by changing the azimuth angle where blade feathering is applied.

• Hover performance based on rotor figure of merit calculations was excellent.

• Level flight performance expressed in terms of total helicopter lift/drag ratio (L/D), was within the same range as most other helicopters.

• The rotors remained aeromechanically stable throughout the test program, and no adverse elastic couplings were recorded.

• Rotor blade tip clearance remained adequate for all flight conditions. Although the ABC rotor blades are extemely stiff and rigidly attached to the hub, deflections occur due to air load, gyroscopic and inertia forces.

• The sustained load factors developed during pull-ups and pushovers of +2.5 g and 0 g respectively met contract objectives and were attained without reaching the endurance limit of any critical component. This was considered a major achievement and indicates potential for considerable weight reduction in a production ABC helicopter.

• Blade feathering bearing failures occurred on two occasions. Bearing condition was initially monitored by conducting periodic spectrographic analyses of grease purged from the rotor blade sleeve bearing assemblies.

• Hover control power and damping in pitch and roll were outstanding. Directional control power and response was characterized by a yaw acceleration of 40 deg/sec^2 and a peak yaw rate of 70 deg/sec achieved three seconds after control input.

• Autorotational entries were stable and relatively straightforward. Minimum rate of descent was 2280 ft/min at 100 percent rotor speed and 2000 ft/min at 95 percent rotor speed.

• Vibratory levels in the cockpit were highest at 50 knots and at maximum speed. The primary sources of vibration were 3-per-revolution lateral forces and rolling moments.

• Noise signature of the XH-59A was measured in hover and compared with a variety of other helicopters. Results showed the aircraft to be much quieter than all other helicopters except the OH-6. Credit for low noise signature is attributed to lack of a tail rotor and to running the rotor at a relatively low tip speed at 650 ft/sec. Quietness of the XH-59A helicopter in forward flight is dramatic when compared with 2-bladed helicopters that produce blade "slap."

The XH-59A was modified by the installation of two J-60 turbojets, ancillary equipment, stabilizer angle change, and airframe beef up. The first flight with cold jets occurred in April 1978, and the aircraft was airborne with hot jets for the first time on 2 August 1978.

The aircraft was then moved to Sikorsky's Flight Test Development Center in Florida where there was more clear air space and more extensive data-reduction facilities.

Gross weight of the aircraft had increased to 12,500 lbs. compared to a design value of 11,100 lbs. This caused some initial concern about runway length required in case of engine failure at point of liftoff. However, as often happens, another problem crops up. In this case, the main landing gear developed cracks and flying was suspended until newly designed gears were available.

First flights were devoted to the establishment of piloting techniques for normal and emergency procedures.

Since aircraft trim requirements at a given airspeed could now be satisfied for a variety of control settings and power/thrust levels, simple plots showing airspeed versus control positions became carpet plots. These involved

J-60 thrust, lift engine torque, and control positions for a family of airspeeds. It complicated the process of tracking actual flight test data against predictions.

The aircraft was in a flight test status from 6 November 1978 until 17 May 1979. Of the 19.2 hours accrued, 5 hours were government pilot familiarization and evaluation flights to 170 knots. Piloting techniques were established for normal and emergency flight with level flight speeds up to 227 knots; load factors to +1.95 g at 180 knots and 0 g at 180 knots were developed.

These flights confirmed the basic controllability of the XH-59A aircraft with auxiliary propulsion. Good correlation was obtained between preflight performance predictions and actual data in spite of the aircraft flying four to five degrees more nose up than predicted.

As might be expected, a variety of problems with instrumentation and subsystems hampered progress. The previous problem of blade feathering bearing failure occurred on two more occasions, and small airframe cracks appeared.

One of the most frustrating problems was high stress in the aluminum lug-type fittings that attach the horizontal stabilizer to the tailcone. These stresses exceeded the endurance limit for many trim flight conditions.

Even after incorporation of drag braces to redistribute the loads, they limited the regimes that could be explored. High stresses were caused by airframe excitation that resulted mainly from 3-per-revolution rotor induced rolling moments.

Although rotor shaking moments and forces were predicted to be high without isolation, the analysis predicted that the fuselage response to these forces would be lower at reduced rotor speed. The problem was that the flight envelope could not be expanded sufficiently at 100 percent rotor speed to initiate testing at substantially reduced rotor speed.

At 100 percent rotor speed and 204 knots, cockpit vibration levels had reached 0.9 g and structural damage was occurring in the J-60 engine mounts, tailcone, stabilizer lugs, and certain rudder control components.

After reaching this "wall" on vibration, the aircraft was taken out of flight status and subjected to various inspections, tests, modifications, and refurbishments.

Flight testing resumed on 15 November 1979 with a maintenance check flight. On 20 November 1979, the aircraft was flown to 140 knots and a significant improvement in ride qualities was reported by the pilot. Unfortunately, high stresses developed in the vertical fin attach fittings and flight tests were suspended until stronger fittings could be installed. Flight testing resumed again on 7 January 1980 and is continuing as of this writing.

Short-Term Plans. Vibration isolators that had been fabricated some years ago may be required to demonstrate original speed goals. In addition, high altitude tests will be conducted to define a rotor stall boundary and gain insight into rotor solidity requirements for future missions.

Tests will also be conducted at a more forward center-of-gravity to assess handling qualities and structural characteristics in this configuration. These flight tests will be conducted under Army contract with Navy funding.

Under a NASA contract, a restored version of the crash-damaged XH-59A aircraft will be tested in the NASA-Ames 40-foot × 80-foot wind tunnel. Performance and stability data will be collected for correlation with small-scale tunnel tests and flight tests. Drag reduction tests will also assess the effect of fairings on rotor hub drag.

Mid-Term and Long-Range Plans. Mid-term and long-term plans are still in the formative stage, and no funds have been committed as yet to support these planes. Assuming favorable flight test results and continued availability of the XH-59A aircraft, several different types of flight tests could be initiated.

Tail-off tests in a pure helicopter mode would be of value in defining stability boundaries and identifying control parameters and concepts needed for satisfactory flight in this configuration. The payoff from this type of testing is to obtain data to assess the worth of building future ABC rotor vehicles for NOE application.

Concept evaluation tests could be conducted at Fort Rucker to introduce this new type of helicopter to Army troops and obtain feedback needed for future planning. Another possibility is for the Navy to conduct preliminary evaluations to help judge the applicability of a high-speed ABC rotorcraft to Navy V/STOL type A missions.

Further plans involve improvements in structural and propulsive efficiencies. Since the primary objective of the Army contract was to demonstrate the feasibility of the ABC rotor (within minimum resources), the XH-59A was designed with conventional materials and used a twin-pac (two turboshaft engines) for lift and two turbojets for thrust.

A production version of an ABC helicopter would undoubtedly incorporate a lighter weight rotor of high modulus material and a simpler, lighter control system.

A high-speed ABC aircraft would use an integrated propulsion system that powers the rotors or thrusters (fans or props) individually or distributes power as required between them. Plans to develop these components were in the hopper many years ago but resources have not been available for this purpose.

The ABC program has followed a bumpy road as technical, management and funding problems surfaced. Concept feasibility as a pure helicopter has been demonstrated, but it is still too early to declare the ABC rotor suitable for high-speed missions. The verdict on suitability for high-speed/high altitude applications is expected before April 1981.

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EVOLUTION of the COBRA

By CPT James R. Snider

AH-1S showing new universal turret equipped with 20mm cannon, ALQ-144 IR Jammer, and Hot Metal Plus Plume exhaust system.

From a modest and controversial beginning, the attack helicopter has taken its place as a potent member of the Combined Arms Team. Since 1961 when GEN Hamilton Howze chaired the Army Tactical Mobility Review Board, from which the present concept of the armed helicopter emerged, the attack helicopter has evolved to the present AH-1S Modernized Cobra, the most formidable existing armed helicopter in the Free World.

The importance of the attack helicopter concept on the modern battlefield was inevitable, its greatest assets being the very cornerstone of victory—firepower and mobility. Realization of this concept, however, was a long developmental process in which the Cobra was steadily updated and improved to respond to a more lethal battlefield environment.

The Vietnam era established the helicopter as an indispensable asset to the Army's war efforts. The air assault consisting of waves of UH-1 troop carrying aircraft afforded the ground commander another dimension in moving troops quickly in and out of battle, but these flying formations were vulnerable to enemy fire en route and especially during insertion and pickup in the landing zone.

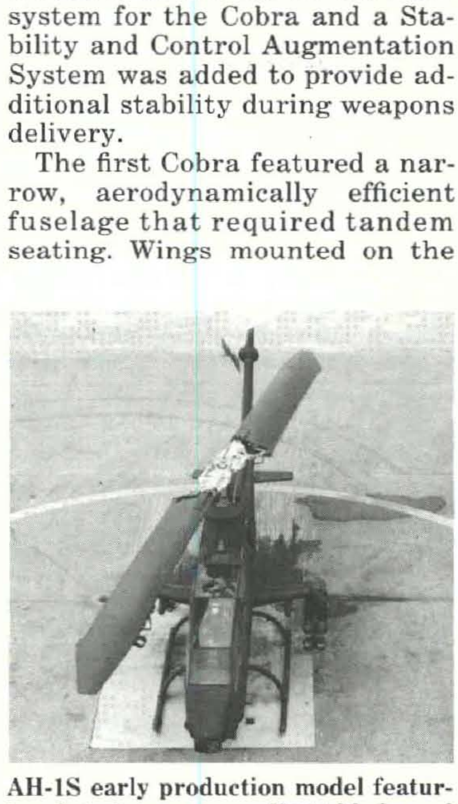
The aerial escort mission was therefore critical and neither the UH-1B nor UH-1C gunships possessed the speed required to move quickly through the formation to provide suppressive fire. The AH-1 Cobra then, was fielded to satisfy this requirement for a faster, more effective armed helicopter.

Anticipating the requirements for an armed helicopter, private industry had begun design work in the late 1950s. Bell Helicopter, producer of the UH-1, constructed the first Huey Cobra, the Bell model 209 in 1965. Less than six months later the first Cobra reached a speed of 170 knots in level flight.

A successful competitive Army evaluation led to concurrent development and production contracts for 110 AH-1Gs in 1966. First delivery followed 13 months later with combat introduction to Vietnam in August 1967.

The first AH-1G was configured with the proven dynamics of the UH-1C, including the same engine, transmission, and rotor system. The stabilizer bar was removed from the UH-1C 540 rotor system for the Cobra and a Stability and Control Augmentation System was added to provide additional stability during weapons delivery.

The first Cobra featured a narrow, aerodynamically efficient fuselage that required tandem seating. Wings mounted on the fuselage provided quick release hard points on which a variety of weapons systems could be carried. Wing mounted weapons included the M-18 gun pod, a self-contained 7.62 machinegun and ammo drum; the M158 rocket launcher, capable of carrying seven Folding Fin Aerial Rockets; and the M200 rocket launcher, capable of carrying 19 rockets.



AH-1S early production model featuring flat plate canopy, K747 blade and TOW missile launchers.

A turreted 7.62 mini-gun controlled by a movable sight in the copilot/gunner's position provided flexible and immediate fire. Later an improved turret, the M-28 system, paired a 40mm grenade launcher with the mini-gun. In addition, selected Cobras were armed with a 20mm cannon which was mounted on the left wing of the aircraft.

Production of the AH-1G, the Army's first special purpose helicopter, continued until 1973. During that first 5-year period, 1,126 AH-1Gs were produced at rates up to 35 a month. The Cobra established a record of over one million combat flying hours in Vietnam and emerged as a versatile weapons system which could perform multiple missions.

Ground commanders quickly learned the tremendous firepower and immediate response of the Cobra in providing close air support for infantry and armor units. Without the requirement for prepared airfields, Cobra units were deployed to the field close to the fighting troops and it was only a matter of minutes from mission alert to the Cobra delivering its ordnance on enemy positions.

Reconnaissance and security missions provided a requirement for teamwork between the Cobra and the Scout (OH-6 or OH-58) helicopter, which is still vital to attack helicopter operations on the mid-to-high intensity battlefield. Operations then consisted of tailored Scout-Cobra teams, the Scout flying low in search of enemy locations while the Cobra provided overwatch protection from higher altitudes.

Tactics developed for the Cobra in Vietnam were based on the total air superiority enjoyed by U.S. Forces and until the later war years the absence of sophisticated enemy air defense employed against Army aviation. The AH-1G rockets and miniguns could be used at close ranges and at altitudes of 1,000 to 2,000 feet with relative immunity.

An airspeed based jump correction and eyeball estimated range correction were sufficient for getting turreted gunfire near the short range targets. The fire was then "walked" onto the target. For rocket delivery, a manually preset flex sight was used along with the tactic of making a shallow dive at the target.

Focusing on the use of the attack helicopter in Vietnam, Army planners gave scant attention to the role of the attack helicopter on the mid-intensity battlefield. With few exceptions even Army proponents of the Cobra in Vietnam were skeptical of the attack helicopter's effectiveness and survivability in a "more modern" battle setting.

Events, however, were causing Army planners to reconsider that portion of the Howze Board findings related to high threat environment. In the early 1970s a UH-1B equipped with the Army's Tube Launched, Optically Tracked, Wire Guided (TOW) Antitank Missile System, was engaging and destroying Soviet tanks in Vietnam.

Shortly thereafter, the 1973 Israeli-Egyptian war demonstrated the technological leap that had been made in fighting conventional wars. With the introduction of long range antitank missiles and a new generation of antiaircraft weapons on the battlefield, the supremacy of the tank supported by tactical jet aircraft was significantly degraded.

The war spurred new exploration in tactics and technology to cope with sophisticated enemy air defense systems and in defeating his armor. Consequently, through a multitude of studies, simulations, and tests conducted at various Army posts and training centers, the importance of the attack helicopter on the modern, mechanized battlefield was established.

The challenge that faced the Cobra was primarily one of adapting to the modern battle setting through the development of nap-of-the-earth tactics and aircraft survivability equipment and, more specifically, the adaptation of an antitank missile system to the airframe. These challenges were met through training and a steady process of product improving the AH-1.

The first improvement was the addition of the TOW Missile and Helmet Sight Subsystem (HSS) to the basic AH-1G. Designed for antiarmor, the TOW is a stand-off weapon that is rocket propelled and wire guided. The primary TOW delivery technique following acquisition and lock-on, requires the Cobra to hover while the gunner optically tracks the target. The effective range of the TOW is from 500 to 3,750 meters.

The capability of the TOW to accurately destroy targets at long range gives the Cobra crew a stand-off advantage over many air defense systems. The TOW's 3,750 meter range is well beyond that of the Soviet SA-7 surface-to-air missile which has a range of 3,000 meters and the ZSU-23-4 and ZPU 14.5 antiaircraft guns which have maximum ranges of 3,000 and 1,400 meters respectively.

The Helmet Sight System is an electro/mechanical device linking the pilot's helmet sight to the TOW Telescopic Sight Unit and to the Cobra turret. The HSS allows for "hands off" sighting for rapid target acquisition for TOW missile attack by the copilot/gunner, and it has the dual capability of controlling the Cobra turret by directing the turret weapon system in the direction that the pilot or copilot looks.

The addition of the TOW Missile System (TMS) and the HSS to the AH-1G were accomplished under the Improved Cobra Armament Program (ICAP). As a result of this program the Army changed 290 AH-1Gs to the qualified ICAP configuration. The first 92 of these Cobras were modified and redesignated the AH-1Q.

The ICAP program was successful in the light of the improvements afforded the AH-1 in terms of superior capability, but it was obvious to those guiding the Cobra program that additional advances were needed.

The requirements that the Cobra operate under the stringent conditions of a pressure altitude of 4,000 feet and a temperature of 95 degrees F, plus the increased weight of the TOW Missile System severely taxed the output of the conventional AH-1G 1,400 hp T53 engine. In addition, the improvements noted to enemy helicopter defenses dictated improvements in the Cobra's armament and onboard defensive systems.

The requirement to upgrade Cobra performance led to the Improved Cobra Agility and Maneuverability (ICAM) program. The Cobra's maximum gross weight was increased to 10,000 pounds with the addition of a new transmission, drive train, and the 1,800 horsepower T53-L-703 engine.

The ICAM program converted 198 AH-1Gs and the 92 AH-1Qs to the AH-1S (Modified) configuration. This ICAM Cobra did not represent the ultimate AH-1S. It was only the first step in a modernization plan which will eventually bring all Cobras to a standard known as the "Modernized S."

The Modernization Plan is being accomplished in seven steps and will result in a standardized Cobra Modernized S fleet by the mid-1980s. The major improvements, which lead to the Modernized S and which will demonstrate the foresight and flexibility required of Cobra developers, are:

• The Modernized S features a new, semi-flat surface canopy that is optimized for low light reflectivity, low radar signature, and improved pilot head room. A ballistic jettison system is designed to explosively cut the acrylic side windows from the canopy in the event emergency egress is required.

• A new composite main rotor blade was developed for the AH-1S. The K747 blade features a cambered air foil and a significant increase in lift coefficient over the previous blade. The new blade offers reduced radar signatures and lower acoustic detectability.

It has an improved survivability rating which allows for 30 minutes of flight after having suffered a direct hit by a single 23mm round and it is invulnerable to single hit from a 12.7mm round. The K747 has a maximum allowable operating time of 10,000 hours compared to 1,000 hours for the previous blade.

• The new turret is similar in principle and purpose to previous AH-1 turrets, but differs in that it carries a heavier armament system and a more advanced control system. It offers an improved antipersonnel and antimateriel effectiveness and the ability to accommodate either a 20mm or a 30mm cannon.

The universal turret fires through plus and minus 110 degrees forward azimuth and has maximum elevation of 20.5 degrees and a maximum depression of 50 degrees. The turret presently mounts a 20mm M197 3-barreled gun which has a rate of fire of 730 rounds per minute and a maximum effective range of over 2,000 meters.

• The features of the new Fire Control Subsystem include a pilot Head-up Display (HUD), Fire Control Computer (FCC), Air Data Subsystem (ADS), and the Laser Rangefinder (LRF). The HUD uses a cathode ray tube optical display and provides essential flight and fire control information to the pilot in his normal field of view.

The ADS collects three dimension airspeed and environmental conditions and transmits the data to the FCC, while the LRF permits precise range calculations to be made by the Cobra. The FCC is a digital computer which accepts information from the other subsystems and computes a fire control solution for the turret and rocket weapons.

• The AH-1S is equipped with advanced infrared suppressors in the form of a cooled-plug-type suppressor in the engine exhaust and an IR suppressing exhaust shroud. This design uses large volumes of ambient air to cool exposed metal surfaces and exhaust gases to facilitate the lowering of plume temperatures. In addition, the Cobra is equipped with the ALQ-144 IR Jammer designed to accommodate jamming needs for the foreseeable future.

The ALQ-144 is an active IR countermeasures unit that confuses IR seeking missiles. The AN/APR 39 radar warning receiver provides the pilot an audio and visual warning that he is being "painted" by enemy radar. The warnings system provides range and direction information on the enemy radar location.

These are some of the major improvements made to make the Cobra a viable and survivable weapons system on the battlefield. Additionally, several technological advances are planned for incorporation on the Modernized S. One of these is the FACTS/ITOW program.

"FACTS" or Forward Looking Infrared (FLIR) Augmented TOW System provides the Cobra a passive night capability as well as an enhanced daylight capability in smoke, fog, or other battlefield obscurations. The Improved TOW (ITOW) upgrades the lethality of the present TOW Missile.

This article has provided a brief summary of the development of the Cobra to its present modernized status. The Cobra program has expanded from a program requiring three principal contractors and 700 vendors to one requiring eleven contractors and over 3,000 vendors.

The program's success may be attributed primarily to the continuous efforts of both the military and civilian members of the Cobra team under the direction of the Cobra Project Management Office, an element of the U.S. Army Troop Support and Aviation Materiel Readiness Command (TSARCOM), commanded by MG Richard H. Thompson.

From its inception in March 1972, the Project Office, working with troop units, the Training and Doctrine Command, and the contractors has achieved an enviable record of success. The success is demonstrated in that the Cobra is ready *now*, deployed with troop units and capable of fighting and surviving on the modern battlefields. The Cobra Program will continue to be dynamic, moving ahead in response to technological advances, and to the needs of the Army.

CPT JAMES R. SNIDER is currently serving in the Cobra Project Manager's Office. He was commissioned in Armor from the U.S. Military Academy in 1970, and has served as tank platoon leader, Battalion S-1, aeroweapons platoon commander, and armored cavalry troop commander. A graduate of the Infantry Officer Advance Course, he holds a master's degree in aeronautical engineering.

CH-47D CHINOOK

CH-47 using dual/triple hooks

By COL Terry L. Gordy

Success stories don't generally occur everyday. However, the monetary savings alone, accrued from modernizing the Army's CH-47 Helicopter rather than developing a new one, definitely put the CH-47 in the category marked "success."

Thus far, the modernization approach for the CH-47 is estimated at having saved upwards of $700 million in research and development and $400 million in production costs.

The Chinook, as it is referred to, has been used principally for the past 15 years for airborne medium lift tasks, and was designed for the types of threats that would be encountered by a medium lift helicopter in war.

The new CH-47D Model Chinook has been redesigned to improve reliability, availability, maintainability (RAM), and safety, increase productivity, and reduce vulnerability. Late last year a milestone was reached when the first CH-47D prototype was delivered to the Army by Boeing-Vertol Co. for development testing at Fort Rucker, AL.

Although it might have been desirable to develop a new helicopter incorporating the latest technology, the Army has a limited budget to develop major new weapon systems. A 1975 Cost and Operational Effectiveness Analysis concluded that modernization of the current fleet of CH-47A, B and C models to the CH-47D model would achieve most of the Army's goals at considerable savings when compared to the cost of developing a new aircraft. Another spinoff to a single-model fleet is simplification of maintenance and logistics support requirements.

Thus, the CH-47 modernization program was initiated. The hardware phase began June 1976 with the signing of an R&D contract with Boeing-Vertol, Philadelphia, PA. The company was assigned the responsibility of designing, developing and qualifying the CH-47D model.

Three CH-47s (A, B and C models) were chosen to be converted to the D model prototypes. All three helicopters chosen, had lengthy service because one aim of the R&D program was to evaluate the cost and feasibility of converting the CH-47 fleet.

A breakdown of the improvements Boeing-Vertol engineers designed for the CH-47D are as follows.

Fiberglass rotor blades have been incorporated. They have more efficient airfoils. They were originally developed during the Heavy Lift Helicopter Advanced Technology Component Program. The result is increased lift capability, cruise speed, and fuel efficiency. These improvements are achieved at a lower rotor speed of 225 revolutions per minute, thereby reducing noise and leading edge blade erosion.

The new blade has demonstrated a capability to withstand 23 millimeters high explosive hits in critical areas and still keep the helicopter aloft with a flight load. Fiberglass blades also provide a lower radar cross section despite an integral metal mesh incorporated in the blade to ensure protection against lightning.

The fiberglass blade requires less maintenance than metal blades because of the elimination of corrosion problems and integral spar inspection system checks. Fiberglass construction makes it much easier to repair in the field without having to remove it from the aircraft.

Finally, the new blade is tuned dynamically by simple weight adjustments. With the regular trim tabs, the maintenance officer can more easily track the blades and reduce rotor induced vibrations.

All the transmissions are new designs based on proven technology.

New gear materials have been introduced and combined with advanced tooth profiles that improve bearings and housings and integral (main and auxiliary) lubrication and cooling systems. This provides improved survivability, fewer component and leak points, and simplified maintenance.

New drive system components and improved debris detection and protection systems, including an electrified screen have been added. This greatly reduces false alarms and provides more reliable warning information to the crew.

Improved magnesium alloy transmission cases with a corrosion inhibiting coating and composite sumps capable of withstanding small arms fire further reduces transmission maintenance. New one-piece gears (the shaft is integral with the gear) also reduces maintenance through the elimination of bolted joints.

The new transmission increases RAM. It also allows full use of available engine power at altitudes and temperatures up to the maximum produced by the 7,500 shaft horsepower dual engine and a 4,600 shaft horsepower single engine emergency rating.

The original hydraulic system has been replaced by modularized and self-contained separate flight control and utility hydraulic systems. Modularization has reduced parts, leak points, and vulnerable area.

Separate hydraulic pumps, one on the forward transmission and one on the aft, have separate lines. This improves combat staying power and the use of MIL-H-83282 hydraulic fluid reduces fire hazards.

Not all of the cargo handling system is new, but the differences are significant. The center hook has been upgraded from a 20,000 to 28,000 pound capacity. The curved beam and hook carriage, with the wear prone rollers, have been replaced by a newly designed diamond shaped aluminum alloy beam with a fixed-hinge mounted swivelling hook.

All the operating modes, basic (electrohydraulic), emergency (electropneumatic) and backup (mechanical) remain unchanged.

Two 20,000 pound hooks have been added, one forward and one aft of the center hook. Each hook is attached to a recessed reinforced airframe structure. These hooks are activated by two electrical systems and feature a mechanical backup. They can be used in any combination to transport one to three individual loads.

Unprecedented flexibility is provided and use of the two new hooks in tandem greatly improve load stability. This permits increased cruise speed while slinging large, low density or aerodynamically unstable loads. The result is far greater productivity with more ton-miles per day.

Pilots were queried for suggestions concerning proposed changes in cockpit arrangements. Consequently, the overhead console has been modified and lowered to make it easier to reach switches including engine condition levers. These have been relocated from the center console.

Circuit breakers have been moved to panels along side the pilot and copilot. In addition, labelling of controls and switches for quick identification has been improved.

Additional systems have been added to assist pilots to do their job more efficiently. An instrument landing system is now part of the variable omnidirectional range (VOR). In addition to the rearrangement of controls and displays, a radar altimeter has been added, and the aircraft's intercom improved. A radar warning system has been installed and the identification, friend or foe (IFF) improved.

Another major pilot assist is the addition of the Advanced Flight Control System. This system improves aircraft stability. It also reduces pilot workload for terrain flying with and without external loads and at night under adverse weather conditions.

Heading and altitude hold with turn command features increases mission effectiveness, and the Built-In Test Equipment (BITE) improves maintenance efficiency of the Advanced Flight Control System.

The electrical system features dual 30/40 kilovoltampere oil cooled brushless generators with increased power and new solvent resistant wiring. Separation of the aircraft's redundant system, installed on each side of the cockpit, reduces the helicopter's vulnerability to electrical failure. A battery charger reduces maintenance on the nicad battery and prevents early battery failures.

The new auxiliary power unit no longer drives accessories through an accessory gear box mounted on the aft transmission. Instead, a 20 kVA generator and a hydraulic motor/pump are mounted on a separate APU gearbox to provide the required power for ground operations, systems checkouts and main engine starting.

An electronic sequencing unit (ESU) has been added to control the APU start sequence and operation. This ESU provides the pilot with a push button to start the APU. The ESU then checks the APU which will automatically shut down should the malfunction occur during the start cycle. In addition, the BITE display indicates the problem area.

Another improvement is a panel in the rear of the troop cabin. It is composed of gauges and lights indicating the status of each transmission and hydraulic system.

The helicopters qualified maximum gross weight has been increased from 46,000 to 50,000 pounds, even though the original airframe remains basically unchanged. Progress on testing and production of the CH-47D has been excellent. The first prototype was finished on 6 March and flown on 11 May 1979, four months ahead of schedule.

The three modernized prototypes have passed the Army's preliminary airworthiness evaluation. For this evaluation, the aircraft were flown at a gross weight of more than 50,000 pounds and at speeds exceeding 180 knots.

Now that the first CH-47D has been delivered to the Aviation Development Test Activity at Fort Rucker, AL, development testing has begun. During this evaluation the prototype will be tested in temperatures of −65 degrees to +120 degrees fahrenheit at the climatic hangar at Eglin Air Force Base, FL. In-flight icing tests will then be conducted at Minneapolis, MN.

Following these tests, the CH-47D will be deployed for operational testing by the 159th Assault Support Helicopter Battalion of the 101st Airborne Division (Air Assault) at Fort Campbell, KY. The helicopter will be operated and maintained in the field as it would under normal military conditions.

In addition, masses of engineering and RAM data will be secured to detect potential deficiencies and measure how well the aircraft is meeting operational objectives. To insure the evaluation is valid, two CH-47C models will perform identical missions and receive identical maintenance.

Results of these tests will be forwarded to the Army and Defense Systems Acquisition Review Council in September 1980 for a production decision. A favorable decision by the Council could result in the modernization of 24 CH-47s to D models by February 1984. The remainder of the 361 CH-47s could be converted at the rate of three per month. While this is the current plan, a production rate of five per month is being considered.

COL TERRY L. GORDY is project manager of the CH-47 Modernization Program at the U.S. Army Aviation Research and Development Command, St. Louis, MO. He holds a BS degree in business administration from North Georgia College, and a master's degree in industrial management from the University of Tennessee.

SOVIET HE

Ninth in a series of photospreads submitte nology Center to ARDAM, since November- eign Armored Reconnaissance Vehicles; For Destroyers; Foreign Combat Engineer Te Weapons; Foreign Infantry Fighting Vehicl nology; and Photos of the 1977 Red Square

Mi-12 (Homer) Heavy-Lift Helicopter can carry 35.4 tons. First flown in 1968, but never went into production.

Mi-1 (Hare) Light Utility Helicopter, used primarily for ambulance and rescue missions. First observed in 1951.

Mi-2 (Hoplite) is an enlarged, twin-turbine version of the Mi-1. First observed in 1961.

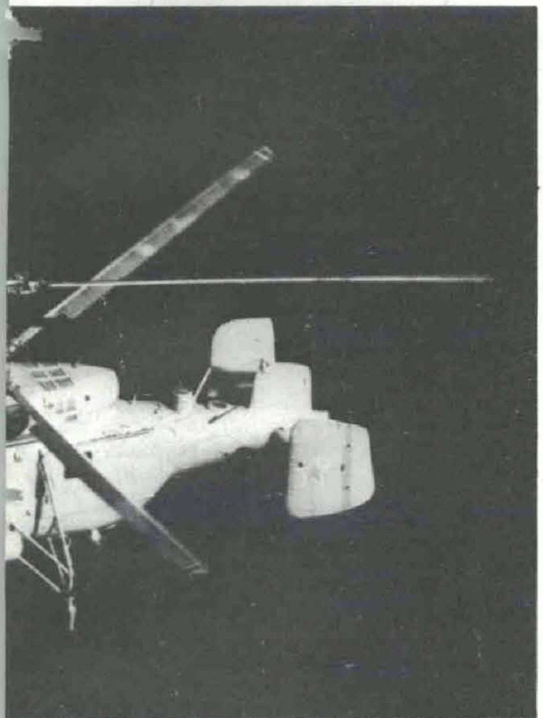
Mi-6 (Hook) can carry 65 combat-equipped troops or 12 tons of cargo. First observed in 1957.

Ka-25 (Hormone) antisubmarine warfare heli observed in 1967.

Ka-26 (Hoodlum) is a utility helicopter used in 1968.

LICOPTERS

| by the U.S. Army Foreign Science and Tech-)ecember 1977. Previous issues covered For- ign Armored Support Vehicles; Foreign Tank hnology; Russian Infantryman's Arsenal of s; Advances in Foreign Transportation Tech- 'arade.



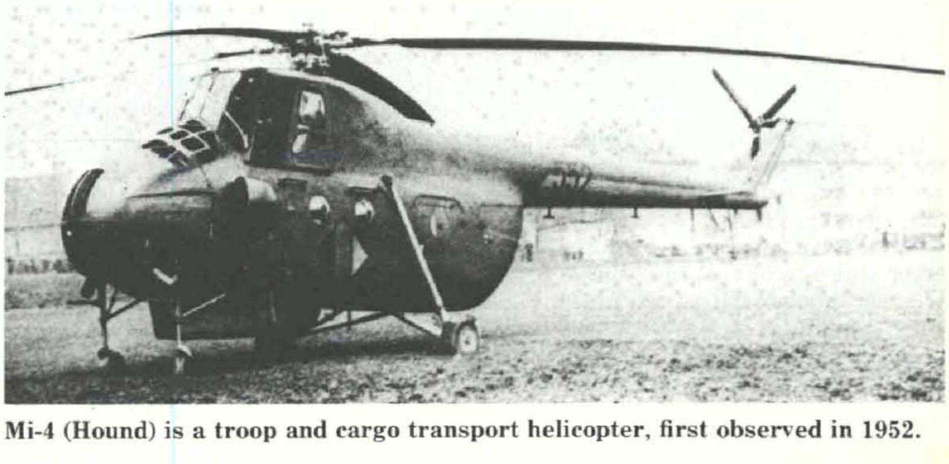
opter with a coaxial rotor configuration. First

ıainly for agriculture, and was first observed

Mi-24 (Hind-D), first observed in 1977, is an advanced attack helicopter that can be used in air fire support, antitank, and air-to-air roles.

Mi-10 (Harke) is a heavy-lift helicopter that can carry 15 tons. It was first observed in 1960.

Mi-14 (Haze), antisubmarine warfare version of the Mi-8 (Hip) troop transport that can also be used in combat and fire power roles.



Mi-4 (Hound) is a troop and cargo transport helicopter, first observed in 1952.

Radar Threat Trainer & Army Aviation

By COL Daniel J. Delany

The days of true low intensity combat, where Army helicopters operated with relative impunity are over. But Army aircraft have become essential elements of today's and tomorrow's combat, performing crucial missions involving reconnaissance, intelligence, command and control, battlefield mobility, electronic warfare, and weapon systems effectiveness.

Army aircraft will operate worldwide, under adverse weather conditions, in both day and night hours, and in the face of an ever increasing air defense threat.

Today's low and medium altitude antiaircraft systems seriously impair the survivability of ground support aircraft. The Mideast War of 1973 gave ample evidence of this. The modern battlefield then, with all its lethaly sophisticated air defense systems has dictated the need to emphasize aircraft survivability—a critical dimension of "staying power."

Since the U.S. Army must be prepared to enter the next war outnumbered, we cannot afford anything approaching equal attrition exchange rates with our enemy, and survivability becomes an essential characteristic of Army aircraft.

Survivability is a function of many interrelated factors such as aircraft performance, target detection/acquisition, weapons systems effectiveness, tactics, training, and aircraft survivability equipment. For aircraft survivability equipment to be of real value, it must not only reduce attrition, but it must also aid the pilot in the accomplishment of his primary mission.

A major threat involves radar-directed weapons. It follows that radar-controlled weapons systems must be detected and avoided so combat and mission support aircraft can achieve their objective over safe routes to and within the battle areas.

The current standard AN/APR-39 Radar Warning Receiver (RWR) can reduce combat attrition by providing the aircraft crew with warning of an impending radar-directed weapon engagement. It also gives the pilot the confidence to expose himself more often and do things that he might not do without such a warning receiver.

With the addition of an active radar countermeasure such as the AN/ALQ-136 radar jammer, or the M-130 chaff system, the aviator can remain in an exposed position longer, permitting the acquisition of more targets and the completion of more "kills" that might otherwise have been aborted.

It is vital though to remember that aircraft survivabilty equipment is only as good as the people who use it. Therefore, training becomes a large part of the final product as it is deployed. Helicopters and their crews can survive on the battlefield populated with lethal sophisticated air defense weapons only if the crews are well-trained in survivability techniques and in the use of their survivability equipment.

A significant step in providing Army aircrews with far better training in this area has recently been assured by the acceptance by the Army of the Tactical Radar Threat Generator (TRTG). Developed by Emerson Electric Co., St. Louis, MO, the TRTG is a lightweight, mobile ground radar emitter for training aircrews. With the Army's propensity for using acronyms, it has been dubbed GRETA (Ground Radar Emitter for Training Aviators).

Display Indicator Radar "Lock-On."

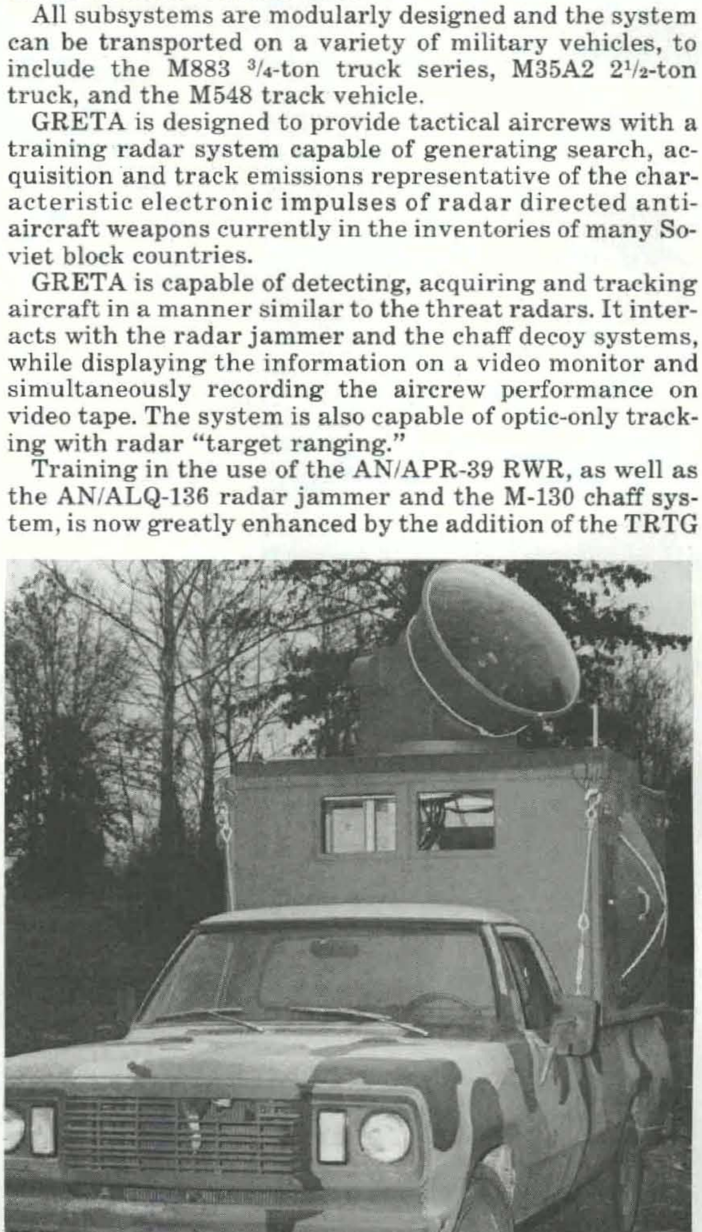
It is a self-contained, state-of-the-art training system consisting of a modified military aircraft radar and an enslaved-parallel electro-optics system. The radar-optics system is integrated into an S-250/G utility shelter containing a VHF-UHF radio intercom system to communication requirements, a video recording system, and an Environmental Control Unit.

All subsystems are modularly designed and the system can be transported on a variety of military vehicles, to include the M883 3/4-ton truck series, M35A2 2 1/2-ton truck, and the M548 track vehicle.

GRETA is designed to provide tactical aircrews with a training radar system capable of generating search, acquisition and track emissions representative of the characteristic electronic impulses of radar directed antiaircraft weapons currently in the inventories of many Soviet block countries.

GRETA is capable of detecting, acquiring and tracking aircraft in a manner similar to the threat radars. It interacts with the radar jammer and the chaff decoy systems, while displaying the information on a video monitor and simultaneously recording the aircrew performance on video tape. The system is also capable of optic-only tracking with radar "target ranging."

Training in the use of the AN/APR-39 RWR, as well as the AN/ALQ-136 radar jammer and the M-130 chaff system, is now greatly enhanced by the addition of the TRTG



Tactical Radar Threat Generator built into a modified S-250 Shelter, permitting it to be carried on a variety of vehicles.

to the U.S. Army training device inventory.

In the event extreme "target clutter" is experienced during training, the AN/APN-225 Transponder (BEACON) can be used as a target enhancement feature. The BEACON is quickly and easily mounted upon the aircraft skid and is fully self-contained.

The BEACON derives its power from easily replaceable and rechargeable battery packs. This target enhance capability can provide up to seven uniquely identifiable radar "targets." It therefore provides positive identification of each training aircraft. Each GRETA will contain the AN/APN-225 Transponders, spare batteries, storage and recharging facilities.

GRETA is also capable of providing on the spot pilot performance evaluation utilizing the remote video capability. This capability consists of a removable video recorder, display unit and radio-intercom control head connected to the system. It provides real time video display as well as the capability to replay previously recorded video tapes.

Communication with the GRETA operator, instructor, and the aircrew are possible from the remote site through use of the radio-intercom system. Additionally, the storage positions of the remote equipments are wired for in-the-system use as spares, or to provide GRETA operator training through the use of video tapes.

The combination of these capabilities produces a quality device capable of providing realistic in-flight training for tactical aircrew. Aircrews will have the ability to correctly interpret RSR information, and to execute the prescribed procedures during the conduct of tactical operations training.

This training vastly improved the aircrew's chances for survival by providing the ability to successfully outsmart and outmaneuver radar directed weapons systems. Successful application of the GRETA System will ensure the long term combat survivability of aircraft and aircrew in a hostile environment, insuring their return from today's missions to fly tomorrow.

COL DANIEL J. DELANY is currently the project manager for Aircraft Survivability Equipment, AVRADCOM, in St. Louis, MO. His previous assignments include project officer for Project Left Bank, Heliborne Aerial Radio Direction Finding System, chief of Analysis Branch at USEUCOM in Germany, and product manager for 30mm Ammunition Program.

BRL Research Provides Survivability to Aircraft Engines

The Army's Advanced Attack Helicopter (AAH) is reportedly capable of fighting at night as well as in adverse conditions and is considered the most advanced helicopter ever developed. However, a group of researchers at the Ballistic Research Laboratory (BRL) take particular pride in improving the helicopter's reliability and survivability against enemy gun fire.

Mr. Walter Thompson, a mechanical engineer who has been associated with vulnerability testing since 1966, and head of the BRL Engine Vulnerability Test Facility, says that his team of researchers provide the key for a better insight into the relationship between ballistic threat and aircraft engines.

"Our tests yield important data for improving engine materials and give us information to make recommendations that can improve the operation and survivability of aircraft engines," Thompson says. "In addition, our test results provide other knowledge that can assist designers of warheads and other weapons systems."

At the outdoor test site in BRL's Vulnerability/Lethality Division, the performance of damaged aircraft components are investigated using both engine and helicopter rotor test stands, where firings of projectiles and fragments can be made on operating aircraft and running engines.

BRL helicopter engine experiments have proven that positive pressure in fuel plumbing was a major factor of fuel fires caused by projectile and fragment hits. This problem has been eliminated in the AAH and in the Army's Utility Tactical Transport Aircraft Systems. As a result, suction fuel systems will be required on all future Army helicopters. In addition, recommendations for vulnerability improvements on both Navy and Air Force aircraft engine design are based on the results of BRL experiments.

According to Thompson, data obtained from a 1976 BRL evaluation of a turbofan engine are still used as the primary guidance for engine jet fuel ingestion problems of most new Air Force aircraft.

BRL's vulnerability investigations are conducted under a test and evaluation program sponsored by the Joint Technical Coordinating Group for Aircraft Survivability that includes the Army Materiel Development and Readiness Command, the Naval Material Command and the Air Force Logistics and Systems Commands.

In addition, BRL's research team's recommendations heavily influenced specifications and designs of military advanced propulsion systems for high survivability in combat.

2 Contracts Awarded For RSI Simulators

Development of a Rotorcraft Systems Integration Simulator—to provide a total systems approach to helicopter R&D—is called for in two contracts announced by the U.S. Army Research and Technology Laboratories (AVRADCOM) and the NASA Ames Research Center.

Franklin Research Center, Philadelphia, PA, will receive $2,350,000 to design, build and install a new Rotorcraft Systems Motion Generator. It will be adapted to the Vertical Motion Picture Simulator to provide the six-degree-of-freedom motion capability for simulating NOE flights.

Boeing Military Airplane Co. will provide a conceptual design for an Advanced Cab and Visual System, under an eight month $246,090 contract. The contract also calls for performance requirements, cost estimates, and development schedules.

The new simulator is expected to be operational by 1985 when the new motion generator and visual systems are integrated on the Vertical Motion Simulator.

A History of Army Aviation

By Dr. Laurence B. Epstein*

Today's Army aviation was officially born on 6 June 1942. On that date, the War Department directed that a team of two light aircraft, together with two pilots and a mechanic, be assigned to each Field Artillery battalion and every brigade, division and corps artillery headquarters.

Thus, each infantry division had 10 aircraft and each armored division had six and later eight. The Army Air Forces were to purchase the airplanes and all their associated equipment for the Field Artillery and provide basic flight training for the pilots.

Establishment of organic light aviation detachments within Field Artillery units culminated years of effort to improve aerial observation and the adjustment of artillery fire. These functions were first provided during the Civil War when Prof. Thaddeus S. C. Lowe, director of the Army of the Potomac's Balloon Corps, used a telegraph to direct artillery fire from a balloon in 1862.

During the Spanish-American War, an American balloon was instrumental in the success achieved at San Juan Hill in 1898. Due to their vulnerability to airplanes, their use in World War I eventually tapered off and was abandoned altogether in 1940.

Aerial observation and the adjustment of artillery fire became critical in World War I due to the increased range of artillery. Yet, because the aviators flew from airfields behind the lines, the artillery commanders did not know either the pilots or the observers, and the latter were unfamiliar with the artillerymen they served. It was not a situation that enhanced cooperation and understanding.

During the post-war period, the Field Artillery studied these problems in order to overcome them. It concluded that the airplanes should be owned, operated and maintained by the Field Artillery units they served. Both the pilots and the air observers should be Field Artillerymen regularly assigned to their units.

As aircraft became capable of flying higher, faster and farther, they became less suited to the needs of the Field Artillery. Heavy airplanes were restricted to flying from permanent airfields behind the lines at the same time field armies were becoming more mobile. They were too fast for performing

"Sausage balloons," or "rubber cows" were used for directing artillery fire, with an observer in a wicker basket, or as "barrage balloons," with chances of snagging an airplane on its cabling. Because of their vulnerability to airplanes, their use in WWI tapered off and was abandoned in 1940.

well in their role. Moreover, they required sophisticated repair and maintenance facilities.

The Army Air Corps, established as a separate combat arm by Congress in 1926, felt that it should not be chained to ground support functions.

Many aviators, led by BG William "Billy" Mitchell, advocated the doctrine of strategic bombing as the only true and effective use of airpower which, to be properly applied, should be a separate service.

The struggle for autonomy led to a battle with Army leaders that pushed the Air Corps interest in ground support roles aside. It spent its funds, limited by a parsimonious Congress to all services, on developing a strategic bomber capable of carrying out its theories. The Air Corps also resisted any efforts to place its aircraft again under the control of ground force commanders.

While the effort to establish organic light aviation for the Field Artillery owed itself to a number of people, the catalyst was Joseph McCord Watson Jr., a lieutenant in the Texas National Guard.

Watson experimented with adjusting artillery fire from a Piper Cub he rented for the purpose while on maneuvers. He was the only man in the 36th Infantry Division to have a pilot's license.

The division was federalized in 1940 and assembled at Camp Beauregard, LA, for maneuvers. Air Corps observation aircraft were high in demand and short in supply. Watson suggested to BG Robert O. Whiteaker, 6th Field Artillery Brigade commander, that Piper Aircraft Corp. be asked to provide several pilots and aircraft to perform the task.

Mr. William T. Piper Sr., agreed and Mr. Thomas A. Case, Piper's district sales manager for the eastern United States, participated in the first of many such maneuvers over the next two years.

At Mr. Piper's suggestion and effort, a "Grasshopper" squadron was formed that included other light aircraft manufacturers. It was so named by the 1st Cavalry Division's commander, MG Innis P. Swift,

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when he first observed a Cub bouncing along the ground upon landing.

These unpaid civilian pilots and their light airplanes went from one series of maneuvers to another at the suggestion of Mr. Robert A. Lovett, Special Assistant to the Secretary of War and a private pilot himself.

The Grasshopper Squadron proved the concept sound. They flew more than 400,000 miles during the spring and summer of 1941, completing over 3,000 missions without the loss of a single aircraft.

During the same period, the Air Corps wrote off 11 of their observation aircraft, each costing 10 times the $2,500 cost of a Piper Cub. The heavier and larger 0-49s had to operate from permanent airfields. They could not land in cow pastures and on highways, or taxi up to filling stations to refuel with regular gasoline.

The end result was the setting up of official tests which were delayed as a result of the confusion following the Pearl Harbor attack. The 45-day tests were successfully completed in April 1942.

The invasion of North Africa in November 1942 witnessed the commitment of Army aviation to combat. Three Piper L-4 Grasshoppers flew from the deck of the aircraft carrier *USS Ranger* five months after Army aviation's establishment.

The urgency of wartime need caused the commitment to combat to be made without a firm plan of either organization or tactical employment. Many of the Field Artillery commanders did not know what to do with their aviation detachments. As a result, the Army aviators were on their own.

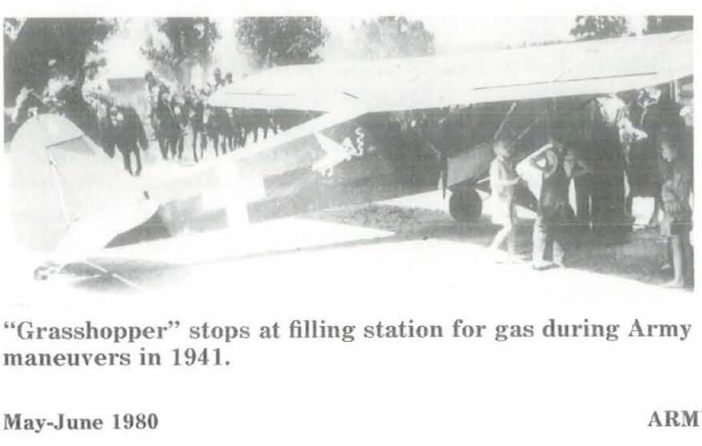
It was due mainly to their initiative, imagination, dedication to duty, and belief in the role they knew they could play that made Army aviation effective and viable. Perhaps more than any other combat element in World War II, theirs was a grass root function.

The belief that unarmed, underpowered light aircraft could not survive in the battle zone, even more, to contribute effectively to the outcome of combat, was a difficult one to dispell. However, the handful of Army aviators proved their cause through actions and deeds, not memorandum.

By the end of the North African campaign, the Field Artillery's "air force" had established itself as a self-evident success.

A pattern for the employment of Army aviation and its logistical support took shape through improvisation and experience. There was to be little change throughout the remainder of the war.

Furthermore, field commanders came to recognize the value of organic light aviation toward achieving their objectives and in performing a wide variety of tasks other than observation and the adjustment of artillery fire.



"Grasshopper" stops at filling station for gas during Army maneuvers in 1941.

L-19 flying in Korea.

Little aircraft could go places even the jeep could not. Commanders found them to be excellent taxis. Other jobs included everything from wire laying to dropping emergency supplies to isolated units.

Later, in Europe, several pilots tried lashing bazookas to the wing struts and went tank-hunting. One was credited with five German tanks.

The versatility and effectiveness of Army aviators erased the hostility and indifference to organic light aviation within the Army Ground Forces by the end of World War II. In August 1945, the War Department extended organic aviation to the Signal Corps, the Tank Destroyer Corps, the Infantry, the Corps of Engineers, Armor, and the Transportation Corps.

Ground troops knew that the appearance of a Army aviator overhead reduced enemy fire. This was because the enemy respected their ability to locate and call down accurate counterbattery fire. When V-J Day came, 2,630 pilots and 2,252 mechanics had been trained while 1,600 light aircraft were in the inventory.

Demobilization and post-war economies reduced the inventory to around 200 aircraft. Army aviation was a useful auxiliary, but no expansion of its role or equipment was planned. Although the Air Force became a separate service in the National Security Act in 1947, it still purchased the Army's aircraft and performed depot maintenance on them.

The outbreak of the Korean War in 1950 found the Army's aircraft inventory at 725, mostly World War II surplus. It jumped to 1,094 a year later. By December 1952, there were 2,573 aircraft in the inventory, including 719 helicopters. An additional 817 fixed-wing and 666 rotary-wing craft were on order.

Few Army helicopters were employed during the Korean War, mostly in the latter stages. However, their impact was profound and visable. The machines were fragile, built mostly by hand, expensive and horrendous to maintain.

Helicopters, however, were worth their weight in jewels in a rugged terrain largely without roads. Thousands of wounded soldiers were saved through their quick evacuation by helicopter from otherwise inaccessible terrain.

The first Army cargo helicopter company arrived in Korea during February 1953. The Army had established an experimental cargo helicopter program in 1950. As a result of this program, the Transportation Corps, on 11 August 1952, assumed responsibility from the Ordnance Corps for the total logistical support of aviation within the Army. This was done to centralize and give direction to the program.

The Army had 5,500 aircraft by June 1959. But many of these were substandard and it needed 900 more, and a replacement for the L-19 Bird Dog. A key decision was to proceed with the development of the Bell UH-1. Another was to power it with a turbine engine. The UH-1 was to become to Army aviation what the DC-3 was to scheduled airlines.

The appointment of the Rogers Board in January 1960 provided the essential guidance necessary for the development, procurement, and personnel planning for Army aviation through the Army Aircraft Development Plan.

The Howze Board was set up as a result of Secretary of Defense Robert McNamara's desire for the Army to apply modern methods to increase its mobility. Organizational and operational aspects of the air mobility concept were evaluated and tested.

The Air Assault Division developed by the Howze Board became a key tactical innovation in which helicopters and fixed-wing aircraft became the principal elements, not merely the auxiliaries.

The War in Vietnam proved the airmobility concept to be a viable one. The first aviation elements arrived in Vietnam in 1962 to give the Republic of Vietnam's army mobility. This modest contribution continued to expand until the United States committed its combat troops to the conflict.

The Army's air fleet in 1965 numbered 2,611 fixed-wing and 4,412 rotary-wing aircraft. During the next five years of combat, the size of the airplane fleet gradually decreased while the size of the helicopter fleet more than doubled, from 4,412 to 9,903.

The value of this fleet increased from $1.2 to $3 billion whereas the value of spare parts and other items required to support the inventory rose from $588.9 million to $1,894.4 million during the same period. The high had been $2,187.3 million.

An armed helicopter became essential to protect the troop lifters, and later as an attack element on its own merits. An entire airmobile division served successfully in the field for the first time. Vietnam became the proving ground in which airmobility was molded into a reality.

In less than four decades, and in three conflicts, Army aviation advanced from a useful auxiliary to the Field Artillery to become a major innovative concept of tactical employment on the battlefield. Its impact has changed the battlefield as dramatically as the tank has done before it. Today, army aviation operates more than 8,000 aircraft.

USAISR Honored by U.S. Marine Corps Meritorious Unit Citation

The U.S. Army Institute of Surgical Research, the world famous burn treatment unit at Fort Sam Houston, TX, has become the first Army organization since the end of the Vietnam war to receive the U.S. Marine Corps Meritorious Unit Citation.

The Institute of Surgical Research (ISR) was honored for its emergency care and treatment of 38 Marines, who were severely burned in an explosion in Japan, last October. The subsequent mass casualty evacuation marked the largest number of severely burned patients to be admitted to the institute at any one time since Vietnam.

Marine Corps LTG Adolph G. Schwenk, deputy chief of staff for plans and policy, presented the unit citation to COL Basil A. Pruitt Jr., who has served as commander and director of ISR since 1968.

Other Army personnel who directly supported the institute were among those commended. They included personnel from Brooke Army Medical Center, Academy of Health Sciences, 41st Combat Support Hospital, 94th General Hospital and 117th Combat Support Hospital. The 94th and 117th are Army Reserve and National Guard units.

In addition, the Commandant of the Marine Corps Certificate of Commendation was presented to Brooke Army Medical Center. Accepting the award recognizing the support given by the medical center was BG Andre J. Ognibene, Brooke Army Medical Center commander.

The Institute of Surgical Research is a component of the U.S. Army Medical Research and Development Command. It is considered the most complete burn treatment facility within the military and one of the most renowned within the medical profession.

The tragedy occurred 19 October, when a fuel storage bladder, located on a hill overlooking Camp Fuji, ruptured during a typhoon which struck the area during the night. High winds and rushing water carried the fuel into the camp, where it ignited, setting fire to several quonset huts where the Marines were sleeping.

The day following the fire, a 19-member team from ISR was airlifted from San Antonio to Yokota Air Base in Japan, where 38 victims were given initial emergency treatment. The team, according to the citation, was responsible for stabilizing the condition of the most seriously burned and with keeping them alive during the long flight back to San Antonio.

The citation praised "the quick reaction and emergency life-saving techniques of the medical support team (which) . . . prevented a more serious loss of life than might have been expected." One Marine died en route, and eight others succumbed during hospitalization.

The death toll probably would have been much higher, if not for the efforts of the ISR. According to the citation, the ISR staff ". . . overcame the life-threatening effects of infection, pneumonia and septic shock over an intense period of approximately three weeks."

The Institute of Surgical Research annually treats between 250 and 400 extensively burned, life-threatened patients and has participated in the care of victims from numerous military and civilian disasters.

In addition to the treatment of the Marines, the ISR gained national prominence in 1977, when it received 14 survivors of the collision of two 747 aircraft at Tenerife in the Canary Islands. Additional information on the Institute for Surgical Research appears in the September-October 1975 issue of this magazine.

TRADOC's Role in the Aviation R,D&A Process

By MG James H. Merryman

MG JAMES H. MERRYMAN is commander of the U.S. Army Aviation Center and commandant of the U.S. Army Aviation School at Fort Rucker. He holds a BA degree in biology from Henderson State Teachers' College and is a graduate of the U.S. Army Command and General Staff College and the U.S. Army War College.

The research, development, and acquisition (RDA) process is a long and involved process, particularly in the area of aviation systems. The U.S. Army Materiel Development and Readiness Command (DARCOM) shoulders most of the responsibility for assuring that this process is carried out with a minimum of delay and diversions.

For the most part, people recognize and understand this key role that DARCOM performs in the RDA process. However, people are unaware of the role performed by another of the Army's major commands—the Training and Doctrine Command (TRADOC)—in the RDA process.

Why TRADOC—some may ask? First, DOD and DA policies and regulations either encourage and, in some instances, require TRADOC participation in the RDA process. This may sound like just another level of management to bog down the process, but it does not have to be so.

The *user representative*, TRADOC, can actually expedite the process. When the user representative (who, as the name implies, represents the soldier who uses the equipment) is actively involved in the development process, it eliminates those situations, at operational testing time, when the users say "This is not fulfilling the mission. Go back and redesign it." When the developer and user are actively talking and working together, the time needed to field a new system can actually be shortened.

This DARCOM-TRADOC interaction will be discussed later, but first a little bit about what TRADOC is and does.

To understand how TRADOC participates in the RDA process, we have to look at how TRADOC is organized and what it has at its disposal to interface with the RDA process. Basically, the TRADOC charter is geared to fulfill the Army's need for an organization to provide training and the necessary doctrine to implement that training.

The TRADOC organization is broken up into functional areas with each post generally responsible for one functional area.

TRADOC proponency for Army aviation systems does not rest with any one Center or School, but is, instead, assigned to several of them. Aviation proponency within TRADOC is assigned to Fort Knox, KY (Armor School), Fort Rucker, AL (Aviation Center), Fort Benning, GA (Infantry School), Fort Huachuca, AZ (Intelligence School), and Fort Eustis, VA (Transportation School).

In 1978, the responsibility for integrating the Army's aviation *material developments* was assigned to the Aviation Center at Fort Rucker, AL. The primary advantage is that it gives DARCOM and DA a single point-of-contact within TRADOC for the user concerning aviation.

The internal organization of each of the Centers/Schools is generally structured to have a Training Directorate, a Training Developments Directorate, an Operational Test Activity, a Combat Developments Directorate, and other support activities.

The majority of the responsibility for coordinating with DARCOM on new materiel development is found in each Center/School's Combat Developments Directorate. These directorates have an excellent rapport with the user, who is the soldier in the field, and are very much aware of present and near term needs.

Now, how is this user interest integrated into the activities of DARCOM? The Aviation Center is actively involved in matching needs of the Battlefield Development Plan (BDP) and the Science and Technology Objectives Guide (STOG) with work areas contained in Modernized Army R&D Information System (MARDIS) Reports, Systematic Planning for the Integration of Defense Engineering and Research (SPIDER) Charts and the Army Aviation RDT&E Plan. One of the products of this matching is a determination of areas that need additional work.

In addition to determining short falls in the R&D process, the Aviation Center coordinates a priority listing with other TRADOC proponents having aviation interest. This priority list, in conjunction with a threat assessment, can be used to place emphasis on and accelerate those areas that will provide the most operationally effective benefit. In TRADOC, this is part of the process we call Combat Developments.

For the combat developments process to succeed in assisting development and fielding of combat equipment, it demands close cooperation between the user and the developer. In order for the developer to do his job right, the user must provide him with definitive and timely information. The developer can then insure that our technology effort is exerted in the appropriate direction.

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

As stated before, the Aviation Center has been tasked to function as the integrator for *all* aviation mission proponents in support of improved aviation effectiveness in the Combined Arms Team. To accomplish this, we see our mission to be: involved in *all things* pertaining to Army aviation; serve as Aviation Systems Integrator for TRADOC; make sure the Army gets what it should from Army Aviation; keep appropriate people involved; don't try to do it all at Fort Rucker; insure efforts are on the right things; work closely with DARCOM and DA; and *make the right things happen on time*.

The level where the most effective interface can take place is at the project officer level. Aviation Center project officers regularly visit the DARCOM labs to find out what each of the lab programs are and what the expected yield is as relates to Army Aviation. This enables us to better understand lab programs and provide participation with HQ TRADOC at the DARCOM Spring Lab reviews.

The Aviation Center participates with AVRADCOM in the annual DARCOM Laboratory Project/Budget Review process, and influences the funding of programs of peculiar interest to the user. The Center's participation as the user representative in this review process enables us to learn what can be done in the various technology areas, and then to influence how those technologies are applied to specific user interest.

The Advanced Systems Directorate

at AVRADCOM, works closely with the Aviation Center's Combat Developments Directorate in the preparation of AVRADCOM's Aviation RDT&E Plan. This plan sets forth AVRADCOM programs and objectives for the next 20 years, with emphasis on the first five years.

Joint participation between AVRADCOM and the Aviation Center is also carried out annually in preparation of the TRADOC Materiel Acquisition Priority Program. The thrust in this area is to identify and align the most critical development and procurement programs to meet the Army's needs.

AVRADCOM, as well as other developers, use this as input to structure their lab programs, as it represents the user's statement concerning his most urgent shortcomings. Underlying all of this, of course, is affordability. We are addressing affordability by getting the user and developer together early in the cycles to reduce lost motion, misunderstanding and wasted resources.

TRADOC views are solicited at these reviews to assist in prioritizing each command and laboratory's RDT&E program, funding critical programs and eliminating marginal or unproductive programs.

At this point, we should summarize what has been said thus far. TRADOC does have a role to play in the RDA process, and, when it comes to aviation materiel developments, the Aviation Center has been established as the single user voice to which DARCOM can turn for TRADOC aviation matters.

At all times, our goal has been to become a productive partner along side DARCOM in the RDA process so that we can produce for the Army the equipment it needs to fight (and win) on the next battlefield.

The constantly changing threat causes certain modifications in every development effort. To expedite acquisition, it is necessary to freeze a configuration as soon as possible in the development phase. Therefore, we have an incompatibility.

We need to continually change our system to fit the threat and changing doctrine. We also need to freeze the system configuration so that production can commence. This causes a significant communications problem.

We hear the materiel developer asking, "What do you want and please don't change the requirement next week?" Also, we hear the combat developer is not responsive to the needs of the modern battlefield and is working with five-year-old or older technology. It must be realized that it takes a certain amount of time to field a given technology and it must also be realized that threat and doctrine change constantly.

To make the best use of the RDA system, the combat developer (TRADOC) and the materiel developer (DARCOM) must make a conscious effort to stay abreast of milestones and leadtimes. In this way, the Army will field equipment with current technology in the shortest time. The user will also know the capabilities and limitations of the equipment.

Coordination and cooperation is the only way that we can build the best fighting Army possible. It is in this vein that TRADOC has undertaken a positive program to have active interface between the TRADOC project officers and the DARCOM labs and development organizations.

Let me again reaffirm the Aviation Center's commitment to the RDA process. We feel the Army Aviation can make significant contributions to the Combined Arms Team; however, if the value depends on its effectiveness on the battlefield, in this regard our equipment and doctrine must be established in harmony with one another. It will do little good to design sophisticated equipment if the operators and maintenance crews are not trained to use it.

We all must think of the total impact Research, Development and Implementation have on the U.S. Army. We at the Aviation Center are committed to this end.

WES Developing SACON for Training

The U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, is developing special concrete mixes that may make it possible for Army units to train safely for military operations in urban terrain using live ammunition.

The concrete mixes, labeled SACON (shock absorbing concretes), are being developed for use in construction of mock cities to support live fire training. SACON stops bullets, minimizes ricochets, and does not spall (chip off) like conventional concrete. Air voids and fibers added to the mix create these special properties.

Mr. Bob Denson, project engineer for the WES study, explains, "The concrete contains about 40 percent air voids. This is achieved by adding a preformed foam to a sanded cement slurry. The foam, much like shaving cream, stands up and holds its bubble system intact until the cement hydrates, creating an air void system. This forms a cellular concrete, which has a structure much like a dry sponge."

Another version of SACON uses expanded polystyrene beads instead of foam. Fibers made of glass, plastic, or steel are added to both types of concrete to increase flexural strength.

"When a bullet enters the concrete, its energy is spent in crushing the cell and matrix system. The fibers hold the material together to keep it from spalling."

WES engineers were able to develop the desired materials response by combining two established properties. First, cellular concretes are used in explosive tests to absorb shock. Secondly, fibers made of various materials are added to increase flexural strength, resistance to impact loading, and spall resistance.

Twenty-four mixtures of varying unit weights and different fibers were tested at WES in the laboratory and under controlled live fire conditions. The six best mixes were selected for further testing under field conditions at Fort Bragg, NC.

The first field tests were conducted in February using cellular concrete. Three test cubicles were built under WES direction. The cubicles were eight feet square and had one door opening and one window.

The same engineer troops who constructed the cubicles fired 8,000 rounds from M16s into the structures, some from as close as eight feet.

"We were very pleased with the results," Denson said. "All three performed well. The only bullets to pass through the concrete went diagonally through the corners."

Three more mixtures were tested recently at Fort Bragg, using SACON made with expanded polystyrene beads in place of foam. Again, the glass, plastic, and steel fibers were added.

Results will be analyzed to refine the mix. "We will consider whether we can cut back on any of the ingredients to make it a more cost effective material that still gives us a good response," Denson explained.

He foresees another year of research and perhaps six months to prepare a report. The resulting product will be a design criteria for construction of the training cities.

The Army has asked Congress for funds in the next fiscal year to build a troop training village at Fort Bragg. For this reason, testing of SACON has been concentrated there, but Denson said if the concept is accepted, it will probably be used at other infantry installations as well.

Programable Handheld Calculators Aid Field Artillery Units

Logarithms, anti-logarithms, and trigonometric functions are all used by Field Artillery units to determine where a shell or rocket will hit.

Computation by hand, using tables and charts, is a long and tedious process, prone to human error. As a result, the U.S. Army Armament Materiel Readiness Command has recently purchased Programable Handheld Calculators (PHHC) to assist soldiers in performing these mathematical computations.

Preprogramed memory modules, called "chips," are the heart of the calculator system. There is a chip for each caliber of howitzer—105mm to 203mm. Each chip contains approximately 90 percent of the gunnery solutions for its caliber. A special chip contains a program to handle computations that are applicable to all calibers.

Additional chips are used for the Lance rocket, sound and flash operations, and survey applications. Each chip can figure complicated artillery data faster than manual operations. Current manual computations for the Lance, for example, require 15–20 minutes and are open to numerous operator errors. One of the new calculators can cut that time down to less than five minutes.

Currently, the primary means for solving gunnery problems is a Field Artillery Digital Automatic Computer (FADAC). Manual procedures are used as backup. But the major problem with using FADAC is that it represents 1950s technology, and it will be phased out gradually by a Battery Computer System in 1982.

Until then the handheld calculator will be used, and as backup later. The calculator has limited capabilities, so it can't completely replace FADAC, but its versatility will contribute to the effectiveness of battery fire direction.

The calculator can be powered by both direct and alternating current, as well as operate on 12-volt batteries. By using a special adapter, it can be plugged into vehicle battery systems or into backpack radio batteries.

The unit can be purchased in any store that sells TI-59 calculators. Because it uses current technology, its circuitry is easier to replace or repair. The use of preprogramed chips enables the operator to make only a simple entry of additional data to complete a computation.

Assault Breaker Contractor Named

The U.S. Army Missile Command (MICOM) has awarded $16 million to Martin Marietta Aerospace at Orlando, FL, to be integration contractor for a 15-flight, technology demonstration program for the new antitank concept called Assault Breaker.

The Assault Breaker program is sponsored jointly by the Defense Advanced Research Projects Agency and the Army. Later in the flight test program, the Air Force will participate using its Pave Mover radar which detects and acquires ground targets and updates the missile in flight.

Martin Marietta, which signed a contract late last year to furnish the T-16 booster for the flight test program, and competed with Boeing to become the integration contractor, will begin flight tests early next year at White Sands Missile Range, NM.

Martin will also manufacture dispensers, integrate submunitions and demonstrate the complete Assault Breaker system during the flight test program. Boeing and General Dynamics Corp., are competing for the contract to furnish the system's infrared terminally guided submissile.

Assault Breaker is envisioned for use in destroying large scale tank assaults by hitting them with precisely aimed clusters of smart bomblets or guided submunitions. Submunitions will be carried to the general vicinity of the armor, released and terminally guided to their targets. Technology in this program is expected to be used in the anti-armor role by the Army's Corps Support Weapon.

MICOM's Advanced Systems Concepts Office, Artillery Systems Branch, manages the Assault Breaker program. MICOM has conducted research on much of the new technology since 1975. In earlier tests at Redstone, seeker-equipped missiles were dropped from helicopters to hit an idling tank.

AMMRC Develops HPLC Technique

Dr. Gary L. Hagnauer and Ms. Beverly M. Bowse of the Polymer Research Division, U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA, have developed new testing methodology for fingerprinting chemical compositions and quantitatively analyzing specific components in hydraulic fluids.

The work was performed as an Army (DARCOM) Materials Testing Technology project to devise inspection procedures for implementation in problem areas which include specifications and procurement, field monitoring of fluid composition, trouble-shooting hydraulic system failures, developing and evaluating new or modified fluids.

A relatively new analytical technique, high performance liquid chromatography (HPLC), was implemented for the separation and detection of chemical components in hydraulic fluids. The instrumentation is automated, low cost, and simple to operate.

HPLC provides rapid and accurate analyses and requires no special sample preparation. Quite small samples (microliters) may be injected into the liquid chromatograph and analyzed within minutes.

The technique is versatile in that a variety of separation modes (size exclusion, adsorption, reverse-phase chromatography) and detection devices (ultraviolet, visible, fluorescence, infrared, refractive index) may be utilized.

Test procedures were designed for both petroleum-base and synthetic hydrocarbon-base hydraulic fluids and the results of a case study on a MIL-H-6083D hydraulic fluid were presented May 1980 at the 35th Annual Meeting of the American Society of Lubrication Engineers in Anaheim, CA.

ERADCOM Awards $17 Million for SLAR

A follow-on production contract for more than $17 million has been awarded by the U.S. Army Electronics Research and Development Command (ERADCOM) to Motorola, Inc., Tempe, AZ, for 45 APS-94F, the Side Looking Airborne Radar (SLAR). The SLAR is a surveillance radar mounted on the twin-engine Mohawk aircraft.

It provides near real time detection of moving targets as far as 100 kilometers from either side of the aircraft. A reduced capability version is being used by the Coast Guard for non-military purposes, such as tracing oil slicks and measuring flood waters. A "hardened" version of the APS-94E, the APS-94F uses the same recorder, processor viewer. Changes include a new receiver transmitter, modified signal processor and antenna.

Vought is Contractor for MLRS Development

The U.S. Army has selected Vought Corp. of Dallas, TX, as the prime contractor for further development of the Army's new Multiple Launch Rocket System (MLRS).

With the selection, the Army Missile Command (MICOM), Redstone Arsenal, AL, awarded $20.7 million to Vought for final qualification and design refinements, leading to the fielding by the U.S. Army of a free flight artillery rocket system.

Vought and Boeing Aerospace Co. of Seattle, WA, for the past 33 months have competed for continuation of the MLRS development. During that time, both contractors built, tested and demonstrated their respective weapon systems.

Proposals from both firms were evaluated by an independent evaluation committee of approximately 100 members, during an intensive 6-month study at Redstone Arsenal, AL. Their work, in turn, was reviewed by senior military and civilian personnel.

The Army's decision was based on cost and operational effectiveness. Vought is teamed with Atlantic Research Corp. of Gainesville, VA, for the propulsion components, and Bendix Corp. of Teterboro, NJ, and Norden of Norwalk, CT, for the fire control system.

MLRS consists of a 12-round launcher mounted on a highly mobile, tracked vehicle that can fire rockets singly or in rapid ripples. Rockets have a range of more than 30 kilometers.

MLRS may be coproduced in both the U.S. and Europe with Great Britain, West Germany and France. The four countries signed a memorandum of understanding last July for cooperative development of a standard NATO rocket. Hardware will be standard except for communications equipment.

The Army plans to field the system in the early 1980s. COL Monte Hatchett is MLRS project manager at Redstone Arsenal.

Technicians Produce 'High-Life' at BRL

Two technicians at the U.S. Army's Ballistic Research Laboratory (BRL), Aberdeen Proving Ground, MD, reportedly know how to produce "high life."

Mr. Doug Sprouse and Mr. Jack Williams, both assigned to BRL's Vulnerability/Lethality Division, operate the high altitude blast sphere on a BRL island test range. They conduct experiments where altitudes of more than 300,000 feet are simulated.

Sprouse, who has been operating the Spesutie Island test facility for twenty of his 31 years of federal service, says the chamber is a "perfect sphere," 30 feet in diameter with nearly 3-inch-thick walls.

"In here," Sprouse states, "we can set up complete components or sections of many modern aircraft and missiles for studies using explosive charges at simulated altitudes. The sphere can withstand the blast from several pounds of high explosives, much like those employed in some missile warheads." The maximum simulated altitude that can be attained in the sphere is 170,000 feet, but it is possible to pump out the attached 40-foot cylinder to simulate 370,000 feet, nearly 72 miles. It takes about 2½ hours to pump out the air for the maximum altitudes.

Sprouse points out that by attaching a 10-foot-diameter gun chamber, experiments can be conducted when projectiles are fired at targets within the sphere. Using both chambers provides a high altitude firing range more than 60 feet long which accommodates a gun as large as 57 millimeters. The range can also hold a small scale rocket track so studies of blast effects on moving targets can be done under high altitude conditions.

Comparison studies of various types of explosives have led to the development of a photographic light source for use under conditions of very low ambient pressures or high altitudes.

The BRL sphere has also been used to study the effects of high altitudes on fire balls, to experiment with thermal radiation and to test, at simulated altitudes of 60,000 feet, the Nike Hercules missiles' cutting charges. Evaluations have also been conducted of Soviet projectiles in the simulated altitude chamber.

Most recently, the blast sphere was used to shoot at aircraft fuel cells, to study their burning at different altitudes.

Nondestructive Testing Meet Set for November

The 29th Defense Conference on Nondestructive Testing will be hosted by the U.S. Air Force 18–20 November 1980, at the Woodlake Inn, 500 Leisure Lane, Sacramento, CA 95815.

The prime purpose of the conference is to provide a forum in which DOD agencies can disseminate information and develop potential solutions relative to NDT problems. Additional information may be obtained from: Mr. Albert P. Rogel, AFLC/MME, McClellan AFB, Sacramento, CA 95652 or Autovon 633-6176.

Perry Announces MM Wave Concept

Development of a new family of weapons which may ultimately counter the current Soviet armor arsenal, was announced recently by Under Secretary of Defense for Research and Engineering Dr. William J. Perry.

The primary factor in the new weaponry is a millimeter wave detection system that locates tanks on the battlefield. Tiny antenna are placed in the nose of a missile, bomb, or artillery shell and linked to a miniature size computer.

The missile or bomb is guided by the antenna-computer system to the metal target—which can be a tank or even a ship. According to Perry, the single foot soldier can stand a mile away from the intended target and still hit it.

All that is reportedly necessary is that the soldier aim in the direction of the tank or cloud of smoke surrounding it. The missile will fly over the tank and a little wave sensor searches it out and destroys it.

Perry noted in a recent interview that the millimeter wave concept is especially attractive because it is not affected by weather conditions or darkness, and is self-contained. Perry also indicated that the U.S. is about five years ahead of the Soviets in precision guided weaponry.

The new weaponry could be deployed as early as the late 1980s, says Perry.

MICOM Materials Division Serves Many Missions

The low-slung, white block building just off Redstone Road at the U.S. Army Missile Command (MICOM), Redstone Arsenal, AL, opens into a bay strewn with drawings, nose cones (radomes), machine tooling, mandrels, even a box-shaped oven perched on steel legs eight feet or more above the concrete floor.

The building is 7103, the workshop for a new breed of MICOM engineers and researchers who are materials experts for Army missile and rocket programs.

The Materials Division of MICOM's Engineering Directorate has cradle-to-grave responsibility for MICOM weapons development. Materials that should be selected for new systems, or used to improve older ones, are just a few of the problems they solve for Redstone project managers, MICOM laboratories, other Army agencies and commands.

The Materials Division also tests materials, studies ways to prevent deterioration and prolongs the service and shelf life of materials, and evaluates foreign technology.

The Division, under Mr. Willie K. Patterson, has approximately 30 people skilled in metallurgy, ceramics, chemistry and nondestructive testing. With facilities in buildings 5400 and 4500, as well as 7103, the Division has access to MICOM's broad technology base for problem solving.

The Ceramics Team, under Mr. Phil Ormsby is supporting the Patriot Project Office in Huntsville Research Park. Patriot, the Army's most advanced air defense weapon, utilizes a radar that has thousands of individually controlled, electronic elements, or phase shifters made of a yttrium oxide garnet material.

MICOM, working closely with Raytheon Co., Patriot prime contractor, is developing an alternate material, lithium ferrite, to replace the garnet. "Lithium ferrite is easier to process, less expensive in raw materials and will save the Army several dollars per element," Ormsby says. "This could mean a savings to the Army of several million dollars."

Ormsby notes that MICOM also has developed an ultrasonic technique to measure more precisely the wall thickness of the elements. "With this technique we can determine closer tolerances and improve performance of the elements," he said.

New Corrosion Inhibitor Extends Antifreeze Life

A new corrosion inhibitor that extends the useful life of vehicle antifreeze has been developed by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA.

The inhibitor was formulated by the MERADCOM's Energy and Water Resources Laboratory, Fuels and Lubricants Division, as part of the national effort to conserve petroleum resources. Ethylene glycol, the base fluid component for all military and most commercial antifreezes, is a petroleum distillate, and extending its useful life helps to reduce crude oil consumption.

Testing of the extender was conducted in both gasoline and diesel powered vehicles. Test vehicles were selected with a coolant that retained adequate freeze protection while the corrosive protection was rated as marginal or discard. When added to the cooling systems in a three percent concentration, the extender recharged the antifreeze corrosion protection for an additional year of use.

Tests also indicated that the extender is an excellent corrosion inhibitor for any water cooling systems. It proved to be especially effective in providing protection to aluminum cooling system components at very high temperatures. Therefore, the antifreeze extender will not only extend the useful life of antifreeze, but will also serve as a corrosion inhibitor for water cooled systems that do not require antifreeze protection.

A patent covering the new inhibitor combination has been applied for, and a specification is being prepared so that the Army will be able to procure it for future use.

NBC Marking Set Undergoing Tests at APG

Scientists at the U.S. Army Armament R&D Command's Chemical Systems Laboratory have reportedly proposed the addition of an item to the Army's line of nuclear, biological and chemical (NBC) defense equipment through NATO procurement.

Designated the NBC Marking Set, the device is currently undergoing a series of tests in CSL's Detection and Alarms Producibility Engineering Branch and in the International Materiel Evaluation program at the Army Test and Evaluation Command at Aberdeen Proving Ground, MD.

According to Mr. Charles McKnight, project engineer for the marker, the simple device for marking the location of NBC contamination on the battlefield was developed by the Federal Republic of Germany and has been in use in that country for many years.

The manually operable, portable set, which conforms to NATO standards, contains metal stakes, yellow nylon ribbon and colored plastic flags, printed with "bio" for biological agents, "gas" for chemical agents and "atom" for nuclear contamination. Procurement through the West German Government depends on the Army's acceptance and standardization, expected in 1981.

The West German marking set will undergo testing for U.S. specific requirements this year, including rough handling, cold temperature and corrosion tests. In addition, troops from the Army Training and Doctrine Command will test the item in operational testing while wearing protective clothing in various climatic conditions and in darkness.

AMMRC Develops Composite Gun Barrel Extension

The U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA, has developed a high stiffness, lightweight composite barrel extension to prove the feasibility of applying advanced composites to large caliber weapon systems.

Field tests of the extension showed a marked improvement over that of the conventional all-metal barrel extension when fired on a 75mm rotating chamber single-shot firing fixture.

The composite extension was developed through a joint program led by Mr. Craig Douglas of AMMRC's Composite Development Division and LTC Jack Houle of ARRADCOM's Large Caliber Weapons Division. Test firing took place at the Ares Corp., Port Clinton, OH.

The new composite extension displayed one third the total dispersion area compared to that of the all-metal extension. The vertical dispersion was decreased considerably while little effect was noticed on the horizontal dispersion.

This increased performance is attributed to the lighter weight and higher stiffness of the composite extension that gave rise to a decrease in initial barrel droop and an increase in natural frequency of the barrel. This, in turn, combated the well known whipping phenomena.

With this improved performance, AMMRC plans to investigate the application of composites to the complete barrel which should cause an even greater improvement in overall performance.

Capsules . . .

XM1 Performs Well in Early APG Tests

The first XM1 battle tank off the assembly line is performing well in its early testing stages at Aberdeen Proving Ground, MD, according to Materiel Testing Directorate officials.

The vehicle, the first in the Low Rate Initial Production Phase, was officially christened the "Abrams Tank" in honor of the late GEN Creighton W. Abrams, and nicknamed "Thunderbolt." It is undergoing exhaustive testing to determine if contractual compliance to the system's specifications will be met.

The tank is in the third phase of developmental testing. Officials stated that at the end of the second phase, 20 deficiencies were noted on the prototype model.

"Most of these deficiencies have had corrective action taken," said Mr. Eddie Meadows, senior test director for the automotive and weapons phase of testing. "Whether these actions are adequate is what we're testing now. The significant thing is that an effort has been made to correct the deficiencies by the contractor."

This first tank is being tested for Reliability, Availability, Maintainability and Durability (RAM-D).

During its year at APG, it will go through 12 cycles of testing including the exercising of all components as well as the automotive and fire control aspects.

Each cycle will include driving the vehicle 500 miles over paved, gravel, hilly and level terrain test courses. The tank will fire 100 rounds from stationary and on-the-move positions during each cycle.

The tank will be joined by the five others by the end of the year. The next production model, the fourth off the assembly lines, arrived at APG in May. It, too, will be RAM-D dedicated, but testing will be done by the Military Support Division of MTD.

One hundred and ten tanks are being produced in the Low Rate Initial Production phase. Fifty-five will go to Fort Hood, TX, where soldiers will test and train on them. The rest will go to Fort Knox, KY, Yuma Proving Ground, AZ, White Sands Missile Range, NM, and the Cold Regions Test Center.

AEL Announces Contract for EDET

Production of two Elevation Data Edit Terminals, to detect and correct errors in computer tapes of digital elevation data, is called for in a recent $958,032 contract announced by the U.S. Army Engineer Laboratories, Fort Belvoir, VA.

DBA Systems, Inc., Melbourne, FL, is developing the terminals for eventual use by the Defense Mapping Agency. One terminal will be delivered to the Mapping Agency's Hydrographic/Topographic Center, Brookmont, MD, and the other will go to the Agency's Aerospace Center, St. Louis, MO.

EDET will superimpose the digitial elevation data on the aerial photos from which the data were originally compiled. EDET will work by application of anaglyphic stereoscopic technique, the same principle used in 3-dimensional comic books and movies.

Each terminal will resemble a television with only two colors, red and blue. Red and blue images are the right and left half of a stereo pair of aerial photos. Viewed with spectacles, the double television picture becomes a 3-dimensional picture or stereograph of terrain as seen from the air.

Raw digital elevation data on magnetic tape are also fed into the terminal. Each elevated point on the grid is displayed as a dot in space. If the stereo pair and the data are accurate, the dots in space will be neither above nor below ground level in the stereograph.

Where a data point appears suspended above ground or buried underground, a data error is suspected. The photos and the data can be examined in detail to find the source of the error and correct it.

Digital elevation data and stereographs can also be displayed as a profile (cross section) of the terrain. Elevation data can also be depicted as contour lines superimposed on the relief of the stereograph.

In addition to correcting inaccurate data, EDET can validate large masses of data, putting a higher confidence value on the maps and charts produced from the digital elevation data base.

Army Fields OL-192 Weather Devices

The OL-192, a device that enables operators to send accurate, up-to-the-minute meteorological information to artillerymen in the field, is now being fielded throughout the world. The device was developed by the Army Electronics R&D Command's Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth, NJ.

The OL-192 consists of a calculator, a reader/perforator, and a housing case. Parts are manufactured by the Hewlett-Packard Co., Colorado Springs, CO; the Remex Division of Ex-Cell-O Corp., Irvine, CA; and Metric, Inc., of Bohemia, NY. In operation, it relays ballistics information taken by airborne weather stations to an artillery fire direction center by teletypewriter, on tape punched by the reader/perforator. Artillerymen can thus make rapid adjustments in artillery fire direction according to atmospheric changes.

APG Tests XM272 Water Testing Kit

A lightweight detector kit, weighing less than four pounds and containing chemicals to detect hazardous levels of nerve, mustard, Lewisite and blood agents, is now in the advanced stage of development in the CB Detection and Alarms Division of the Army Armament R&D Command's Chemical Systems Laboratory (CSL), APG, MD.

The concept model of the kit was designed and fabricated by the Midwest Research Institute. When fielded, the kit will contain simulants of the four classes of chemical agents for training personnel.

Designated the XM272, water testing kit, chemical agents, the kit is intended for use by tactical units for reconnaissance of water supplies and to verify that processed water is free from chemical agent contamination.

Project Officer Mr. Achille Silvestri pointed out that the kit functions in raw or treated water and contains a new enzyme ticket designed specifically for detecting nerve agents in water. The kit uses an effervescent procedure to expel other agents from water so they can be detected by standard detector tubes.

The kit does not require electrical power. However, when testing for mustard gas either a compact "D" cell battery or the use of matches is required.

When fielded it will be a separate item of issue as well as a component for the Corps of Engineers "Water Quality Analysis Set."

ERADCOM Awards VHSIC Contracts

The U.S. Army Electronics Research and Development Command (ERADCOM) recently awarded contracts totalling more than $3.5 million to enhance and further develop Very High Speed Integrated Circuit (VHSIC) technology.

VHSIC is a tri-service program which will be accomplished in three phases over a six year period. The program will provide critical technology and elctronic subsystems to meet Department of Defense signal processing requirements.

Rockwell International, Anaheim, CA, received $1,574,800, Hughes Aircraft, Culver City, CA, $1,519,990, and General Electric Aerospace Electronics Systems, Utica, NY, $510,732. The contractors will define approaches to system architecture, chip architecture and design, circuit-processing technologies, and testing.

Army Establishes ALMO Under OTAG

An Army Library Management Office (ALMO) has been established, under the Office of the Adjutant General, to coordinate library activities within the Army. The ALMO will act upon issues developed by an Army-wide Library Council (ALC).

This council, which also was recently established, is primarily responsible for coordinating agency/command efforts in the operation of Army library programs, improving the system and sharing ideas.

The first quarterly council meeting was held in January 1980, and Ms. Omdahl, DARCOM staff librarian, was elected council chairperson for a one-year term. Elements of appropriate bylaws were discussed, and suggestions for issues to be reviewed included procurement, contracting of services, staffing guide preparation, relationships to the Army Library Institute, relationships and possible exemptions to certain policies and regulations.

The second quarterly meeting, held in April, reviewed a draft of the bylaws and discussed committee actions related to the above issues. The minutes of the quarterly meetings are distributed to all Army libraries and may be reviewed by any interested personnel.

A council objective is to discuss library issues of mutual interest across command lines. However, it should be noted that Army Regulation 70-45 governs operational and data management policies for Army technical libraries and information centers and therefore will take precedence over council and/or ALMO actions. The proponent office for AR 70-45 is U.S. Army Materiel Development and Readiness Command, ATTN: DRCDE-RE.

Problems and/or issues appropriate to Army Library Council consideration may be forwarded to the council through your local command library or directly to the following council member: Mr. Edward J. Kolb, Principal Army Technical Information Officer
U.S. Army DARCOM, DRCDE-RE
5001 Eisenhower Avenue
Alexandria, VA 22333—AV 284-9828

Battelle Reports on 1979 S&E Salaries

The 1979 monthly median salary for engineers and scientists engaged in research and development in the U.S. was $2,385, according to a recent study by Battelle Columbus Laboratories, Columbus, OH.

The study, conducted for the U.S. Department of Energy, reports that the monthly median salary for researchers and supervisors with a bachelor's degree was $2,201; master's degree, $2,462; and doctor's degree, $2,688. These figures are based on salaries of degreed nonsupervisory and supervisory researchers at 322 establishments.

Battelle, which has conducted the study annually since 1968, sampled 91,315 scientists and engineers in 1979. These researchers work in industry, nonprofit research institutes, federally funded contract research and development centers, educational institutions, and the federal government.

Of the researchers surveyed, 8.6 percent did not hold any academic degree; 45.7 percent had bachelor's; 26.2 percent had master's; 18.5 percent had doctor's; and 1.0 percent had medical degrees.

According to Ms. Jean Newborg, who headed the study, a comparison of monthly median salaries for nonsupervisory researchers with bachelor's or master's degrees shows those working as mining/petroleum engineers and aeronautical engineers earned the highest salaries while agricultural and biological researchers earned the lowest.

For nonsupervisory researchers with doctor's degrees, mining/petroleum engineers earned the highest monthly median salaries, and psychology researchers earned the lowest. The survey presents salary information for 19 scientific and engineering occupations.

Newborg said a trend analysis of 162 of the establishments that had participated during the past five consecutive years shows median salaries for researchers increased 6.8 percent in 1979. This compares with increases of 7.0 percent in 1978, 6.0 percent in 1977, and 6.2 percent in 1976.

The Battelle study also included an analysis of the effect on salary levels of such factors as size and location of an organization and the number of researchers in the area. Newborg said of these factors, size of the establishment had the most consistent effect on salaries in 1979, with the larger establishments paying higher salaries.

XM445 Fuze Enters Final Evaluation

The XM445 electronic time fuze for the Multiple Launch Rocket System (MLRS) successfully completed all developmental and operational tests (DT/OT) on the Boeing and Vought competing rocket systems.

The fuze, designed and built by the Army's Harry Diamond Laboratories (HDL), reportedly performed perfectly during the tests in which system temperature extremes and operating ranges were also validated.

The Army will now proceed with final evaluation and selection of one of the two missile systems before beginning system maturation and low-rate production.

HDL, the largest element of the Army Electronics R&D Command, Adelphi, MD, has been the Department of Defense and Army principle electronic fuze developer for over 25 years. The XM445 will be the seventh HDL fuze to enter production in the past six years.

In Brief . . .

Perry Discusses Acquisition Process

Tailoring of the acquisition process, inflation, and NATO cooperative programs were major topics discussed by Under Secretary of Defense for Research and Engineering Dr. William J. Perry during a recent guest appearance at a HQ DARCOM Commander's Call gathering.

Dr. Perry, who is the Department of Defense acquisition executive, began his presentation by stating that today the DOD has the best program managers in the world. Their professionalism, he said, is due in large part to the fine job that the Defense Systems Management College is doing.

Recently revised DOD Directives 5000.1 and 5000.2 will add more competition to the acquisition process, emphasized Perry. Said he: "We are putting more competition in full-scale development and production." He added that more importance is also being placed on the "statement of the need" phase of acquisition.

The revised DOD directives, continued Perry, will also help program managers tailor the acquisition process to their specific program needs. This, in turn, will give a better view to the PM of what his program risks are.

Under Secretary Perry also discussed the concept of concurrency in the acquisition process. He noted that it has definitely been of value in the acquisition process of some programs. Some of the specific programs he discussed were the Fighting Vehicle Systems, XM1, DIVAD, and the Air Launched Cruise Missile.

The Fighting Vehicle Systems Program had slight concurrency between its development and production phases. Perry termed the DIVAD Program the "ultimate" in concurrency because the program went directly into full-scale development. Risks were considered low and we approached DIVAD from a "hands-off management" perspective, said Perry.

Dr. Perry stressed that the key to concurrency is that we must be prepared to accept development problems when we undertake such a program. Another factor which is very important to the acquisition process is how to gracefully transition from development to production.

Relative to inflation, the Under Secretary stated quite candidly that he really didn't know of a good way of dealing with it. High interest rates, he explained, are a disincentive for contractors to invest, and this, in turn, is bad for the program manager. The PM does have some flexibility in dealing with inflation, added Perry.

Dr. Perry concluded his remarks with a brief discussion of NATO cooperative armament programs. He stated that there are some problems with cooperative programs, but that there is a misperception that they are not cost effective and they are undertaken largely because of political considerations.

Cooperative programs, he continued, are truly undertaken because there is a genuine belief that they will provide an effective fighting capability. One of the problems, he added, is getting U.S. technology into NATO systems, and vice-versa, when applicable.

The Under Secretary stressed that we must get cooperative agreements which allow U.S. technology into British, Dutch, and German equipment. Perry noted that he emphasizes U.S. involvement because the U.S. puts $13 billion annually into defense R&D. Subsequently, the U.S. has a very good technology base. He closed by stating that the key to cooperative programs is to get the best and cheapest technology in deployed NATO equipment as quickly as possible.

Career Programs . . .

S&E Apprenticeships Established

The Department of Defense is participating in a special program to provide scientific apprenticeships to high school students. The program is designed to have special appeal to minority and women students interested in careers in the science and engineering professions.

Minimum goal for the summer of 1980 is 200 apprentices who will study and work with a professional mentor in either DOD contract research establishments or in the DOD laboratories. The program will be administered by the individual military departments.

DOD point of contact for this program is Mr. Albert M. Bottoms, care of Deputy Under Secretary of Defense for Research and Engineering (Research and Advanced Technology), Room 3E114, The Pentagon, Washington, DC 20301, telephone (202) 695-6888.

The Army program will be conducted at the Army's R&D laboratories located in the U.S. Also, Army not-for-profit contractors, mostly universities, will participate on a volunteer basis, thus broadening the geographic locations for potential apprenticeships. The Army expects to identify these locations by the end of March and apprentices by the summer.

The program will be administered by the U.S. Army Materiel Development and Readiness Command, the U.S. Army Medical Research and Development Command, the U.S. Army Corps of Engineers, and the U.S. Army Research Institute for the Behavioral and Social Sciences.

Army officials will be seeking recommendations of possible apprentices from high school administrators, based on the students' ability in science and engineering fields, participation in extracurricular activities related to science and engineering, and scholastic achievement.

Additional information may also be obtained from Army point of contact Mr. Jim Spates, Office, Deputy Chief of Staff for Research, Development and Acquisition, Washington, DC 20310, telephone (202) 697-3460.

NRC Accredits CSL Research Program

The U.S. Army Armament R&D Command's Chemical Systems Laboratory (CSL) has been accredited for a resident research associate program by the National Research Council (NRC), National Academy of Science.

The NRC program provides post-doctoral scientists and engineers of unusual promise and abilities with opportunities for research on military problems.

Referred to as "postdocs," the research associates are selected for a position based on their area of specific research interest and assigned to an advisor who approves the proposed line of study.

The NRC accreditation provides CSL with an important link to research conducted in the academic community and opens the door for CSL researchers to collaborate with leading post-doctorate and senior research personnel in high institutions of learning.

Selected federal organizations provide nearly 250 opportunities for research in various scientific disciplines. The program has mutually benefitted the research activities as well as NRC.

In making the announcement, Dr. B. L. Harris, CSL deputy director, said the NRC accreditation points to the high scientific stature of CSL and its personnel and provides an opportunity for CSL to bid for the short tour services of post-doctural and senior research personnel.

USMA Seeks Department Head

The Superintendent of the U.S. Military Academy has announced that applications are now being accepted for the position of Professor and Head of the Department of Engineering. The individual selected will be responsible for planning and directing undergraduate instruction in core and elective courses and fields of study related to general and specialized engineering subjects, and for administration of the department.

Applicants should have a PhD degree in an engineering discipline and demonstrate a high capacity for further academic achievement. Additionally, applicants should have attended a senior service school. Anyone interested in the position should address an application, including biographical and professional information, to LTC Schell, Office of the Dean, USMA, West Point, NY 10996.

Dagostin Begins Executive Training

Mr. Frank A. Dagostin, a chemical engineer at the U.S. Army Armament R&D Command's Chemical Systems Laboratory, Aberdeen Proving Ground, MD, recently became the 35th civilian employe selected for six months of training under CSL's executive training program.

He will receive a 3-month segment of training in the Office of the CSL Director and a similar training period at HQ U.S. Army Materiel Development and Readiness Command, Alexandria, VA.

Prior to his selection as an executive trainee, Dagostin was project engineer for the development of a binary projectile for the 8-inch howitzers. He has also been involved in smoke pyrotechnics, and riot control R&D programs.

He is a graduate of Pennsylvania State University, holds a master's degree in management engineering from George Washington University, and is a member of the American Institute of Chemical Engineers.

Awards . . .

NARADCOM Honors Achievements

Achievements in research, engineering and administration were recognized recently during annual awards ceremonies at the U.S. Army Natick (MA) R&D Command.

Dr. William Porter received the Technical Director's Gold Pin for Research for contributions leading to establishment of scientific rationale for selecting antitoxidant inhibitors in food ration items and for developing a rapid test for the detection of antitoxidants.

Mr. Gil M. Dias and *Mr. Armando C. Delasanta*, textile research chemists won a Technical Director's Silver Pin for Research and the Inventor of the Year Award. They were credited with improving flame retardancy and reducing the thermal transfer properties of textile materials used in chemical and protective overgarments.

Dr. Matthew L. Herz, a research analyst, also received a Silver Pin for Research for developing a method for determining all possible chemical warfare threat items and for providing data to design future protective clothing.

Mr. Justin M. Tuomy, *Ms. Carol P. Shaw* and *Mr. Gerald Darsch* were awarded the Technical Director's Gold Pin for Engineering. They were cited for providing technical support to the new food service system established at Walter Reed Army Medical Center.

Dr. Robert J. Byrne, chief, Operations Research Systems Analyst Office, and research analysts *Mr. Gerald Hertweck* and *Mr. Harry J. Kuejczyk*, and food technologists *Dr. Robert Decareau* and *Mr. Ivor T. Nii* received a Silver Pin for Engineering. They designed a new combat food service system which enables greater frequency of delivery of hot meals by less personnel.

Mr. Vincent D. Iacono and *Mr. Joseph Fratantuono* also won a Silver Pin for Engineering for development of specialized protective systems for combat vehicle crewmen. Their concepts include garments which can cool or warm the user.

SSG Martin J. Neises, Aero-Mechanical Engineering Laboratory, was presented with the Commander's Military Award for Research, Development, Test and Evaluation. He was cited for outstanding efforts as military project officer during development and modification of the CTU-2A High Speed Aerial Delivery Container and its parachute subsystem component.

Mrs. Mary W. Barnum and *Mr. Charles F. Murphy* were winners of Gold Pins for Leadership in Administration. Barnum was cited for Natick's new Integrated Logistics Support Program. Murphy was praised for achievements associated with his work as chief of the Legal Office. *Mrs. Elda B. Key* received the Silver Pin in Administration for execution of Natick's RDT&E appropriation.

It was also announced recently that *Mr. George Turk*, Food Engineering Lab; *Dr. D. Paul Leitch*, *Mr. Richard P. Richardson*, *Mr. Brian Hill*, and *Mr. Paul Short* will receive the 1979 COL Rohland A. Isker Award from the Research and Development Associates for Military Food and Packaging Systems.

The group was cited for outstanding contributions to national preparedness in the field of food and food containers. Specifically, they designed a fast food service system which has been adopted by the U.S. Navy and installed aboard the *USS Saratoga*.

Bullock Gets DA Commander's Award

Commander's Award for Civilian Service is presented by COL (P) J. C. Bahnsen, 1st Aviation Brigade commander (left) and COL Stanley C. Knapp, USAARL commander, to Ms. Sybil Bullock.

Ms. Sybil Bullock, chief, Scientific Information Center, U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL, was recently awarded the Department of the Army Commander's Award for Civilian Service.

The Commander's award is given to an individual by a general officer or civilian of equivalent rank for exemplary contributions to the activity which the individual serves. This award is the third highest Department of the Army honorary award.

Ms. Bullock has been serving as Fort Rucker's Federal Women's Program Manager since October 1978 in addition to her duties at the Scientific Information Center.

"A rare blend of managerial skills, outstanding leadership ability, professional competence, wholehearted dedication, and an understanding of people" were cited as qualities that contributed to her selection by MG James H. Merryman, commander, U.S. Army Aviation Center, Fort Rucker, AL.

Ms. Bullock worked to bring training workshops to Fort Rucker, to have a special supervisor's development course taught, and to send representatives to the Federally Employed Woman's Conference.

She was also credited with providing additional library services to the research staff at USAARL and has furthered EEO for library science students.

In an effort to meet the needs of laboratory research investigators, she has obtained direct on-line computer access to the Defense Technical Information Center as well as a terminal for the MEDLAR system. She is currently developing concepts for in-house computerized library services.

Ms. Bullock began her civil service career in 1964 as a library technician, Aviation Training Library, Fort Rucker. In 1972, she was promoted to librarian (cataloger). This led to her transfer to the U.S. Army Aeromedical Research Laboratory as librarian in 1975.

Patent for Communications Device

Dr. Theodore J. Klein, Mr. Paul F. Sass and Mr. George E. Krause, electronics engineers with the Army Communications R&D Command Center for Communications Systems, have been granted a United States patent for an apparatus which automatically selects the best telecommunications channel.

The apparatus reportedly provides extremely reliable communications over difficult terrain under varying propagation conditions. Several channels of a telecommunications link are continuously monitored to determine which was the least interference and noise level.

The new system includes a microprocessor and adaptive threshold detector which select one of the channels in a predetermined manner to transmit data. A test message is transmitted to a quiescent, remote, unmanned location to insure proper operation before transmission of the desired signal.

Klein has been associated with communications research and development at Fort Monmouth since 1958, and is chief of the Advanced Communications Technology Team, Signal Processing Division, CENCOMS. He has worked as an electronics engineer in application of communications theory and system design.

Sass has been employed since 1971 in the Signal Processing Division of CORADCOM's Communication Systems Center, originally the Communications Automatic Data Processing Laboratory.

Krause has been employed at Fort Monmouth since 1954, with the Army Radio Propagation Agency, and since 1966 with CENCOMS and its predecessor, the Communications and Automatic Data Processing Laboratory.

Miniature Dose-Rate Indicator Patent

Two Army inventors have been granted a U.S. patent for a pen-size instrument used in measuring the dose-rate of fallout gamma radiation.

The patent was granted to scientist Mr. Michael J. Basso and electronics technician Mr. Henry Brown, employes of the U.S. Army Electronics Research and Development Command's Army Combat Surveillance and Target Acquisition Laboratory.

The Meterless Operation Dose-Rate Indicator reportedly provides the user with a small, rugged, meterless device to measure fallout gamma radiation dose-rate. The instrument can be used in place of larger, more costly dose-rate meters.

In practice, the user turns a miniature, calibrated potentiometer in the end of the instrument until a small light on the instrument barrel is seen to come on. The user then reads the gamma dose-rate from the dial on the potentiometer.

Scientist Patents Tiny Circuit Chip

Mr. William B. Glendinning, a physical scientist at the U.S. Army Electronics R&D Command, Fort Monmouth, NJ, has been granted a patent for an ultra-miniature analog-to-digital converter silicon integrated circuit chip.

The chip, believed to be the world's smallest A/D IC electronic device, reportedly increases circuit density and provides improved communication, surveillance, and intelligence signal-type processing equipment.

Micron-sized electrical charge packets are transferred in a see-saw manner between two adjacent locations of a glass-silicon semiconductor interface. Using this see-saw action, in a "weighing" process, an analog electrical signal amplitude is subdivided into its equivalent binary code of signals.

Glendinning has a bachelor of science degree in electrical engineering from the Newark College of Engineering and a master's degree in electronic engineering from Monmouth College. He has published a number of papers in the microelectronic advanced device and process technology fields and has 12 patents issued previously.

Personnel Actions . . .

Chesbro Assigned as Firefinder PM

COL John S. Chesbro

COL John S. Chesbro is the new project manager for Firefinder, following the reassignment of COL Thomas F. Cameron as commander of the School Brigade, Army Missile and Munitions Center and School, Redstone Arsenal, AL.

A 1954 graduate of the U.S. Military Academy, COL Chesbro has a 1962 MSE degree from the University of Michigan (Ann Arbor), and has completed course requirements of the Army Command and General Staff College, and the Army War College.

Prior to his new assignment, COL Chesbro was chief, Systems Evaluation Office at the Army Armament R&D Command, Dover, NJ. He also served at ARRADCOM as chief of Research, Development, and Engineering.

His other tours of duty have included chief, Programs Transition Team, AMC Committee-Armament, HQ AMC; Office, Joint Chiefs of Staff; and in Vietnam as executive officer, 1st Artillery Field Force, and commander, 1st Battalion, 92d Field Artillery.

COL Chesbro is a recipient of the Legion of Merit, Bronze Star Medal, Meritorious Service Medal with two Oak Leaf Clusters (OLC), Air Medal with three OLC, Joint Service Commendation Medal, and Army Commendation Medal with two OLC.

Goetz Becomes ACT Project Officer

MG Emmett Paige Jr., commander of the U.S. Army Communications R&D Command (CORADCOM), has designated the Army Communicative Technology (ACT) Office as a development project office and has named COL John A. Goetz as development project officer.

COL Goetz, who is the chief of the ACT Office, was commissioned as a second lieutenant in the Signal Corps in 1956. He holds a bachelor's degree in broadcasting from Michigan State University. His military schooling includes the Command and General Staff College and the Signal Officer Advanced Course.

His prior assignments include deputy commander, 1st Signal Brigade, Korea; commander, 57th Signal Battalion, Fort Hood, TX; chief, Training Extension Course, Combat Arms Training Board, Fort Benning, GA; Staff and Faculty, Army War College; and commander, SEA Pictorial Center, Vietnam.

COL John A. Goetz

He is the recipient of the Bronze Star Medal with "V" device and three Oak Leaf Clusters (OLC), the Meritorious Service Medal with OLC, and the Joint Service Commendation Medal.

The Army Communicative Technology Office, which is located at Fort Eustis and jointly manned by DARCOM and TRADOC personnel, is responsible for life-cycle management of new systems for the delivery and storage of doctrinal, instructional, and technical materials.

Irish Selected as Analysis Centers PM

COL Kenneth M. Irish

COL Kenneth M. Irish has been named project manager, Control and Analysis Centers (CAC), Vint Hill Farms Station, Warrenton, VA. He succeeds COL Terence D. Sargent. CAC is one of four PM programs directed by the Army Electronics R&D Command.

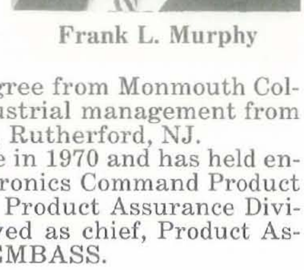
Assigned to ERADCOM since 1978—first as an EW staff officer and more recently as ERADCOM operations officer—COL Irish served earlier as commander of the Allied Forces Southern European Communications Command, Naples, Italy.

Other key assignments have included a 3-year tour in the Office, Chief of R&D Department of the Army; professor of military science, University of Michigan ROTC Program; and project officer, Communications Division, Electronics R&D Laboratory, Bangok, Thailand.

COL Irish received a BS degree from Western Michigan University in 1957, and holds a master of science degree in electrical engineering from Georgia Institute of Technology. He has also completed the Signal Officers Basic and Electronic Warfare Staff Courses.

His military honors include the Legion of Merit with first Oak Leaf Cluster, Meritorious Service Medal, Air Medal, and the Army Commendation Medal.

Murphy Chosen as Firefinder Deputy PM



Frank L. Murphy

Mr. Frank L. Murphy recently became deputy project manager (PM) for the Army's Firefinder/REMBASS programs. Both programs are directed by the Army Electronics R&D Command, Adelphi, MD.

He succeeds Mr. Andrew D'Angelo who was named director of Product Assurance for the Communications and Electronics Materiel Readiness Command (CERCOM), Fort Monmouth, NJ.

Murphy earned his BSEE degree from Monmouth College, and a MBA degree in industrial management from Fairleigh Dickinson University, Rutherford, NJ.

He entered the federal service in 1970 and has held engineering positions in the Electronics Command Product Assurance Directorate and the Product Assurance Division of Firefinder. He also served as chief, Product Assurance Division, Firefinder/REMBASS.

DIAL Adds Dimensions to Mapping

Although it is still only experimental, the Digital Image Analysis Laboratory (DIAL) at the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, VA, is providing products and services which were only dreamed of several years ago.

Believed to be one of the most sophisticated interactive digital processing facilities in the world, DIAL is used primarily to conduct research in mapping and intelligence. However, uses of the facility include archeology, industry, biomedicine, topography, law enforcement, space, and defense applications.

Digital picture processing has improved the quality of picture transmissions from distant spacecraft such as the Surveyor, Mariner and Apollo. Other benefits have included improved restoration of the electron microscope, and accurate detection of earth resources.

Dr. Bryce L. Schrock, a physical scientist working in the Computer Sciences Laboratory at ETL, is responsible for the conception and ultimate implementation of DIAL. He proposed the system in 1975 as a way to meet modern mapping and terrain analysis requirements.

Schrock proposed the system when it became apparent that digital image processing was potentially far superior to other methods of image analysis. He believed that the *flexibility*, which such systems offer, would greatly improve ETL's mapping and image analysis capabilities.

DIAL has met the requirements for its creation and, in operation since 1977, has reportedly resolved many of the problems inherent to digital image processing. Applications and capabilities are said to exceed those originally proposed and DIAL today is a state-of-the-art system.

Basically, DIAL, which uses FORTRAN computer language, is composed of four subsystems: a host processor, a parallel processor, a low speed workstation and a high speed workstation.

DIAL is used primarily to satisfy mapping and intelligence requirements in the areas of digital photogrammetry, photo interpretation, feature extraction and terrain analysis.

There are, however, frequent requests from outside sources for the use of DIAL's special capabilities. DIAL has been used, for example, for weld-x-ray analysis where digitized X-rays of metallic welds were processed in order to locate and quantify certain weld defects.

Infrared images of cloud formations were pseudocolor encoded to delineate the temperature bands, and consequently the elevation ranges in the clouds. A contouring routine was also used to locate the isothermals in the clouds.

The Congressional Committee investigating the assassination of President John F. Kennedy also used DIAL during the course of their work. Various photographs taken at the time of the assassination were digitized and manipulated to determine if advanced digital image processing techniques could cast additional light on the assassination.

DIAL was used recently as a tool in the investigation of subliminal advertisement. According to the persons involved in the studies, there was reason to suspect that "loaded" images or words were being enmeshed or embedded onto the packaging and advertisements of certain products—visible only subliminally, but psychologically influential to the consumer.

Work was performed recently for the Drug Enforcement Administration and the Federal Burea of Investigation (FBI). Both cases involved a process called "image restoration" or the capability of the digital system to "deblur" and enhance poor quality photos.

The Drug Enforcement Administration requested assistance from DIAL in a court case involving the possession and passing of drugs and the FBI is interested in digital image restoration for many reasons including fingerprint analysis and handwriting restoration.

Presently, DIAL's capabilities are being used by members of the Microwave Research Laboratory at the Walter Reed Army Institute of Research who are studying the biomedical consequences of microwave exposure.

Until the special display and processing techniques of DIAL were discovered and utilized by the Walter Reed scientists, research had come to a standstill. With the aid of DIAL's enhancement procedures to contrast or code intensity levels of the biomedical images, research is continuing.

Army Tests M43E1 Detector at Fort Story

Five of the Army's M43E1 chemical agent detectors will be tested over a 24-hour period at Fort Story, VA, this summer as part of a product improvement program, according to a recent announcement by the U.S. Army Armament R&D Command's Chemical Systems Laboratory.

The purpose of the test is to determine the detector's capability to operate in salt spray environment. Arctic tests on the detector have been completed. The detector, a principal part of the Army's chemical agent alarm system, senses the presence of chemical agents in the atmosphere.

Both the detector and the alarm system were developed in CSL's CB Detection and Alarms Division. Mr. Dan Nowak, the developing engineer on the M43E1 product improvement program, said the detector operates on the principle of molecular ion clustering.

"The M43E1 is made up of several replaceable components," he said, "and one of the components, the cell module, contains a radioactive source, Americium 241, an alpha and gamma emitter."

Each detector contains 250 microcuries of Americium 241, sealed in materials specifically developed for use in the detector. However, when operating, the detector does not produce any significant amounts of radiation and no impact to the environment is expected.

The Army's current field detector, the M43, operates on a wet chemical system and requires the service of an M229 refill kit every 12 hours. The improved M43E1 will operate without the need for a refill kit, thereby improving logistical support as well as reducing costs.

A compact, portable unit, the detector is about 16 inches high and weighs about 13 pounds when equipped with a battery and handle. The improved version is expected to be fielded in 1984.

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