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ARMY RESEARCH AND DEVELOPMENT

March-April 1975

SPEAKING ON . . .

Pride in Army R&D Achievements for All America—Farewell Tribute

When an Army research and development scientist caps more than 33½ years of Federal Civil Service by having the Secretary of the Army present him with a fourth award of the Decoration for Exceptional Civilian Service, the record of his achievements is remarkable if not unique.

Secretary of the Army Howard H. Callaway made that indication even more evident by the warmth of his tribute, the vigor of his handshake, when he congratulated Deputy Assistant Secretary of the Army (R&D) Charles L. Poor after presenting him recently with the Army's highest standard award to a career civilian employe (see photo at right).

The accompanying citation credited "Charlie's extraordinary dedication of purpose, mature wisdom, sound judgment and distinguished leadership . . . imaginative supervision and assistance to the Research, Development, Test and Evaluation Program of the Army. . . ."

The occasion was Poor's retirement from Federal Civil Service and a position in which he had served since June 24, 1963, following duty from December 1960 as assistant to Assistant Secretary of the Army (R&D) Dr. Finn J. Larsen and his predecessor, Richard S. Morse. Poor earlier served 14 years in progressively high-level assignments with the Army Ballistic Research Laboratories, Aberdeen Proving Ground, MD.

The citation further acclaimed him for "broad comprehension and astute analytical approach" (which) "have contributed immensely to the successful accomplishment of the mission, goals and objectives of the Department of the Army. His multi-disciplined engineering knowledge, combined with a thorough understanding of research and development methods and management at all levels, has allowed him to provide both technical and management guidance throughout the Army research and development establishment."

Nominated by the Army for the Rockefeller $10,000 Public Service Award in 1966, Poor highlighted his career by achieving distinctions too numerous to list within the purview of this article. For example, he served as a principal assistant or deputy under every Assistant Secretary of the Army (R&D). Frequently he served many months at a time as acting ASA(R&D) between appointments of noted industrial leaders to fill the top post.

Another unusual aspect of his career is that he served continuously in Army R&D assignments following graduation from Harvard in 1941 with an AB degree in aeronautical engineering—except for 1942–46 duty as a Navy officer in an R&D assignment. Yachting has been his prolonged hobby and he was commodore of the Chesapeake Sailing Club; also entered the Bermuda races.

Many high-ranking Department of Defense and Department of the Army leaders joined Poor's working associates to honor him upon his retirement. Expressive of his pride in the privilege of working with them and characteristic of his attitude during his career in Army R&D is this farewell message.

★ ★ ★

People do funny things in this room. Some smile, some cry, some make long speeches about how much they owe to the little woman, and how much to all the great people who worked for them and made all this possible. Others just say thanks, and go away.

I wondered what to say to all of you friends who so kindly came today, and I decided you can't very well go away from some 30 years without saying a little about what it all has meant.

I have been hearing a lot lately, about the low credibility of the Army R&D commuity, and how poorly we have done. And I asked myself how come if it was so bad, it has been so exciting, and so rewaring to have been a part of the Army R&D community? Why have I stayed in it for so very long?

The answer seems to come easily. By any reasonable standard of measurement, the Army should be proud, and pleased, and eager to be called to account for its performance.

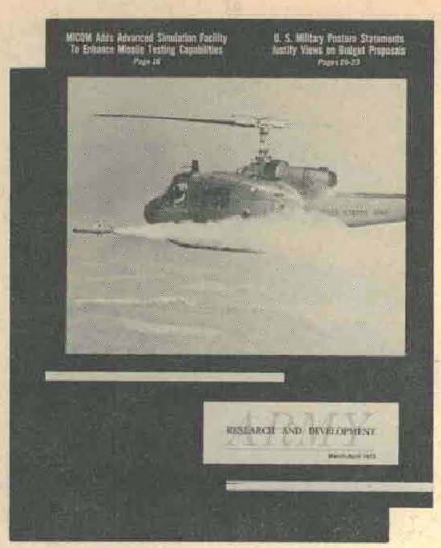
We pioneered the development and application of large-scale electronic computers, in the 40s and 50s, and built the foundation of a new industry. We worked with NASA and the other Services to build an understanding of high-speed flight, and rocketry, and guided missiles. We built the first communication satellite, and the first satellite that measured the world.

We built a new kind of fighting force, based on helicopters, freeing our soldiers from the mud and trees and misery of a ground-bound Army, and built a new industry. We learned to see at night (development of night-vision devices), and built another new industry.

We developed antiaircraft guided missiles, and antitank guided missiles, and even the ABM (antiballistic missile). All of these things stretched the technological muscles of the country, strengthened our economy, and stimulated our imaginations.

Along the way we developed new things to make the soldier in the field safer, better fed, more comfortable. Freeze-dried foods—another new industry. Fire-resistant clothing, and crash-resistant aircraft, and better tents, and better radios, and better shoes, and far, far better ways of medical care—traumatic surgery, burn care, and prosthetic devices that help all of the people of the country.

All of these things the Army did—with help from a marvelously dedicated industrial and university community—in its laboratories—helped and supported by the Congress. It is today the best-equipped, best-supported, just plain best Army in the world. So it has been fun helping a little to bring it all about.



ARMY RESEARCH AND DEVELOPMENT

Vol. 16 No. 2 March-April 1975

ABOUT THE COVER:

Missile test firings, ground-launched and from aircraft, are a part of the routine at Redstone Arsenal, AL, headquarters of the Army Missile Command. MICOM's newest "marvel" for missile research is a $40 million Advanced Simulation Facility termed the most modern of its kind in the world. Reportedly, it is capable of simulating virtually all environmental conditions a missile may encounter to accomplish its mission. The facility is available for use by U.S. Armed Forces and defense contractors.

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FEATURES

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Selective Scanner . . .

U.S., UK, FRG Evaluating New Tank Gun Systems

Simultaneous announcement of the opening of tripartite firing trials to evaluate three candidate systems for the next generation of tank guns was made recently by the Federal Republic of Germany (FRG), the United Kingdom (UK) and the United States.

Representatives of France will participate as observers of the firing trials in the UK. Over-all evaluation of the firing program was started in December 1973 and is scheduled to end with decisions in September 1975.

The tripartite program is another effort to share the benefits of research and development programs within the western alliance and achieve greater standardization of materiel within North Atlantic Treaty Organization (NATO) nations.

Candidate systems under consideration in the firing trials are the FRG 120mm gun, the UK 110mm gun and the current U.S. 105mm gun with improved ammunition. They are being evaluated for use on the FRG Leopard tank, the joint FRG/UK future main battle tank and the U.S. XM1 tank.

The purpose of the evaluation is to seek a common weapon for the next generation of tanks fielded by the three countries and which can ultimately be offered to other NATO nations.

Senior representatives of the tripartite participating countries at the opening of the firing trials were: For the FRG, Hans Eberhard, deputy, Armaments Department, Ministry of Defense; LTG John R. Deane Jr., (later raised to 4-star rank as commander of the U.S. Army Materiel Command); and for the UK, General Sir John Gibbon, Master General of the Ordnance, Ministry of Defence.

2d Armored Division Adds 3,800-Man Brigade

Planned establishment of an additional 3,800-man brigade in the 2d Armored Division, Fort Hood, TX, was announced recently by Secretary of the Army Howard H. Callaway.

This action will permit Fort Hood, home of Project MASSTER (Modern Army Selected Systems Evaluation and Review), to maintain its normal 3-brigade divisional structure in CONUS while deploying a brigade to Europe on a rotational basis. Major elements will include a brigade headquarters; tank battalion; field artillery battalion; and two mechanized infantry battalions.

Formation of the 4th brigade is part of the Army's continuing effort to create a 16-active-division force within an authrized strength of 785,000 men. Manpower is to be reallocated from headquarters and support activity reductions.

Huachuca 'Old Post' Recognized as Historic Site

The U.S. Army's Fort Huachuca, AZ, "old post" area has been added to the U.S. Department of Interior's National Register of Historic Places as worthy of preservation by the U.S. Government and the State of Arizona.

A grassy quadrangle surrounded by late-1800 vintage homes and buildings, the "old post" area is the second site at Fort Huachuca to be listed on the Historic Places register. The first selection was "petroglyphs" in the Garden Canyon area.

Any changes planned for the "old post" area must now be approved by a 3-party committee of Arizona, the Department of the Army (owner of the site) and the Advisory Council on Historic Preservation, which includes 10 current or former presidential cabinet members.

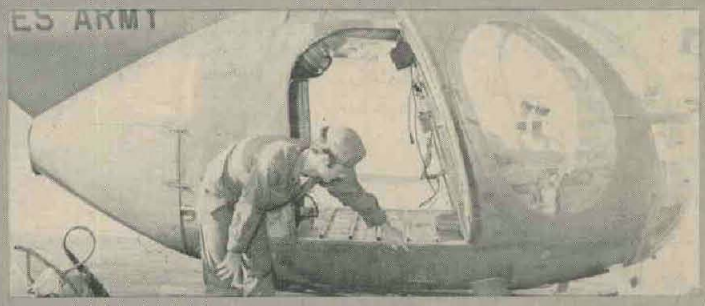
Tank Production Program Office Established

A U.S. Army Tank Production Acceleration Program Office has been established under Program Manager MG Chester M. McKeen Jr., serving as principal assistant and staff adviser for matters pertaining to rebuild and retrofit of M48-series and production of M60-series tanks.

Assigned within the Office of the Chief of Staff, the program manager will exercise staff supervision over all Army Staff elements and participating organizations for planning, direction and control of the program for accelerating production.

Creation of the office reflects the Army's resolve that upgrading the M48-series tanks and increasing M60 production will proceed expeditiously under a streamlined management concept that will ensure the best use of available resources.

AATB Modifies CWFS for Cayuse Helicopter



The U.S. Army Aviation Test Board (AATB), Fort Rucker, AL, is testing an OH-6 "Cayuse" helicopter equipped with a modified crashworthy fuel system (CWFS) to determine compatibility of long-haul operations (see photo above).

A similar CWFS has been used since 1970 on the UH-1 "Huey," the OH-58 "Kiowa," and the AH-1G "Cobra." Operations in Southeast Asia showed that the CWFS assures that the bulk of onboard fuel will remain intact in the event of a crash.

Basic design criteria of the modified Cayuse CWFS objectively will eliminate gross fuel spillage through use of high-impact fuel cells, breakaway lines, and a series of ingenious cutoff valves.

The Cayuse is used primarily by National Guard units and by the Silver Eagles, the Army precision aviation team.

Federal S&E Employment Statistics Decline

Federally employed scientists and engineers decreased by three percent in 1973, dropping to the lowest total noted since 1968, according to statistics recently released by the National Science Foundation (NSF).

The NSF also reported that the U.S. Department of Defense and U.S. Department of Agriculture employed more scientific and engineering personnel than other federal agencies, and that women scientists has been improving in average grade.

Physical and biological scientists declined by four percent, mathematicians and statisticians leveled off by two percent, and social scientists were down by one percent.

DoD Clarifies Public Comment on Rule Making

Implementation of procedures clarifying public participation in Defense rule-making processes is proceeding despite a statutory exemption available to the DoD, Secretary of Defense James R. Schlesinger has announced.

Military Departments and Defense agencies have until Apr. 1, 1975, to adjust procedures for implementation of DoD Directive 5400.0, "Publication of Proposed and Adopted Regulations Affecting the Public."

The directive outlines the policy and procedures for public comment on specific directives, instructions, regulations, policy memoranda, manuals and other rule-making patterns. The DoD announcement states in part:

"It is the policy of the Department of Defense to encourage the maximum practicable participation of the public in the formulation of regulations having a substantial and direct impact on the public. In addition, the DoD plans to inform the public fully through publication in the *Federal Register*. . . ."

MASSTER Evaluating Aircraft Mechanics' Checklist

Checklist procedures to be used by helicopter mechanics when inspecting aircraft are being evaluated for safety, unit operations, availability of aircraft, and maintenance operations at the Modern Army Selected Systems Test, Evaluation and Review (MASSTER) Agency, Fort Hood, TX.

Under development for several years as "Project INSPECT," the checklists are the result of a detailed computer study. Conducted for the U.S. Army Air Mobility R&D Laboratory (USAAMRDL), Fort Eustis, VA, the study was backed up by years of operational maintenance data provided by Army aviation units.

MAJ Richard Ladd, MASSTER project officer for the current evaluation, said the study was premised on the possibility that the Army may be "over-inspecting" aircraft.

Data gathered at Fort Hood and Fort Campbell, KY, for the Army's UH-1 (Huey) and the CH-47 cargo helicopter indicate that current inspections could be curtailed, with significant savings in manhours and without impairing high levels of safety.

Further evaluation will continue under direction of the U.S. Army Logistics Management Center (USALMC), Fort Lee, VA, and the USAAMRDL. Checklists utilizing the Project INSPECT concept are being considered for the AH-1G helicopter gunship and the OH-58 observation helicopter.

Modifications to preventive maintenance inspection procedures suggested by this evaluation are scheduled for detailed field evaluation by MASSTER.

$16 Million Awarded for FAMECE Prototypes

Full-scale development protoypes of the Family of Military Engineer Construction Equipment (FAMECE) will be delivered to the U.S. Army under a 4-year $16 million-plus contract.

Prototypes will consist of a common power module and eight compatible work modules, including a dozer, loader, dumper, water distributor, grader, scraper and two compactors. Each module will weigh no more than 15,000 pounds for movement by helicopter. The power and any other module can be coupled to provide a 30,000-pound construction vehicle for a drop from an aircraft.

Announced by the U.S. Army Materiel Command's Product Manager Office for FAMECE/UET, the contract was awarded by the Tank-Automotive Command, Warren, MI, to the Construction Machinery Division of Clark Equipment Co. The contract includes producibility engineering planning (PEP) for FAMECE and testing by the manufacturer. The Army Test and Evaluation Command, Aberdeen (MD) Proving Ground, will participate in the testing program.

Initial funding for FY 1975 is programed at about $2.3 million with added funding extended over the contract.

USACC Far Exceeds Cost-Reduction Quota

U.S. Army Communications Command (USACC) validated cost-reduction savings of $12.4 million exceeded by 91 percent the FY 1974 USACC quota set by the Department of the Army. Actions taken will effect total savings of $25 million over a 3-year period (FY 74-76).

MG Jack A. Albright, USACC commander, termed the achievement "truly remarkable" in commending the dedication of all members of the USACC.

USACC-CONUS (Continental United States) was cited for cost reductions of more than $3.8 million. Other citations went to the 5th Signal Command, Europe, $1.8 million; 6th Signal Command, Pacific, $1.6 million; U.S. Army Communications Systems Agency, $1.3 million; HQ, USACC, $1.2 million; and Safeguard Communications Agency, $1.7 million. The 11th Signal Group savings of $128,000 exceeded the goal 644%.

LOGC Plans Ground-Breaking for New Building

Ground-breaking ceremonies for construction of a multistory administration building for the U.S. Army Logistics Center (LOGC), Fort Lee, VA, are planned this spring.

The building, which will have about 100,000 square feet of office space, will enable LOGC to consolidate 10 staff sections now in eight buildings at four separate locations within Fort Lee. Other facilities will include a 150-seat conference room equipped with modern audio-visual equipment, a printing and publications section, an area for small-scale command post exercises, and a cafeteria.

MG Erwin M. Graham Jr., who has been LOGC commander since its establishment at Fort Lee in July 1973, initiated the building project. Completion of construction is scheduled during the summer of 1977.

Public Views Weighed on Proposed MOU

The Nuclear Regulation Commission is considering public comments to a proposed Memorandum of Understanding with the Environmental Protection Agency (EPA) that will prescribe responsibilities under the Federal Water Pollution Control Act Amendments of 1972.

The commission was established as part of a recent realignment that created an Energy Research and Development Administration from elements of the Atomic Energy Commission and other federal agencies.

Under the proposed agreement, utilities planning to build nuclear power plants would be able to determine, before construction, the steps they would need to take to meet EPA's thermal water pollution standards. The MOU is near completion.

Determination of technology required to meet water discharge permit requirements currently is made when a plant is about to begin operations, that is, five or six years after construction has started.

EPA and AEC developed the proposed procedures with the help of the Council on Environmental Quality. EPA stressed that the agreement under consideration does not involve any delegation of its regulatory functions. Normal permit procedures would be applied to proposed discharges at sites.

Two more features of the memorandum are intended to avoid duplication of information needed in AEC and EPA licensing procedures, and consideration of combined or concurrent hearings on EPA's preliminary determinations and construction permits.

Other provisions of the memorandum include close contact between the agencies during environmental reviews. Cooperation with state and regional authorities would assure that required water-quality certificates from those authorities are issued in advance of AEC's final environmental impact statement for a specific facility.

Chemists Alter Ethyl Cellulose Coating Process

Frankford Arsenal has announced a technique for making an ethyl cellulose coating which has solved a 15-year-old problem in the manufacture of rocket catapults and other propellant-actuated devices (PAD) for the U.S. Army.

Dr. Henry Gisser and Abe Mertwoy produced a coating which enabled the arsenal to turn out 1631 propellant strip assemblies for the M9 Rocket Catapult without a rejection. Production problems encountered previously were due to variations in the ethyl cellulose coating.

Gisser and Mertwoy eliminated the instability of the viscosity of the ethyl cellulose by heating the solution at 100° C. for several hours immediately after preparation. This insured subsequent viscosity stability.

Dr. Gisser is chief of the Chemistry Research Division at the Pitman-Dunn Laboratory and Mertwoy is a research chemist.

R&D News . . .

Army Revises HLH Program, Sets Competitive Prototype Tests

The U.S. Army Heavy Lift Helicopter (HLH) Program has undergone changes affecting program scheduling and long-range planning for use since its status was reported in the *Army Research and Development Newsmagazine* January-February 1974 edition. Technical objectives have not been altered.

HLH Project Manager COL Richard D. Kenyon, who succeeded BG Jerry B. Lauer in December 1974, reports that the XCH-62 helicopter is still designed to deliver a 22½-ton payload over a 25-nautical mile distance, return to base, and repeat without refueling. His office is at the U.S. Army Aviation Systems Command, St. Louis, MO.

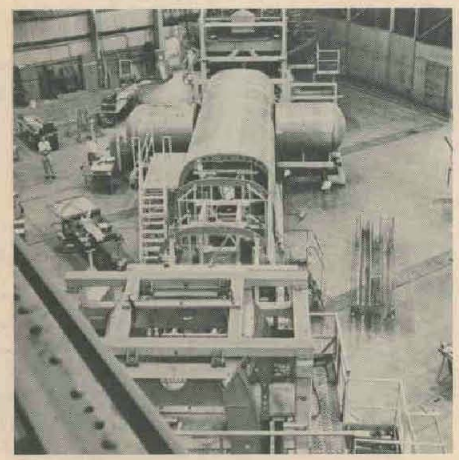
Unchanged also are characteristics such as 118,000 pounds design gross weight, 148,000 pounds alternate gross weight, aircraft length of 162 feet 3 inches with rotor blades turning, and the tandem rotor, crane configuration.

The program was, and still is, set up to design and test major dynamic components in an Advanced Technology Components (ATC) phase and then integrate designs into a flying prototype. The component and prototype efforts are performed under contract with Boeing Vertol Co. as prime contractor. Detroit Diesel Allison Division of General Motors is supplying the XT701-AD-700 turboshaft engines.

The ATC phase is nearing completion, with several significant technological gains to date and others expected as the program proceeds into the flight test stage.

A full-sized HLH aft-rotor system including blades, hub and upper controls was assembled and tested on a whirl tower. This test provided data on rotor performance as well as stress, motion, and blade natural frequencies.

The advanced airfoil rotor blade, made possible by fiberglass construction, proved even more efficient than expected. The rotor Figure of Merit was



HLH Prototype fuselage assembly at Boeing Vertol plant in Philadelphia, PA.

MODEL 347 Fly-by-Wire flying testbed lifting a MILVAN standard container.

.767 versus the HLH design goal of .751 —an indication that the helicopter will lift an additional 2,000 pounds of payload without expending additional horsepower or fuel.

Fatigue testing of critical rotor system parts under the ATC effort revealed the need for some design improvements that will be verified by supplemental fatigue testing before the prototype's first flight. Fabrication of the improved parts for the fatigue tests and for the prototype aircraft is in progress.

The HLH drive system consists of a combiner transmission, forward and aft rotor transmissions, and the interconnecting shafts. The combiner transmission serves to collect inputs directly from the three engines and distributes power to two rotor transmissions through interconnecting or synchronizing shafts.

In the ATC tests, aft and combiner transmissions were run to verify design parameters. Because of its similarity to the aft transmission, a forward transmission was not tested. The ATC transmissions failed under full load in the initial tests but by all existing design practices this should not have occurred.

Contractor and government engineers explored areas outside the previous boundary of transmission design technology to ascertain the cause. Gear resonances and an unfavorable gear tooth load distribution were the sources.

Once a new analytical method was established which accounted for the additional parameters of the transmissions, engineers calculated limits for the existing configurations and produced new designs to meet HLH flying requirements.

Existing configurations, it was concluded, could reach 60-70 percent of power requirements, and test runs at this power confirmed this part of the analysis. However, the fixes could only be made in new gears now being fabricated.

Because the manufacturing lead times for these new parts were extremely long, the prototype flight test had to be delayed until transmissions could be built up and tested at 100 percent power.

In October 1974, the Army revised the ATC and prototype schedules to accommodate the lead times for the new testing requirements. ATC tests are to be completed in April 1975 and prototype flight testing is scheduled for March through October 1976.

The ATC portion of the program features a Dynamic Systems Test Rig (DSTR) which integrates three engines, an aft rotor system, aft and combiner transmissions, and interconnecting shafts. This test is intended to apply additional test time above individual component tests, under load conditions similar to those which a flying HLH would experience.

Fly-by-wire flight controls in the HLH will replace conventional push-pull rods running the length of the fuselage with electrical wires. The wiring is lighter and redundant lines can be incorporated with negligible weight penalty to enhance the HLH survivability in a hostile environment. The electrical system also adapts easily to sophisticated computer programs to enhance HLH stability, ease of control, and safety.

The HLH program evaluated the fly-by-wire concept in the ATC phase by demonstrating its practicality in a flying testbed. The Boeing Vertol 347 helicopter was used because it has a configuration similar to the HLH though it is smaller.

In September 1973, this helicopter became the world's first to fly solely on electrical controls with no mechanical backup. Since then considerable testing has been conducted at the contractor's facility to evaluate the concept and to apply it to load handling operations which are the HLH primary mission.

Demonstrations and evaluations also have been conducted for Army officials in which nonpilots and pilots unfamiliar with the testbed aircraft were able to fly

HLH Dynamic Systems Test Rig (DSTR)

INTEGRATED Test Rig for the HLH Cargo Handling System simulates operational cargo lift cycles with a MILVAN container and an automatic load device.

and perform load acquisition operations, due to the Automatic Flight Control System (AFCS) incorporated into the fly-by-wire system.

The AFCS provides stability augmentation, autopilot capability, and other features to ease pilot requirements. These include: groundspeed feedback to provide velocity stability when moving at less than 40 knots; automatic load stabilization to damp the tendency of a sling load to oscillate during hover; and automatic hover hold to permit the aft-facing pilot to control the aircraft during load acquisition.

The prototype HLH will be the first helicopter designed around the fly-by-wire concept.

Two pneumatic winches provide the HLH with dual-point load hoisting and carrying capability. The ATC cargo-handling system task was to design and demonstrates capacity and operation of HLH hoists on a 70-foot tower at the Boeing Vertol plant. Loads up to 70 tons were lifted and hoisting speeds up to 60 feet per minute with load were successfully demonstrated during tests completed in April 1974.

The Army in August 1974 directed Boeing Vertol to install the ATC hardware in the HLH prototype for the flight test program. Previous plans had called for test loads to be carried by fixed cables attached to hardpoints in the fuselage.

Boeing Vertol originally selected Detroit Diesel Allison Division's 501-M62B turboshaft engines to power the DSTR. The Army contracted directly with Allison, at the inception of the HLH prototype program, to develop this design into a flightworthy engine. Designated the XT701-AD-700, the new engine will produce greater power than any previous helicopter turboshaft engine—8,079 shaft horsepower—and three engines will power the flying prototype.

Considerable experience backs up this engine, including cell tests on the XT701-AD-700, tests on the 501-M62B, and Allison tests on sister engines. All tests were termed by the project manager as "very successful" in meeting performance goals and schedule milestones.

The formal Prototype Preliminary Flight Rating Test will be completed in March and the Safety Demonstration Test in July 1975.

Assembly of the flight vehicle is in progress and the three major sections now being built will be joined at final assembly. An innovation is the use of formed honeycomb panels which combine the aircraft skin and primary structure into one unit. This concept greatly speeds assembly time and provides higher strength-to-weight ratios than conventional web-and-chord construction.

Rollout of the prototype is scheduled for October, under the restructured program, and the first flight as mentioned earlier will follow in March 1976. A 50-hour tie-down test will be conducted between these dates on the total flight vehicle.

Members of the Army Systems Acquisition Review Council (ASARC) met in September 1974 to address the long-term future of the HLH program. The ASARC directed that the HLH program would complete current contracts for advanced development, but would not enter into engineering development.

The ASARC considered the Army's stated operational requirement, the technological advancements to be realized from full-scale development, and the Cost and Operational Effectiveness Analysis. Affordability was the deciding issue, that is, could the Army afford the cost to field the HLH in view of other pressing needs and tight budgetary restraints?

While the HLH technology had produced significant results and many spin-offs into other areas, and could be expected to produce many more, other Army needs were considered more critical at this time.

The Army elected to continue the HLH program through the prototype flight tests with the expectation of realizing many benefits from this development effort. New helicopter designs already are beginning to feature concepts which the HLH development program has pioneered.

CERL Tests Equipment Vulnerability to Shock Effects

When subjected to the shock effects of a nuclear blast or an earthquake, how much strain can various types of buildings or equipment stand?

Reliable responses to that question are pertinent to proper protective actions or design changes in military materiel—for example, ways of "hardening" the Safeguard Antiballistic Missile Defense System tactical support equipment or other elements of national defense systems.

In seeking the right answers to how to design buildings and equipment for maximum invulnerability to nuclear blast or earthquake effects, the U.S. Army Construction Engineering Research Laboratory, known as CERL, at Champaign, IL, is using a Biaxial Shock Test Machine (BSTM).

CERL officials explain the function of the BSTM by saying it is used to "investigate the phenomena of motion and its ensuing problems." Dedicated in November 1973, the BSTM is capable of testing loads weighing up to 12,000 pounds (up to 120,000 pounds for an earthquake environment) to maximum vertical (spectrum) accelerations of 40g and horizontal accelerations of 20g.

The test platform is a 12 x 12 foot mounting surface set in a subfloor-level concrete structure that reacts to test forces. A minicomputer control system regulates platform motion, providing parameters of experiments.

Actual equipment or built-to-scale models are placed on the test platform and subjected to desired variances of vibration, produced by an electro-hydraulic drive system. The control system monitors the machine response with predetermined abort levels and makes necessary response corrections.

When the feedback signal from the test platform indicates incorrect response, the program control signal is adjusted and translated to the electro-hydraulic drive system, consisting of nine vertical and six horizontal drive actuators. Low-distortion servovalves control the movement of oil in the drive system.

CERL researchers have incorporated the concept of "stored energy" in the drive system, that is, the necessary amount of oil to provide the parameters of the experiment is stored under extreme pressure in accumulators—thus reducing the number of pumps needed.

The servovalves translate the movement of oil into applied force (up to 810,000 pounds for the nine vertical hydraulic activators and 450,000 pounds for the six horizontal activators). Results indicate whether or not actual equipment or structures, as simulated by the use of built-to-scale models, can withstand a given degree of motion.

CERL's facilities for experimentation, such as the Biaxial Shock Test Machine and various other test equipment for research, development, test and evaluation are available to U.S. Army and other U.S. Government agencies. Contractors or companies doing work considered beneficial to the government also are eligible for such services on a reimbursable basis.

Persons desiring more information on the BSTM may contact the Materials Systems and Science Division, U.S. Army Construction Engineering Research Lab, P.O. Box 4005, Champaign, IL.

Biaxial Shock Test Machine (BSTM) test platform with equipment to be subjected to vibrations and shock effects simulating those of nuclear blast or an earthquake.

President OKs Act Upgrading Army Chief of RDA to DCS/RDA

Suggestions that have surfaced intermittently since LTG Arthur G. Trudeau was Army Chief of Research and Development in 1958 climaxed recently when President Ford signed a bill changing the title to Deputy Chief of Staff for Research Development and Acquisition.

The amendment to Section 3031 of Title 10, United States Code, increased from three to four the number of authorized Army Deputy Chiefs of Staff. In a letter to Director Roy L. Ash, Office of Management and Budget, Under Secretary of the Army Herman R. Staudt, acting for Secretary of the Army Howard H. Callaway, expressed the Department of Defense view on the proposed change.

Staudt's letter explained that the recent reorganization of the Army staff had increased significantly the responsibility of the Chief of Research, Development and Acquisition, warranting the elevation in stature to other Army Deputy Chiefs of Staff.

GEN John R. Deane Jr., who had served since Aug. 1, 1973, as Chief of R&D and since May 20, 1974, as Chief of RD and Acquisition, was sworn in as the first DCS/RDA. Shortly thereafter, following nomination by President Ford for 4-star rank, GEN Deane was selected to succeed GEN Henry A. Miley Jr. upon his retirement Feb. 10 as commander, Army Materiel Command.

LTG Howard H. Cooksey

LTG Howard H. Cooksey, who had served as deputy to GEN Deane, became the acting DCS/RDA and was nofinated by President Ford on Feb. 19 for promotion to 3-star rank as successor to GEN Deane. LTG Cooksey was sworn in Mar. 10.

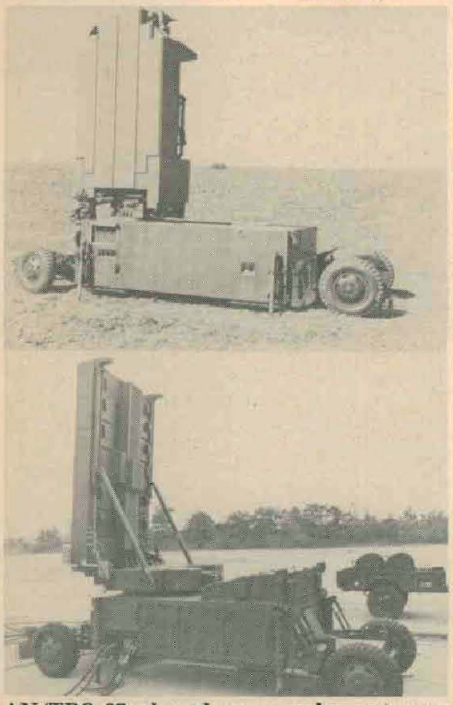
Army Evaluating Artillery Locating Radar Competitive Designs

Two competitive designs of the AN/TPQ-37 Artillery Locating Radar are undergoing an evaluation that will use more than 7,000 artillery projectiles and free-flight rockets in live firings as radar targets at Fort Sill, OK.

The AN/TPQ-37 is being developed under an Army program to provide an operational capability of detecting and tracking multiple targets by 1980.

Contracts were awarded to Sperry Gyroscope and Hughes Aircraft Co. in June 1972, and by late 1974 each contractor had developed and sent a model of the new radar (see photos below) to Fort Sill.

In reporting on early successes during the contractors' preliminary checkouts of their systems, COL William J. Harrison, Army project manager for the radar, said results have been encouraging.



AN/TPQ-37 phased-array radar antennas developed for the Army by Hughes Aircraft Co. (upper) and Sperry Gyroscope (lower) are undergoing competitive live-fire evaluation at Fort Sill, OK.

In just one day, for example, one of the radars tracked more than 250 rounds and plotted the locations of the firing weapons while observing normal firing activity at Fort Sill ranges.

Harrison said automatic features in the radar designs permit simultaneous tracking of more than one weapon at a time. In one case, locations were made of four weapons whose projectiles were all in the air at the same time, requiring the radar to track all four rounds simultaneously. The long-range weapons were located before the rounds had landed.

Development of the AN/TPQ-37 is one of the Army's first efforts to design a system to minimize unit production cost. Competing design contractors performed numerous tradeoffs to limit the final production cost to the government. A disciplined engineering approach has uncovered many areas for dollar saving changes that reportedly have not jeopardized system performance requirements.

Previous attempts to develop an automatic hostile weapons locator have been frustrated, Harrison said, by the problem of the radars "not being able to sort out real targets from imaginary ones caused by atmospheric and ground reflections. Thus far, false returns have not been a problem for the AN/TPQ-37."

Automatic features of the AN/TPQ-37 require only a moderate amount of operator activity to search, verify, track and backplot single and multiple trajectories to determine weapons' locations within seconds, utilizing the on-board computer capability. The operator checks and adjusts for terrain height as locations are pinpointed on a map; otherwise, his duties consist of monitoring radar performance.

The live-firing evaluation began in February as the first step to select the winner of the competition leading to a production contract.

The AN/TPQ–37 program and that of its companion Mortar Locating Radar (AN/TPQ-36) are under the direction of the U.S. Army Electronic Command (ECOM) Project Manager for Mortar and Artillery Locating Radars (MALOR), Fort Monmouth, NJ.

ADPA Selects GEN Miley Executive Vice President

GEN Henry A. Miley Jr., recently retired commander of the U.S. Army Materiel Command, has assumed new duties as executive vice president of the American Defense Preparedness Association (ADPA).

He succeeds MG W. K. Ghormley, U.S. Army (Ret.), who will remain at ADPA as secretary and senior staff consultant. GEN Miley had served as AMC commander since 1970.

ADPA is a nonprofit organization comprised of some 33,000 individual members and 350 companies. The primary objective of ADPA is the pursuit of scientific, engineering, management and industrial preparedness for the common defense of the United States.

UNDER SECRETARY of the Army Herman R. Staudt and Herman Weber, project officer in the Aero-Mechanical Engineering Laboratory at the U.S. Army Natick (MA) Laboratories, discuss a new nylon net developed by NLABS as an antiinversion safety device for T-10 personnel parachutes. More than 2,500 airdrops at Army Airborne Test Activity, Fort Bragg, NC, will determine if Army evaluation officials approve new design. Existing T-10s will be modified if decision is favorable, and future Army procurements will include the safety net.

AMC Prepares Plan for Joint Tests of AMST Aircraft Prototypes

Comprehensive details of a "Basic Development, Test and Evaluation Plan for the Advanced Medium STOL (Short Takeoff and Landing) Transport," a series of design and engineering flight tests of prototype aircraft, have been prepared by the U.S. Army Materiel Command.

The AMST prototype was initiated to develop advanced technologies and provide an option for modernization of the tactical airlift fleet, following approval by the Secretary of Defense Aug. 31, 1972, and award of two contracts in January.

The flight test program is scheduled to begin at Edwards Air Force Base in August 1975. Each contractor is programed for 12 months of flight testing.

The goal is to provide the Secretary of Defense with the necessary information to approve or disapprove full-scale development of an advanced medium STOL transport aircraft.

Secretary of the Army Howard H. Callaway has stated that projected capabilities of the AMST are expected to offer advantages in several areas:

- *Increased Load Capacity* should provide a means to transport the Army's self-propelled field and air-defense artillery, heavy engineer equipment and many logistical support elements which are now lacking. Fewer airframes will be needed to move a single unit because of the expanded internal capacity.
- *Greater Operating Speed* will allow quicker turn-around for force deployment and resupply of assets.
- *Greater Capability for Short Field Areas*, a reduction in the length of required landing zones, should provide flexibility in both the number and selection of assault airstrips. Delivery of supplies closer to tactical units is envisioned.

Managed by the U.S. Air Force, the AMST flight test program is a joint Air Force-contractor effort calling for participation of the Army, Marine Corps, the National Aeronautics and Space Administration (NASA) and Federal Aviation Agency (FAA).

Over-all management responsibility for the combined developmental test and evaluation, and a limited initial operational T&E, is assigned to the Air Force Systems Command. The program will be limited to demonstrating performance of the aircraft as prototype vehicles rather than production models.

Engineering and flight test data as well as studies and analysis data will be evaluated with respect to but not limited to:

- Reaffirming the operational need for the system in light of its cost and projected budgetary constraints.
- The adequacy of the evaluation of alternative approaches.
- The readiness of the system to enter full-scale engineering development.
- The adequacy of the test and evaluation approach and test results.
- Ensuring that cost and schedule estimates remain realistic and acceptable.
- Ensuring that the acquisition strategy and contractual plan are consistent with program characteristics and risks.

The over-all Army objective is to conduct an independent assessment of the potential effectiveness and utility of the AMST to the Army. The aim is to ensure that Army missions and requirements for intratheater tactical airlift are addressed early in development.

Results of the independent Army evaluation will provide the basis for a position to present to the Defense System Acquisition Review Council (DSARC).

To accomplish this purpose, the Army will establish an independent AMST DT&E/IOT&E Coordination Office at the Edwards AFB test site as part of the Joint Test Force (JTF). This office will serve as the Army single point of contact for all AMST test matters, and will coordinate all Army test requirements with the JTF as well as manage the Army portion of the test program.

The Operational Test and Evaluation Agency, Fort Belvoir, VA, will organize the Army Coordination Office and provide the director of the ACO. The Army Materiel Command will provide the deputy director and other essential personnel required to conduct the assessment.

Technical support will be furnished by the U.S. Army Test and Evaluation Command (TECOM); U.S. Army Aviation Systems Command (AVSCOM); U.S. Army Natick Laboratories (NLABS); U.S. Army Ballistic Research Laboratories (BRL); U.S. Army Human Engineering Laboratories (HEL); and the Operational Test and Evaluation Agency. AMC also will effect coordination with other Department of the Army agencies.

Boeing YC-14 AMST

McDonnell Douglas YC-15 AMST

The AMST prototypes, the YC–14 of Boeing and YC–15 of McDonnell Douglas, will be evaluated for safe and routine short takeoff and landing (STOL) performance, landing gear capability, good ground mobility, optimal payload/cargo compartment, and high-speed deployment capabilities.

The YC–14 is powered by two General Electric CF6–50D high-bypass turbofan jet engines, each producing approximately 50,000 pounds of thrust. The YC–15 is powered by four Pratt and Whitney JT 8D–17 jet engines, each producing approximately 16,000 pounds of thrust.

Key Army test objectives, as outlined in AMC's basic development, test and evaluation plan for the AMST, include:

- To demonstrate that the load-bearing capability of the AMST cargo compartment is at least equal to that of the USAF C–130 aircraft.
- Assure that the aircraft's structural integrity can accommodate lashing of U.S. Army vehicles using current restraint criteria.
- Demonstrate the capability to open cargo doors and lower ramp at airspeeds representing the slowest and fastest speed envisioned for airdrop during the 1980s time frame.
- Demonstrate the potential capability to load, secure and airdrop equipment weighing at least 35,000 pounds and to air-land equipment weighing at least 53,000 pounds.
- Measure noise levels and other human factors in troop compartments; also, assure that paratroop exit doors will provide personnel safety equal to or greater than those in the C–130 aircraft.
- Demonstrate AMST compatibility with all standard Army materiel-handling equipment and hardware used in airdrop and transport operations.
- Show the AMST capability to operate from forward airstrips with limited field lengths, taxiways and parking areas.

Following initial flight tests of AMST prototypes at the contractor's facilities, additional flight tests will be conducted at the U.S. Air Force Flight Test Center, Edwards AFB, CA. Airdrop and parachute extraction capabilities will be examined at the National Parachute Test Range, Naval Air Facility, El Centro, CA.

The YC–15 is scheduled for first flight in August 1975 and the YC–14 for August 1976.

MAJ Joseph A. Evans, AMC Liaison officer for the AMST test program, is stationed with Air Force elements at Wright Patterson AFB, Dayton, OH.

AVSCOM Awards $7.6 Million for RPV Evaluation

A major step was taken to evaluate utility and effectiveness of Remotely Piloted Vehicles (RPVs) in battlefield support missions when the U.S. Army Aviation Systems Command (AVSCOM) recently awarded a $7.6 million contract.

In the 25-month RPV-System Technology Demonstration (STD) Program, Lockheed Missiles and Space Co., Sunnyvale, CA, will develop and deliver 30 RPV air vehicles that use five different sets of sensor payloads.

Four sets of RPV launch and retrieval equipment and other ground support equipment will be delivered for use with four ground stations. Automatic tracking data links, interactive displays, computers and command/control functions also will be provided.

The prime contractor will train Army personnel at Sunnyvale, CA, Fort Huachuca, AZ, and Fort Sill, OK, for missions that include surveillance, reconnaissance, target acquisition, artillery fire adjustment, and laser designation in support of terminally guided weapons.

LTC Davies Powers, AVSCOM weapon system manager for RPVs, explained the goals of the RPV-STD Program. The U.S. Army Training and Doctrine Command (TRADOC) will receive realistic prototype RPV equipment for field testing under simulated battlefield conditions to determine potential application to future Army requirements.

LTC Powers said the RPV-STD Program uses existing technology and prototype subsystem hardware derived from earlier Army, DoD, and industrial independent R&D projects. The 120-pound air vehicle is derived from a composite nonmetallic mini-RPV called Skyeye, developed and flown more than 70 times by Development Sciences, Inc.

The air vehicle is powered by a reciprocating engine produced by McCulloch Industries. It contains a Lockheed-developed autopilot, data-link and launch/retrieval mechanisms, and mission sensors acquired from Westinghouse and other subcontractors.

RPV, half-scale, wind-tunnel model displayed on a simulated flight situation. The 120-lb. vehicle will be powered by an 11-hp. engine and fly at speeds up to 100 mph. A dome located forward on the underside of the aircraft will house television and target designation equipment.

The pneumatic rail-launcher and net-recovery systems are a combined development of Lockheed and All-American Engineering Co. of Wilmington, DE.

Upon successful completion of TRADOC tests, the Army will be prepared to establish firm future requirements, which may lead to a formal Required Operational Capability (ROC) document that serves as the basis for engineering systems development.

Pitman-Dunn Laboratory Develops Hydrocarbon-based Hydraulic Fluid

Frankford Arsenal's Pitman-Dunn Laboratory recently announced development of a fire-resistant hydraulic fluid to provide safer vehicle operation conditions for personnel in combat zones and improve longevity of combat vehicles.

Reportedly, synthetic hydrocarbon-based fluid is rust-inhibited and is less flammable than the petroleum-based hydraulic fluid specified for U.S. Army tanks and other combat vehicles.

Joseph Messina, chief of the Fluids and Lubricants Branch, Pitman-Dunn Laboratory, said the "use of the fluid will undoubtedly result in considerable savings in military combat vehicles and personnel."

The fluid is being used experimentally for the gun control, turret and recoil systems in M60 tanks. Plans call for later retrofitting of other armored combat vehicles utilizing hydraulic systems.

The Army's interest in fire-resistant hydraulic fluid was the result of the late General Creighton Abrams' concern over M60 tank turret fires believed due to hydraulic fluid lines ruptured in combat.

The poly-alpha-olefin synthetic hydrocarbon-based hydraulic fluid became available in experimental quantities about seven years ago. Interest in tank use was then considered marginal because flammability of a hydraulic fluid was viewed as having only a small effect on tank vulnerability in the presence of highly flammable fuel and ammunition.

Early research involved the U.S. Air Force and the U.S. Navy. Data obtained by all three services were gathered by Frankford Arsenal for use in developing a specification for poly-alpha-olefin fluid following General Abrams expression of concern about tank turret fires in December 1973.

7 New Deputies Assigned in ASA (R&D) Realignment

Assistant Secretary of the Army (R&D) Norman R. Augustine has realigned his staff—following retirement of Charles L. Poor as his deputy—to consist of seven deputies, each operating in major functional areas.

In effect, the position in which Poor had served since 1960 under all previous occupants of the office now filled by Augustine, is "retired in memoriam." Abolishment of this position means that Augustine will, except for non-delegatable statutory functions, designate one of his functional area deputies to act for him and perform the duties of his position during his absence or disability, and as otherwise directed by him.

All four civilian deputies, three of whom are veterans in OASA (R&D) and the other a recent addition, hold prestigious PL-313 supergrade status.

The military deputies are full colonels. Common to each deputy's mission statement is: "Responsible for coordination of RDT&E matters in his functional area with Office of the Secretary of Defense, other Military Departments, and agencies and activities outside the Department of Defense."

Dr. K. C. Emerson, whose tenure as research assistant to the ASA (R&D) is about equal to that of Charles Poor, is similarly respected throughout the Army R&D community. Dr. Emerson's new title is deputy for Science and Technology, involving research, development, test and evaluation throughout all Army in-house laboratories in the U.S. and work performed under contracts and grants in foreign countries.

Victor L. Friedrich is deputy for Communications and Target Acquisition, with responsibilities for all U.S. Army R&D programs in this scientific area. His duties include acquisition, avionics, data processing, electronic warfare, space, mapping and geodesy and navigation.

Charles L. Woodside, whose association with the Office of the Chief of R&D in financial management also dates to the early days of that office, is the new deputy for Management and Budget. He is now responsible for "all matters pertaining to Army RDT&E management and budget activities, (including) materiel acquisition policies and procedures, and funding actions. . . ."

Charles H. McKinley is the newcomer to ASA (R&D) Augustine's staff. Recently he reported to serve with COL William F. Boiler, currently assigned as deputy for Air and Missile Defense but scheduled to retire July 31, 1975. This duty includes air and ballistic missile defense (deployed systems and advanced technology), command and control systems, and target missiles.

COL Walter Beinke is the deputy for Fire Support, responsible for RDT&E programs for weapons systems designed to provide fire support for ground maneuver forces. Included are cannons, guided missiles and rockets, conventional munitions, tactical nuclear weapons, fuzes, and associated equipment.

COL Donald P. Creuziger, the new deputy for Combat Materiel, is involved in all RDT&E matters pertaining to land combat and support vehicles, armor and Infantry weapon systems (less missiles), combat engineer equipment, mine warfare materiel, automotive components, and Quartermaster equipment.

COL John A. Islin, assigned as deputy for Aviation, deals with all matters pertaining to Army air mobility R&D programs, including rockets, guns and missiles; also, air-delivery and air-drop systems, aircraft safety, survivability, and reliability and maintenance programs.

Studies on AMARC Recommendations Providing Basis for Action

Decisions on implementation of some major recommendations made in the April 1974 report of the high-level Army Materiel Acquisition Review Committee are scheduled for official announcement early next fall.

Meanwhile, various changes are being effected that are considered relatively noncontroversial, in that they are classed as not impacting seriously in physical relocation of facilities and personnel or reductions in force.

Realignment actions being implemented or under consideration by decision-makers have been subjected to thorough review and analysis by numerous study groups, operating under guidance from top Army leaders, for many months.

The objective is clear and reflects a common meeting ground of thought by AMARC and Army leaders: To improve substantially Army materiel acquisition, reduce layering in the decision process, permit the Army to operate within increasing real budget constraints—and to reallocate any savings in manpower support and materiel acquisition procedures to improve combat forces.

Minimizing the impact of changes with respect to human factors involved is another goal being examined in depth. To this end, briefings are being given to members of Congress in the regions that will be affected.

Similarly, representatives of local employes union leaders and civilian offices are being informed and given an opportunity to respond to proposals from the various groups to leaders at the decision-making level.

From 172 recommendations made by AMARC and accepted by HQ DA, 71 were referred to the Army Materiel Command for consideration. AMC Deputy for Materiel Acquisition MG George Sammet Jr., reported in February that AMC has submitted 56 of the proposed actions to the Department of the Army for aproval, and 15 are still in study.

MG Sammet's announcement of this program was made at an Atlanta II executive seminar in Atlanta, GA, under the aegis of the National Security Industrial Association and the American Defense Preparedness Association. The theme was "Systems Acquisition Initiatives: Meeting the Challenge."

Fifty-eight of the recommendations referred to AMC were considered non-major, MG Sammet said, in that they "dealt chiefly with revision of regulations or procedures in such areas as personnel, administration, costing. . . ."

Concern throughout the Army R&D community relative to the AMARC recommendations is focused on the proposals for establishment of eight major "development centers." Controversial considerations regarding certain of these proposals were aired during the series of late February briefings of Congress and leaders in the regions involved.

The development centers are proposed to consolidate Army capabilities in major technological areas, that is, to centralize scientific and engineering with technical expertise along with certain materiel acquisition processes and capabilities.

This objective, as outlined in AMC announcement of the February briefings, includes "laboratories, installation and commodity command research, development and engineering elements, project managers, support elements, and command elements into mission-oriented Development Centers. . . ."

Actions that appeared to be fairly well finished with respect to establishment of the development centers as this edition of the *Army Research and Development Newsmagazine* went to press affected three major laboratory complexes.

"Establishment of the Natick Development Center (at Natick, MA) and the Mobility Equipment Research and Development Center (Fort Belvoir, VA) will be announced," an Army Materiel Command Information Office release said, "following the Congressional information briefings."

The announcement added: "These organizations will evolve from the current assets of Natick Laboratories . . . and Mobility Research and Development Center . . . presently assigned to the Troop Support Command, a commodity command subordinate to Headquarters, Army Materiel Command."

Similarly, the announcement included establishment of the Tank-Automotive Systems Development Center, from resources existing at the Army Tank-Automotive Command, Warren, MI.

Data System May Aid Flood Control

Hydrologic evaluations of the Mississippi River and its tributaries, directed to flood control action, may be improved substantially with an automated data system being developed by the Corps of Engineers.

Plans announced by the U.S. Army Waterways Experiment Station (WES), Vicksburg, MS, call for a network of 49 data collection platforms (DCPs), being installed by the U.S. Army Engineers' Lower Mississippi Valley Division (LMVD) at key locations from north of St. Louis, MO, to the Gulf of Mexico.

The DCPs will transmit information via telemetry from the Earth Resources Technology Satellite (ERTS) to the National Space Technology Laboratory (NSTL) near Bay St. Louis, MS. This data will be sent by telephone lines to a computer at WES for use by water control managers in the River and Reservoir Control Center, LMVD, and district offices in St. Louis, Memphis, Vicksburg and New Orleans.

Initial efforts will be directed to measuring and transmitting river and lake variable stages and rainfall and water quality at a few key locations for evaluating potentially hazardous flood conditions—in time to take protective action to minimize loss of life and property in the Lower Mississippi Valley.

F. P. Hanes, chief of the Instrumentation Services Division of WES, reported that tests conducted with a DCP have proven the feasibility of the satellite system for communications. Hanes is serving as a consultant to LMVD on installation of the new system, the initial phase of which is expected to become operational this summer.

Consisting of a 400-megahertz transmitter and five watts output power, the DCP is capable of scanning and encoding measured parameters from sensors.

When operating with ERTS, the DCP is available for radio communications at a maximum of three successive satellite passes every 24 hours.

The new DCPs are also planned to be operational with the National Weather Service's recently launched Geostationery Orbital Environmental Satellite (GOES). GOES will permit readings at much closer intervals than ERTS.

MIPS Monitors Tank Performance

Prototype development of an improved system for monitoring the location and performance of tanks has gained a $1,500 cash Incentive Award and an Army Commendation Medal for two officers at the U.S. Army Combat Developments Experimental Command (CDEC), Fort Ord, CA.

CPT John Rice and CPT Douglas Swartz, assigned to the Engineering Division, Office, Deputy Chief of Staff for Instrumentation, designed what is termed a Modular Integrated Pallet System (MIPS). Additional cash awards (possibly raising the total to $5,000 or more) may be made by the Training and Doctrine Command, and Department of the Army.

Demonstrated as far more efficient and economical than existing systems, the tank-mounted MIPS weighs 35 pounds, as contrasted to 350 pounds for previous pallet units, and requires only one power source rather than eight or nine. The sophisticated electronic equipment, mounted at the rear of the tank, operates in conjunction with the CDEC range measuring system and a central computer to keep a constant check on the location on a given tank and what is happening to it.

Potential savings in time and manpower are anticipated with utilization of MIPS for experimentation in the field. Estimates range to "millions of dollars." Conventional systems have required hours of "warm-up" and "check-out" efforts.

MIPS can be checked, calibrated and readied within minutes, CDEC announced, thus increasing the number of field trials per day. A single power source is used for MIPS rather than as many as nine formerly used for the several systems the new unit replaces.

The Army has projected estimated savings of $1.5 million by incorporating MIPS into FY 76 budgeting and planning.

USAAMRDL Stresses Importance of Future Aircraft Propulsion Systems

By CPT Timothy D. Balliett & Robert A. Langworthy

Research and development of aircraft gas turbines, train drives and accessories, as related to cost and effectiveness of future aircraft systems, is an area of effort of prime concern to scientists and engineers at the U.S. Army Air Mobility R&D Laboratory headquartered at Moffett Field, CA.

The March-April issue of the *Army R&D Newsmagazine* featured the organization, orientation, and main thrusts of the USAAMRDL—the U.S. Army Materiel Command's lead laboratory for aircraft aerodynamics, and the principal Department of Defense agency for small gas-turbine technology.

AMRDL's aircraft propulsion program includes a continuing effort in the 6.2 exploratory development area. Components and parts are being developed to increase performance, while incorporating features essential to provide more inherent reliability and maintainability in design of propulsion systems.

Incorporating technology gained in the 6.2 exploratory development area, 6.3 demonstrator programs have been established to ensure that components can be combined effectively.

These programs establish the new level of technology as being "on-the-shelf" (i.e., creditable for a moderate-to-low-risk engineering development) and available for incorporation in future aircraft systems developments (see chart below).

The propulsion area of the Eustis (VA) Directorate, USA AMRDL, during the past year, has sponsored gas-turbine research and development in the areas of compressors, combustors, turbines, accessories, inlet particle separators, bearings, seals, rotor dynamics, and noise and emission abatement.

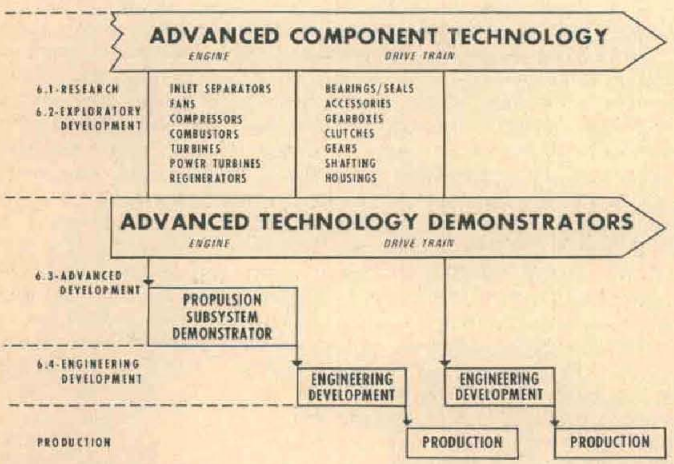
Efforts have been directed, for the most part, toward the small, 1- to 5-pps-airflow, aproximately 100- to 1,000-horsepower engine size, which is of significant interest to the Army. A description of a few of these efforts follows:

• COMPRESSOR TECHNOLOGY. *Single-Stage Centrifugal Compressor.* The design goals of this program are to obtain in a single centrifugal stage compressor, sized for 3.1-pps airflow, a pressure ratio of 10:1 at greater than 75 percent efficiency and at part speed to achieve an 80 percent efficiency at 8:1 pressure ratio.

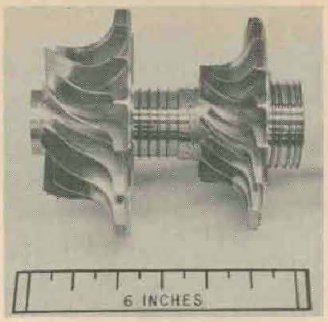
The latter goal was essentially achieved at 95 percent speed, and a peak efficiency of 74 percent was obtained at 10:1 pressure ratio. A follow-on program is modifying and retesting the compressor, with improved performance anticipated.

Two-Stage Centrifugal Compressor. The design, fabrication and test efforts of this program were directed at a small (2-pps airflow) compressor. A 12.3:1 pressure ratio at 78.3 percent over-all efficiency was demonstrated in a full-scale, 2-stage centrifugal compressor at 82,000-rpm design speed.

More importantly, this compressor has demonstrated the potential to achieve operating line efficiencies on the order of 79 percent of 14:1 pressure ratio without variable geometry. This represents a major advancement in technology for compressors of this size and pressure ratio.



Army Propulsion Subsystem Development Approach



Two-Stage Centrifugal Compressor

Axial-Centrifugal Compressor. This program, which is being conducted by the General Electric Co., Lynn, MA, has technical goals of achieving 15:1 pressure ratio at 79 percent efficiency for a 5-pps airflow compressor having one centrifugal and two axial stages.

Testing to date has shown performance of the axial stages to be acceptably close to initial design intent. The centrifugal stage design is being modified, with plans to retest the full compressor. The small, highly loaded compressor stages have proven to be very sensitive to clearances and surface conditions, and the effect of compressor-stage matching is critical.

• COMBUSTOR TECHNOLOGY. *Advanced, Small, High-Temperature-Rise Combustor.* AiResearch Manufacturing Co. of Arizona has recently completed a program in which an attempt was made to eliminate much of the time and effort involved in "cut-and-paste" techniques of combustor design.

The 30-month program was conducted in three phases. The first comprised analysis of various engine cycles and combustor designs encountered in small gas-turbine engines.

In Phase II, 11 different analytical computer models were developed to simulate individual elements of the combustor, such as fuel injectors.

In Phase III, the analytical design techniques developed in Phase II were applied to the design of an actual full-scale combustor. This combustor was then tested in a combustor test rig and came very close to meeting all program performance objectives on the first test.

The design methods developed in this program should reduce cost and time involved in small combustor development.

Emissions Characterization. Recent Eustis Directorate research programs in the aircraft pollution-abatement area have sought to characterize the exhaust emissions of current and advanced small gas-turbine engines.

Engines so characterized have included the T–55, T–53, T–63, GE–12, and PLT–27. Information gained to date has provided a baseline for future efforts to minimize the objectionable gas-turbine emissions, such as carbon monoxide, nitrogen oxides, and unburned hydrocarbons.

Current trends indicate that small, well-designed, high-temperature-rise combustors with an advanced fuel injection system can sigificantly reduce levels of exhaust emissions (CO, HC, NOx, and smoke), with little or no impact on engine performance and durability.

• ADVANCED SMALL AXIAL TURBINE TECHNOLOGY (ASATT). The objective is to provide the advanced technology axial-flow turbine designer with empirically derived techniques to improve the accuracy of predicting losses, flow conditions, velocity triangles, and design point matching for high-workload turbines.

The improved performance prediction techniques are to be valid in the presence of practical mechanical constraints typical of small, highly loaded, cooled, axial-flow turbines.

Turbine cascade testing completed in December 1973 was directed at isolating the variables that affect turbine flow. Data obtained is being reduced to provide input for the development of an axial turbine design model. The model will be evaluated in a full-scale rotating test at a later date.

• ADVANCED ENGINE CONTROLS. This program was comprised of the design, fabrication, and test of an advanced electronic engine control system for small turboshaft engines.

The control system is comprised of three modules: a fuel-cooled hybrid electronic computer, a fluid controller with integral 37,500-rpm pump, and a remote electro-hydromechanical engine geometry actuator.

The system incorporates closed-loop control of turbine-blade temperature as sensed by a radiation pyrometer, W_f/P_{t_6} scheduling for starting, acceleration and deceleration, isochronous power turbine and proportional gas produced gov-

erning, torque limiting, load sharing, start sequencing control, and compressor geometry control.

The system performance previously was demonstrated on 2-pps and a 5-pps analog computer engine simulator. Environmental temperature endurance testing and fuel contamination testing were successfully completed.

In addition to evaluation of the performance of the control system components in the actual environment of an engine, the system will be installed and tested on a small gas-turbine engine to test the installation, integration, and performance of the system. About 50 hours of testing will be performed.

• INSTRUMENTATION. *Turbine-Tip Clearance Device.* The design, fabrication, and test efforts of this program are directed toward the development of a running tip clearance measurement device for small (2-5 pps airflow) turbines.

The probe uses laser optics to produce a spot on a television screen. The location of the spot is calibrated to provide tip clearance measurements. Demonstrating a response rate of $.4 \times 10^{-6}$ seconds, the probe has a range of 0.065 inch with an accuracy of $\pm .001$ inch.

Radiation Pyrometer. As part of the Advanced Engine Control Program, a radiation pyrometer was designed and built to measure turbine blade metal temperatures. The radiation pyrometer developed uses fiber optics to transmit the radiative signal from the turbine blade to the sensor.

The complete blade temperature measuring system has been bench-tested under simulated engine operating conditions, and is expected to be used in the STAGG program.

• DRIVE TRAIN TECHNOLOGY. The constant pursuit of high-performance shaft gas-turbine engines has resulted in a considerable increase in power turbine speeds.

Effective use of the improved turbine engines dictates that drive system components be capable of transmitting power at rotational speeds commensurate with the advanced engines. Clutches, couplings, bearings, and high-ratio speed reducers have been designated as areas requiring specific improvements.

Positive-Engagement Clutch. The objective was to investigate feasibility of a positive-engagement clutch for application in V/STOL drive systems.

The specific clutch developed was to operate at 11,500 rpm and 40,000 in-lb maximum continuous torque—goals consistent with the requirements of the Heavy Lift Helicopter (HLH) main engine overrunning clutch.

The concept of the clutch included a face spline to connect driving and driven members, a pawl and rachet system to provide proper synchronization and indexing for smooth engagement, and a spiral engagement/disengagement.

The test program successfully demonstrated the ability of the clutch to engage, transmit torque, and disengage, statically and up to design speeds. Overrunning tests, which included a lubrication requirements survey, showed that the clutch is capable of long-term overrunning with oil flows down to .5 gpm.

Further effort is planned to examine the clutch's durability under long-term full-power engaged running and high-acceleration-impact engagements.

Rolling Element Bearing Retainer Analysis. This integrated analytical and experimental program was conducted to analyze the operation of rolling element bearing retainers, including forces and lubrication at high bearing load and speed conditions.

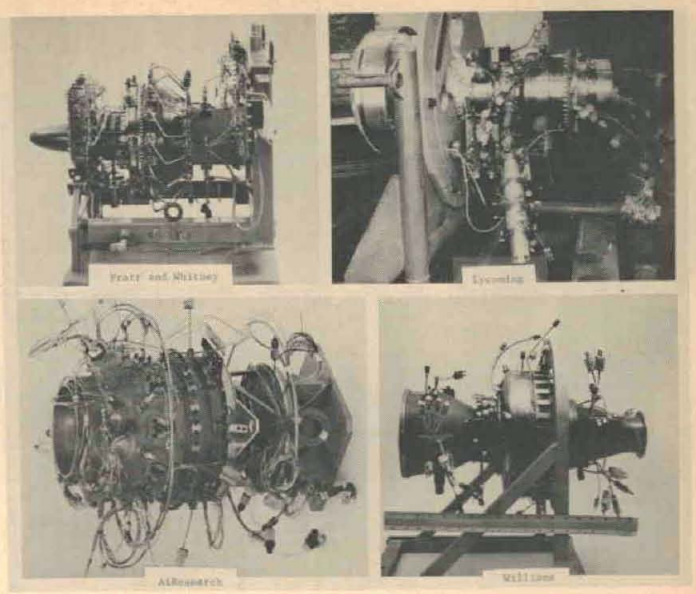
The analytical phase included development of an iterative computer program to produce bearing solutions for arbitrary load and speed conditions.

Experimental tests were conducted, in the second phase, over a wide range of loads, speeds, and lubrication conditions to validate the computer program. Test results indicated that a computer program is an excellent method of analyzing rolling element bearing retainers and attendant lubrication effects.

• SMALL TURBINE ADVANCED GAS GENERATOR (STAGG). The purpose of this program is to design, fabricate, and test four core gas generators in the 1- to 5-pps airflow size to provide the core gas generator technology base for future small gas turbine engine programs.

For two STAGG's in the 1- to 2-pps airflow size, the design goals include a specific horsepower (hp/lb air) 35 percent greater than current production engines and a specific fuel consumption equal to or less than .65 at intermediate power.

The two STAGG's in the 3- to 5-pps airflow size have design



Small Turbine Advanced Gas Generator (STAGG)

goals of a 45 percent increase in specific horsepower and 20 percent decrease in specific fuel consumption as compared to current production engines. Another objective is to demonstrate significant performance improvements with a minimum number of rotating components, with the attendant cost reduction.

Each STAGG has completed the initial component test phase and has begun the initial series of full gas-generator testing.

By incorporating advance technology components, the STAGG's will enable the gas-turbine engines designer to define integration and matching problems at an early date. The goal is to reduce gas-turbine engine development risk and cost.

The STAGG programs are to run for four years and include an engine specification and productivity analysis. The first draft specification for the turboshaft engine derivative has been completed and will be provided to airframe manufacturers for inclusion in future aircraft designs.

Although the results from such propulsion research are dramatic in their effect on the over-all economy of aircraft systems, the cycle from the initiation of research at the component level to the final incorporation into a developmental aircraft system for use in a field is a long one.

Larry Hewin, deputy director of the Eustis Directorate, cited the work leading up to the present T–700 engine, which is to be used in UTTAS and attack helicopters, as an example.

The initial component technology programs with industry were started about 10 years ago, following some in-house studies and analyses by the Eustis Directorate (then AVLABS). The fallout of those programs plus industry IR&D efforts resulted a 1967 competition for a 1,500-hp demonstrator engine.

General Electric and Pratt and Whitney were selected to build the demonstrator engines, and both programs were successful, with each contractor meeting virtually all goals.

Subsequently, a competition for development of the T–700 engine resulted in selection of General Electric Co. Development is based principally on demonstrator engine technology.

Hewin expressed the opinion that there is probably no single technological advance incorporated in the UTTAS and attack helicopter designs which contributes a greater measure of cost effectiveness than does the advanced technology engine.

Another valuable byproduct of the programmatic approach described has been that the government technical staff members who worked with the component development programs and the demonstrator engine program have worked for the T–700 project manager as the principal technical monitors for the final engine development. Thus, they are able to bring all the knowledge gained in the prior advanced technology programs directly to bear on the engineering development version of the final engine.

While conducting current programs to meet today's needs for Army aircraft, USAAMRDL also is striving to achieve payoffs in the propulsion area that may be applied to future versions of Army aircraft.

AMMRC Pilot Plant Aids Electroslag Steel Research

By Arthur Ayvazian

Electroslag remelting of steel (ESR) is bidding for international recognition as a technological advance that eventually may account for production of most extremely high-quality steel for military materiel systems as well as specialized civilian requirements.

Considered in that perspective, the experimental research, development, test and evaluation ESR effort at the U.S. Army Materials and Mechanics Research Center, Watertown, MA—including operation of a new pilot plant that can produce ingots up to 500 pounds—assumes significant importance.

AMMRC Director Dr. Alvin E. Gorum pointed to the portent of this program, initiated in 1972, when he reported on progress at a meeting of U.S. Army Materiel Command laboratory directors in June 1973 at Fort Belvoir, VA, home of the U.S. Army Mobility Equipment Research and Development Center.

Within 10 years, he said, it may reasonably be expected that the bulk of high-quality steel produced in the United States will be ESR steel. The U.S. Army Foreign Science and Technology Center, Charlottesville, VA, has been actively following foreign technology and found the Soviet Union is intensively engaged in advancing the state-of-the-art in electroslag steel technology.

USAFSTC has learned that many patent rights to ESR steel have been developed in the Soviet Union, and that a substantial production capacity has been established. The ninth USSR 5-year plan for the iron and steel industry (1971-1975) calls for about a one million metric ton annual production of ESR-processed materials by 1976.

In terms of weight reduction and protection, ESR steel is considered a highly efficient armor material. Tests have indicated that ESR steel can mean a 30 to 40 percent reduction in the quantity of steel needed to do the job for armor use that other kinds of steel do. Put another way, that means an increase of 30 to 40 percent in protection by using ESR in the same quantity as non-ESR steel.

Initially, U.S. Army Materials and Mechanics Research Center studies were directed to a cost-effective method of producing high-strength, high-toughness, improved material for armor plate for tanks and other ground mobility equipment. The ESR approach was examined in comparison with vacuum-arc refining, vacuum-induction melting, vacuum-degassed and electric furnace methods.

Experimentation to date has established that ESR steels have higher and more uniform mechanical properties, and can be produced in larger ingots and plates than steel from other processes.

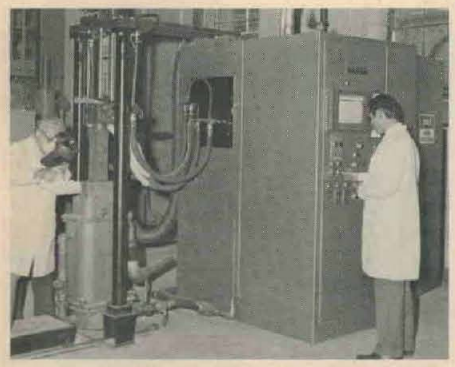
Other reported advantages include excellent surface quality requiring little or no ingot conditioning, good internal soundness with minimum pipe or porosity, superior hot-working characteristics due to fine cast grain size, and higher product yield from initial molten metal to the finished product.

Objectives of the AMMRC program—using the ESR pilot plant for production—are directed to developing the optimum chemistry and heat treatment. Supplementing this in-house effort is a contract with a major steel producer for large-scale armor plate.

Many future applications for either cast or forged ESR steel include components for weapons systems such as gun tubes, suspension arms, torsion bars and other parts requiring exceptionally high-quality steel are envisioned.

British officials also have evidenced interest in the AMMRC program. What is termed a "tremendous backlog of work" has been generated for AMMRC by other U.S. Government agencies.

ARTHUR AYVAZIAN has been employed as a metallurgist at AMMRC and Watertown, MA, since 1952. Currently involved in developing Electroslag Remelting of Steel (ESR), Ayvazian's activities at AMMRC have been directed toward development of steel and titanium alloy, and investigation of high-temperature thermal treatments and their effects on cast components. His education includes a BS degree in chemistry from Northeastern University, and an MS in metallurgy from the Massachusetts Institute of Technology.



ESR Unit at AMMRC, Watertown, MA

Atlanta II Seminar Focuses on Army-Industry Teamwork

Themed on "Systems Acquisition Initiatives: Meeting the Challenge," the Atlanta II Executive Seminar, cosponsored by the National Security Industrial Association and American Defense Preparedness Association, attracted about 250 Army and industry leaders to Atlanta, GA, early in February.

Army Vice Chief of Staff GEN Walter T. Kerwin Jr., keynote speaker, shared the spotlight with GEN John R. Deane Jr.—installed early in February as commander of the Army Materiel Command—who gave opening remarks.

Other principal speakers included AMC Deputy Commander LTG Woodrow W. Vaughan, summary remarks; AMC Deputy Commander for Materiel Acquisition MG George Sammet, "Army Materiel Acquisition Review Committee—Then and Now"; John D. Blanchard, Sammet's deputy, "Acquisition Initiatives, Industry Issues, Army Answers, Healthier Habits."

AMC Director of Research, Development and Engineering BG Harry A. Griffith spoke on "Testing—A Fresh Look," and George E. Dausman, acting director, AMC Requirements and Procurement, discussed "The Flip Side of the Record."

"Project Managers—'The New Breed'" was the topic of Mrs. Sally Clements, assistant chief, Project Management Office, U.S. Army Materiel Command.

GEN Sammet devoted a substantial portion of his address to the progress of the Army Materiel Command since the 1974 Atlanta I seminar in implementing recommendations of the Army Materiel Acquisition Review Committee. (*See AMARC feature on page 9.*)

Other points covered by GEN Sammet included a closer working relationship between AMC and TRADOC (Training and Doctrine Command) to be more responsive to users in new or improved materiel development; transfer of the Army Test Boards to TRADOC and improvement of test procedures; establishment of a new AMC deputy for Science and Technology; and a program to make technical manuals much more effective.

High-ranking government R&D leaders and industrial executives participated as panelists to discuss "Progress Through Teamwork." Thomas R. Steulpnagel, vice president and general manager, of Hughes Helicopters, was the moderator.

Government panel members were Assistant Secretary of the Army (R&D) Norman R. Augustine, ASA (Installations and Logistics) Harold L. Brownman, AMC Deputy Commander LTG Woodrow W. Vanugan, AMC Assistant Deputy for Material Acquisition John D. Blanchard, commander of the Army Electronics Command MG Hugh F. Foster and MG Joseph E. Peiklik, commander, Tank-Automotive Command.

Industrial panelists were William S. Blakeslee, vice president and executive of the Defense Space Group, Chrysler Corp.; Dr. R. L. Johnson, executive vice president, McDonnell Douglas Astronautics Co.; Irving K. Kessler, Government and Commercial Systems, RCA Corp.; Sidney Stark, vice president and general manager, Orlando Division, Martin Marietta Aerospace Corp.; and Robert G. Vande Vrede, president, Celasco Industries, Inc.

AMC DMA's Responsibilities Expanded to Laboratories

Expansion of responsibility of Army Materiel Command Deputy for Materiel Acquisition MG George Sammet Jr., to include supervision of technical operations in AMC in-house laboratories, involves other significant changes.

To help him perform these additional duties, GEN Sammet has established a new position of deputy for Science and Technology, set up at PL (Public Law) 313 level (GS–18 equivalent).

Installed in this position is Norman L. Klein, who has served with AMC since 1962 in a progression of key assignments—since 1966 as chief, Laboratory Operations and (1972-74) as Assistant Deputy for Laboratories. In 1974 he received the Army's highest civilian employe award, the Decoration for Exceptional Civilian Service.

Klein began his Federal Civil Service career in 1942 and in 1946 became a member of a 4-man senior civilian R&D staff, Office of the Chief of Ordnance, HQ DA. He served there until he transferred to AMC when it was established Aug. 1, 1962.

Dr. Robert B. Dillaway, who has served since mid-1969 as AMC Deputy for Laboratories, has a new title as chief scientist, a position vacated by Dr. Craig Crenshaw when he retired in June 1974 after holding the job since 1962.

A small staff comprised of personnel reassigned from the Office of the Deputy for Laboratories will directly support DST Klein, who will report to MG Sammet.

In addition to the broad range of responsibility he has held since Oct. 23, 1973, as AMC Deputy for Materiel Acquisition, including membership on the AMC Research, Development, Test and Evaluation Program Review Committee, MG Sammet now is charged with the mission to:

- Direct the operation of the AMC corporate laboratories, and supervise the technical operations of all AMC in-house laboratories to insure optimum quality of effort; provide technical direction to the U.S. Army Materiel Systems Analysis Agency; act for the AMC commander in relations with higher authority on matters assigned to him.
- Establish policy for the laboratory program in accordance with broad program guidance gained through consultation with the Office of the Director of Defense, Research and Engineering (ODDR&E); the Office of the Assistant Secretary of the Army (R&D); and the Deputy Chief of Staff for Research, Development and Acquisition (DCSRDA), Department of the Army.
- Authorize grants to nonprofit organizations for support of scientific research; develop, administer and evaluate the Department of the Army Civilian Career Management Program for Engineers and Scientists with the exception of those in construction fields.

Norman L. Klein

Deputy for S&T Klein works "under very broad policy guidance from MG Sammet." As stated in his position description, he acts for the AMC commander "in the AMC scientific community . . . to direct the operation of the AMC corporate laboratories and development centers, and to technically supervise the major subordinate command laboratories. . . ."

Klein's responsibilities involve AMC expenditures in excess of $1 billion annually for basic research, and for exploratory, advance and operational systems development of materiel.

About 25,000 AMC scientific, engineering and technical personnel are concerned with projects and programs "in practically every branch of the known sciences and engineering as pertinent and applicable directly or indirectly to the materiel support of the modern Army and as projected the future."

Charged with recommending and establishing policy for the research and development centers, Klein operates "in accordance with broad policy gained through consultation with the Director of Defense Research and Engineering, Assistant Secretary of the Army (R&D), and the Deputy Chief of Staff for Research, Development and Acquisition . . . for an integrated and balanced program among all concerned organizations. . . ."

An important aspect of Klein's responsibilities requires that he act as focal point for coordinating actions associated with the operational vigor and effectiveness of in-house laboratories and other AMC R&D organizations. This involves those functions previously carried out in this connection by the ODL.

Under a new delineation of functions, Chief Scientist Dr. Dillaway is the principal technical adviser to the AMC commander and his immediate staff of deputies as regards over-all scientific and technical programs within the AMC purview.

Dr. Dillaway provides special assistance to the AMC commander; maintains liaison with top-level research scientists, academic institutions and organizations on scientific problems; and serves as representative of the AMC commander at national and international scientific meetings and symposia.

HDL Executive Changes Mark Command Group Shift

Movement of the U.S. Army Harry Diamond Laboratories' command group with about 400 other employe from their location for 21 years in Washington, DC, to an ultramodern new $43 million laboratory complex at Adelphi, MD, was marked by a change of key administrators.

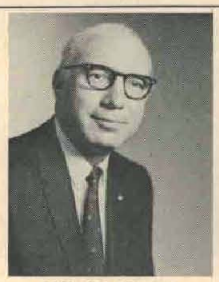
HDL Commander COL David W. Einsel Jr. announced in January the retirement of Billy M. Horton, technical director since 1962, Dr. Henry P. Kalmus, chief scientist, and P. Anthony Guarino, one of four associate TDs. Their Federal Civil Service careers ranged from 27 to 33 years.

Dr. William W. Carter has been selected to succeed Horton in an acting capacity. Chief scientist of the Army Missile Command from 1959 to 1967, Dr. Carter was assistant director for Nuclear Programs in the Office of the Director of Defense Research and Engineering for three years until he became an HDL associate technical director in 1970. He formerly served as a member of The Army Research Council (TARC), Office of the Chief of R&D, HQ DA.

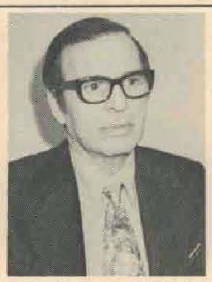
Dr. Helmut Sommer is acting as chief scientist and his position as an associate technical director is being filled by Dr. Edward E. Conrad, until recently chief of the Nuclear Effects Laboratory. Irving N. Flyer has moved up from chief of one of HDL's three R&D Laboratories to succeed Guarino in an acting capacity as an associate TD. Paul E. Landis also is acting as an associate TD, filling a vacancy created by the retirement of Dr. Maurice Apstein in February 1974. All of these men have been with DOFL and HDL over 20 years.

The recent move of HDL personnel to 2800 Powder Mill Road, on a 137-acre site adjacent to the Naval Surface Weapons Center, White Oak, MD, enabled them to join some 400 scientists and engineers who were relocated in February 1974.

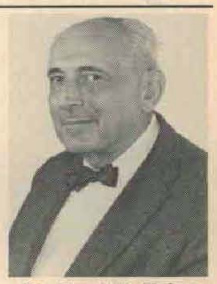
The 3-phase, 3-year relocation of HDL will be completed during the summer of 1976 when about 400 researchers, engaged principally in fluidics, nuclear radiation effects on electronic components of weapons systems, radar antennas and microwave electronics, will move.



Billy M. Horton



P. Anthony Guarino



Dr. Henry P. Kalmus

Collocation of the HDL and the Naval Surface Weapons Center (formerly the Naval Ordnance Laboratory) is anticipated to reinforce their capabilities for cooperative effort.

BILLY M. HORTON ended a 33-year federal career with worldwide recognition as one of the most distinguished U.S. Army scientists. Accredited by a long list of honors, and more than 20 patents for important inventions, he was known also as "one of the principal planners" of the new HDL complex.

After serving with the Naval Research Laboratory, he joined the Ordnance Division of the National Bureau of Standards. Two years later, in 1953, he moved with an NBS nucleus of

(Continued on page 15)

Advanced Ballistic Missile Defense . . .
Solid-Propelled Motor Technology Progress Reported

By Dr. David C. Sayles

The current intense interest in thrust magnitude control (ability to throttle) and thrust vector control (ability to steer) stems from the highly controllable performance necessary for exoatmospheric intercepts contemplated for advanced ballistic missile interception.

In the past, controllability has been achieved using liquid-propelled motor technology. Advantages of solid propellants for interceptor weaponization, however, led the U.S. Army Advanced Ballistic Missile Defense Agency to develop controllable, solid-propelled motor technology—culminating with a series of highly successful static test firings.

The primary objective of this program was to demonstrate, by static firings of full-size interceptor motors, the performance capability of a controllable solid-propelled rocket motor, including full-range thrust modulation, start/stop capability and thrust vector control. The salient technological accomplishments of this advanced endeavor include:

- A newly developed propellant which has the unique performance characteristics required for the motor—such as ultrahigh burning rate in conjunction with high pressure exponent of burning rate (the slope of burning rate *versus* pressure is high)—to provide controllability, extinguishment and restart capability.
- This propellant was extinguished and reignited repetitively in a half-scale and a full-scale motor statically tested under simulated conditions approximating about 100,000 feet altitude.
- The motor thrust level was successfully modulated over a range of 10 to 1 through the use of a pintle-controlled nozzle fabricated mainly from carbon-reinforced resinous composite materials. The nozzle proved to have thermal characteristics adequate to withstand the extreme environment that it would be exposed to during multiple stop-restart duty sequences.

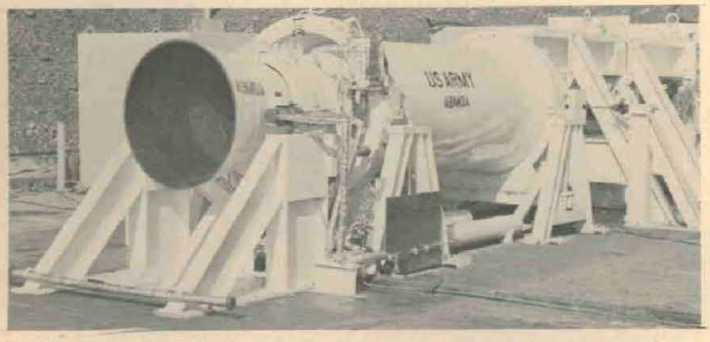


Fig. 1. Static Test of Controllable Solid-Rocket Motor

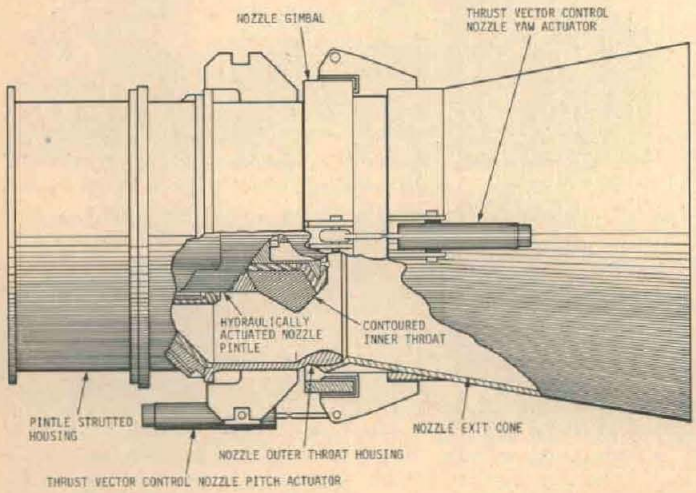


Fig. 2. Pintle-controlled Nozzle and Supersonic Splitline Vector

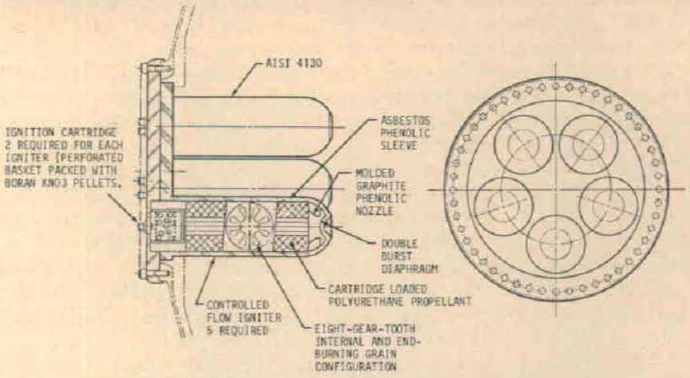


Fig. 3. Ignition System for Full-Duration Motors

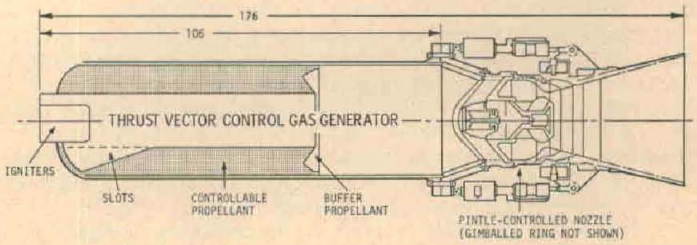


Fig. 4. Cross-section of Thrust Vector Control Gas Generator

- A thrust-vector control scheme, identified as the gimballed supersonic splitline nozzle, was selected as being the most compatible with the pintle-controlled nozzle. The required deflection (±5°) was achieved in both the pitch and yaw planes under all thrust levels and at acceptable slew rates.

The controllable-thrust, solid-propelled motor in this program used a movable pintle to change the throat area of the exhaust nozzle as the means of achieving thrust modulation (throttling, terminating and restarting the motor). Figure 1 depicts a sea-level, static firing configuration.

The principal involved is illustrated in Figure 2. The variable-throat-area nozzle has a hydraulically actuated, strut-mounted pintle centerbody that moves along the motor's longitudinal axis. This movement provides annular variations in throat area necessary to provide variable thrust.

Extinguishment of the propellant is achieved when the pintle centerbody is fully retracted into the strutted housing to provide the maximum throat area. This retraction causes the motor pressure to drop below the minimum required for sustaining combustion, the motor extinguishes, and the thrust terminates.

When the pintle centerbody is fully extended into the nozzle throat, the minimum throat area is achieved. The motor then operates at maximum pressure, producing the boost phase or maximum thrust.

If the pintle is positioned at some intermediate position between fully retracted and fully extended, the equilibrium motor pressures and thrusts are determined by the ballistic properties of the propellant—primarily the burning rate exponent of pressure (slop of motor pressure versus burning rate).

A unique oxygenated polyurethane-based propellant was formulated to achieve the desired controllability characteristics. The high-pressure exponent to produce throttling and improve extinguishment was obtained by additives and an oxidizer coatings. The higher burning rate was obtained through the use of porous ammonium perchlorate, prepared by thermal degradation of ammonium perchlorate.

The ignition system (Figure 3) clustered five identical igniters to achieve multiple start and restart capability. Each igniter case was insulated on both the interior and exterior surfaces for protection from motor heat. The igniter throat was sealed by a double-burst disc, designed to withstand the

operating pressure of the motor but undergo selective rupture when the igniter had reached its operating pressure.

To insure that the pressure in the motor would rise to the same level on each ignition, or reignition (independent of the free volume), the pintle was prepositioned to provide the proper throat area.

Five motors—one subscale and four full-duration—were fabricated and test fired under this program to evaluate the different aspects of their controllablity. To establish confidence in the full-scale motors, a subscale motor (Thrust Vector Control Gas Generator, Figure 4) was first fabricated and test fired. Thirty inches in diameter and 106 inches in length, the motor was designed to have a low mass fraction and a sizable free volume at the aft end—to ensure against the possibility of reigniting the main controllable propellant by thermal radiation from the hot nozzle components.

As additional protection against such inadvertent reignition, the aft end of the main propellant grain was restricted with a slow-burning buffer propellant. Its cool combustion gases helped dissipate motor-generated heat.

Each of the full-scale, full-duration motors (Figures 1 and 6) was test fired at successively more complicated duty cycles. Each contained more than 6,000 pounds of propellant grain having a finocyl (fins on cylinder) configuration. Figure 5 illustrates the thrust-time curve obtained from the final Aug. 26 test firing. The duty cycle consisted of five pulses, and the pintle centerbody was prepositioned so that for the first step of each pulse the motor would operate at 400 psia, followed by operation at 90 psia.

To demonstrate the extinguishability characteristics, the subscale motor and two full-duration motors were tested at the Arnold Engineering Development Center. Thrust modulation, durability of the nozzle components, thrust vector deflectivity and slew rates were assessed by static testing at sea level, and confirmed at simulated altitudes. Full-scale motors were required to demonstrate adequately the performance and manufacturability of the motor.

In summary, the Army Ballistic Missile Defense Agency's efforts resulted in clearly demonstrating the future utility of solid-propelled, pintle-controlled motors for use on advanced interceptors whose mission requirements will involve more complex and extended mission times, thrust termination, stop-restart, throttling and thrust vector control.

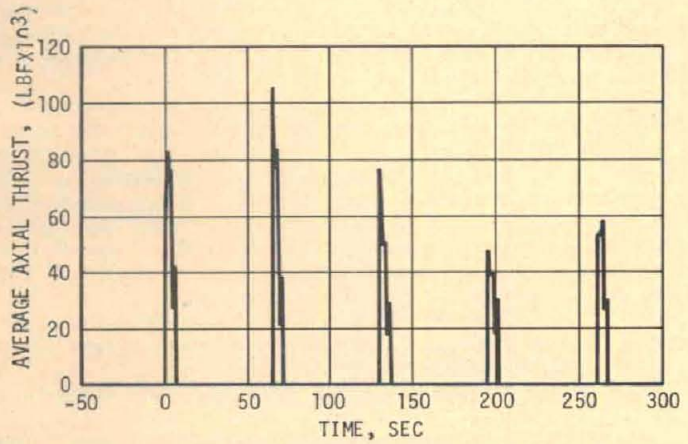


Fig 5. Thrust-time curve for fourth full-duration controllable motor, showing five ignition pulses, and controlled thrust.

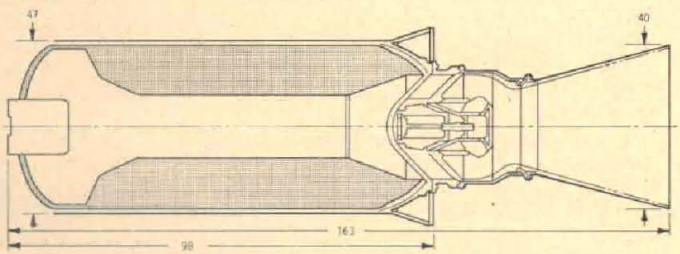


Fig. 6. Full-scale, Full-Duration Motor

DR. DAVID CYR SAYLES, an engineer with the U.S. Army Advanced Ballistic Missile Defense Agency (ABMDA), Huntsville, AL, is primarily responsible for development of propulsion subsystems for advanced interceptors. A native of Canada, he has a BS degree in chemistry from the University of Alberta, an MS degree in chemistry from the University of Chicago and a PhD in chemical engineering from Purdue. He was employed at the U.S. Army Missile Command, Redstone Arsenal, AL, prior to joining ABMDA in July 1970. He is still affiliated with Alabama, and Ohio State University.

Dr. Sayles has authored numerous scientific publications and holds 58 patents. Among his awards are four Department of the Army Certificates of Achievement and two Honor Scrolls from the American Institute of Chemists.

HDL Executive Changes Linked to Relocation

(Continued from page 13)

about 150 scientists to establish the Diamond Ordnance Fuze Laboratories (DOFL) which in 1962 became HDL.

One of Horton's early HDL achievements was the application of noise modulation in radar ranging and detecting systems, leading to a new class of fuzes highly resistant to countermeasures. A DOFL press conference in 1958 served for announcement of development of interactive fluid amplification, leading to the current technology known as fluidics, in which HDL is assigned Army Lead Laboratory responsibility by the U.S. Army Materiel Command.

Fluidics is now finding numerous applications worldwide in industrial and military control systems characterized by simplicity, ruggedness, durability and exceptional reliability.

Horton has been recognized for his numerous inventions and accomplishments as HDL technical director since 1962 by such honors as a U.S. Army R&D Achievement Award, the Army Decoration for Exceptional Civilian Service, and the Department of Defense Distinguished Civilian Service Award.

The highly prestigious Arnold O. Beckman Award of the Instrument Society of America, which has served to honor the greatest of American inventors, was presented to Horton in 1960 for his invention of the principles of fluidics.

The John Scott Award of the City of Philadelphia in 1966 was followed in 1970 by a special award from the Society of Mechanical Engineers. The Patent, Trademark and Copyright Research Institute of George Washington University selected him in 1971 for its Inventor of the Year Award.

DR. HENRY P. KALMUS joined the National Bureau of Standards Ordnance Electronics Division in 1948 and was among the scientists transferred to the Army for establishment of DOFL in 1953. He became HDL's chief scientist in 1962 and is recognized internationally as an expert in the fields of electromechancial devices, electronic measuring instruments and, especially, radar signal processors.

In 1970 he received the Department of Defense Distinguished Civilian Service Award and the Albert F. Sperry Award of the Instrument Society of America. The Master Designer Award sponsored by Product Engineering honored him in 1967. He received the Gravity Research Foundation Award in 1964.

Dr. Kalmus also has received the Department of the Army Decoration for Exceptional Civilian Service (1961), the Department of the Army Certificate of Achievement (1969), the Institute of Radio Engineers Fellowship Award (1956) and Department of Commerce Award for Exceptional Service.

P. ANTHONY GUARINO retired after nearly 30 years of Federal Civil Service, principally as an Army employe, including nearly 13 years as HDL associate technical director. Honored with an Army R&D Achievement Award in 1969, he has served on many working groups as a consultant, including work with the NATO Team on Mutual Weapons Development, and the Quadripartite Technical Cooperation Program involving the United States, United Kingdom, Canada and Australia.

U.S. Army Missile Command...

Adds $40 Million Advanced Simulation Facility to Capabilities

Privileged and highly knowledgeable previewers are calling the $40 million Advanced Simulation Center at HQ U.S. Army Missile Command a modern marvel of the missile world.

Expected to be fully operational by mid-1975 at Redstone Arsenal, AL, the 3-story, 75,000-square-foot facility attached to the McMorrow Laboratories includes three test chambers. Linked to third- and fourth-generation computers, these facilities can simulate most of the environmental factors that affect missiles during flight.

The center will be capable of testing any missile known today or foreseen for the future, including system components under engineering or advanced development.

Anticipated benefits include time and manpower decreases to develop a missile system, millions saved each year in research and development by lowering the need for actual flight tests, and better-tested weapons fielded for combat forces.

Dr. John L. McDaniel, director of MICOM's Research, Development and Engineering Laboratory, said the Advanced Simulation Center will be a national facility, available to all branches of the armed forces as well as contractors.

No other such facility, private or governmental, is known to have as sophisticated a missile research, development, test and evaluation capability housed under one roof. The test chambers, wrapped around the latest analog and digital computers, feature electro-optical, infrared, and radio frequency simulation systems. Test sensors in the visual and infrared bands include those for terminal homing close-air-support and antiank missiles.

Featured in the electro-optical cell is a 1024-square-foot moving terrain model covered with miniature deserts, mountains, rivers, dams, towns and military targets. Missiles can be tested for ability to acquire, track and destroy enemy targets under day or night conditions. The lighting system can simulate natural illumination from starlight to sunlight.

The RF cell—resembling a house of horrors with its anechoic material of black rubber arranged like punji stakes—is used to test ability of radar components to detect and track targets in a simulated battlefield environment, including electronic countermeasures.

Each of the three test chambers is linked to and can "talk" to the computers.

MICOM engineers who have tested the laser-guided projectiles and television seekers report that the center should make it possible to eliminate "false starts." New missile designs and concepts can be tested exhaustively before the Army makes a major commitment to a specific design approach. That way, fewer "bugs" or surprises are likely to surface during live tests of a weapon prototype.

The Advanced Simulation Center, however, is only one of numerous amazing research facilities at Redstone Arsenal, home of the Army Missile Command and birthplace of all U.S. Army missiles and rockets.

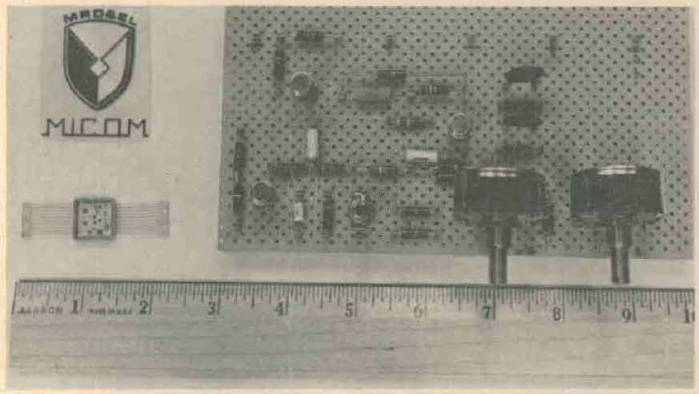
The McMorrow laboratories—focal center of Army missile research, development, test and evaluation—are part of the MICOM Research, Development and Engineering Laboratory. In spotless, closed-door rooms filled with test tubes and electronic paraphernalia, some 1,300 civilians and 40 soldiers keep pushing back the scientific boundaries of the unknown.

Redstone is the soft hum of computers, the slip of a slide-rule, the clank of mechanical arms that remotely handle propellants, the stillness of a quiet room where an engineer wrestles with a thorny problem. But most of all, Redstone is the sound of progress.

Redstone and MICOM's vital statistics are impressive—approximately 40,000 acres . . . an annual budget of approximately $1.6 billion . . . annual payroll of more than $150 million . . . a workforce that boasts more than 90 PhDs, 359 master degrees and 1,865 bachelor degrees.

MICOM's Research, Development and Engineering Laboratory is gifted with talented professional personnel, many of them well known in the world of missilery, and operates perhaps unlike any other R&D laboratory.

The R&D bible that guides laboratory activities is the Army Missile Plan, a classified document that shows where the research, development, test and evaluation program stands, where it hopes to go in the next decade, and technology barriers that must be hurdled along the way.



MINIATURIZED CHIP circuit designed by MICOM and shown below symbol, replaces the components mounted on the board.

Primary intent of the plan is to key programs managed by MICOM laboratories to user requirements. A time-phased analysis of technical areas to be investigated is presented, with resources required to achieve weapons to meet future needs.

Required systems are listed in order of priority, based on factors such as user needs, technology available and order of replacement of operational weapons.

Dr. McDaniel directs laboratory operations primarily on an unstructured basis. That way, as priorities change, or workloads shift, he can assign MICOM's best talent to the most pressing problems.

Another management technique that enhances laboratory flexibility is known as Single Program Element Funding. This gives Dr. McDaniel authority to allocate funds to technology areas which, in his judgment, require emphasis, thus enabling the laboratory to reorient human and fiscal resources as priorities demand.

The primary role of the laboratory, he stresses continually, is to support the soldier. Consequently, he has placed responsibility for R&D weapons programs in the hands of the military under the concept known as "matrix management." Field grade officers (majors and up) manage future weapons programs almost like project managers except that they operate without a charter of mission. They are given resources, responsibility and authority to plan and execute programs, and are fully accountable for performance.

Known as Concept Team Leaders, the officers manage a program from the day a technology concept is born in the laboratories, through advanced development, until the day it moves to engineering development and is transferred to a project manager.

Dr. McDaniel believes there is no better training arena for potential project managers. Each officer is assigned one or two top civilian engineers and the Concept Team runs the show until the mission is accomplished by utilizing MICOM talent and laboratory facilities or by calling on other commands throughout AMC.

Career officers, who work closely with civilian engineers, technicians and scientists, are described as the "insight to the Army that will be using the weapons."

One yardstick used to measure success in MICOM laboratories is the number of weapon systems that go from concept to a project office. Within the past two years, Stinger, Hellfire, SHORADS, Precision Laser Designators, and High Energy Lasers have been born at Redstone. Several other systems reportedly are "coming along." MICOM's top three priority programs, for the third straight year, are terminal homing, high-energy lasers, and free-flight rockets.

Significant advances have been made in adapting laser guidance to an antitank role, specifically to the Hellfire weapon, a modular terminal homing missile being developed for aerial launch from attack helicopters.

Within the past year, MICOM demonstrated rapid and ripple firings from the Cobra gunship—two of the three major objectives of the test program to verify technical feasibility of the Hellfire system. Prototype infrared imaging seekers and television seekers are being readied for flight test programs.

MICOM has found many military and civilian applications for laser technology ranging from missile guidance to health applications. During the 1960s, MICOM conducted extensive experiments that used laser radiation on tissues of mice. Test results led to a request from National Institutes of Health asking MICOM to design and construct a laser scapel adaptable to clinical research. MICOM delivered the surgical device to NIH in 1966.

In the early 1960s, MICOM began working on laser guidance techniques and pioneered the technology and experimental hardware used by the Air Force in the development of its laser-guided "smart" bomb. MICOM's Research, Development and Engineering Laboratory is the Materiel Command Lead Laboratory for Guidance Control and Terminal Homing Technology.

Along with laser guidance concepts applicable to bombs, rockets, missiles, even artillery shells, MICOM has conducted extensive research in laser designators, the "flashlight" that guides the family of terminal homing weapons.

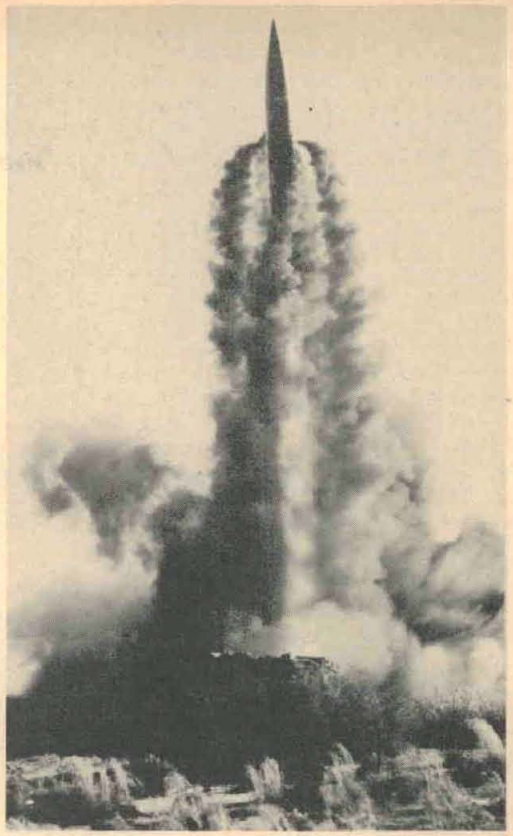
The Army has tri-service responsibility for ground designators which not only steer missiles, bombs or shells but also can detect and track targets, determine range and provide inputs to a fire-direction computer.

Equipment consists of a laser designator, rangefinder, sighting system, tracking system, mount and the interface for a night-vision sight. A Precision Laser Designator Product Office was established in 1974 to develop ground and airborne precision designators for all Army laser-guided weapons.

Significant technology advances in free-flight rockets have been made under the Improved Light Antitank Weapon (I-LAW) Program. Results have demonstrated that the technology is available to provide the infantryman with a new and improved LAW. In other free-flight rocket programs, MICOM is applying today's technology and know-how to the problem of determining what causes errors in flight, and ways to design a round with much greater accuracy.

The Army High Energy Laser Programs Office is investigating potential weapons and a variety of military applications.

FEATURED in electro-optical cell at MICOM's new Advanced Simulation Facility is a 1,024-sq. ft., moving terrain model covered with miniature deserts, mountains, rivers, dams, towns and military targets. Dr. Christopher Kulas is shown adjusting a miniature vehicle on airport runway of the terrain model.



LANCE, one of the many missiles developed through MICOM technology, is fired from White Sands Missile Range, NM.

An example of a non-weapon is the Mobile Test Unit, a research device.

Although MICOM does not manufacture production hardware, it has a Prototype Fabrication Facility which designs and fabricates electronic components so small that work must be done under a microscope.

"You might call us one-shot producers," said Charles Riley, chief of the facility established to respond quickly to military problems, whether the Army needs a component to test prototype hardware or a replacement part for missile equipment no longer in production. "Our goal is to maintain a strong support capability of mechanical skill and technical knowledge. We give the engineer what he wants—from a missile body to a bolt."

Other advanced research facilities at Redstone enable the Missile Command, with its people and know-how, to expand its technology by basic and exploratory research, such as work in solid propellants that led to development of small and large rocket motors that are reliable and easily stored. MICOM also developed a high-performance carborane propellant for tube-launched missiles.

Propulsion research is continuing on hypersonic flight vehicles which could pave the way for a new generation of antitank missiles. Unlike most other weapons, the hypervelocity missile has no warhead, just steel rods which rely on high kinetic energy to penetrate and kill targets.

MICOM researchers are incorporating into missile guidance new fluidic controls that use small streams of gas to direct larger streams which, in turn, activate various control systems. Fuidic controls are reliable since they contain no moving parts and are resistant to in-flight radiation and heat.

The Missile Command's Redstone Scientific Information Center is believed to contain the largest single document and microfiche collection of classified and unclassified data of any government research, development, test and evaluation agency.

The center contains about 1.3 million documents in support of the Army, National Aeronautics and Space Administration, and Department of Defense contractors in the area of Huntsville, AL. Holdings also include approximately 190,000 cata-

(Continued on page 18)

MICOM Adds $40 Million Simulation Facility

(Continued from page 17)

logued books and volumes of periodicals and about 600,000 special items such as patents and translations.

The center monthly receives approximately 7,000 new documents and 1,000 new books, along with regular shipments from more than 30 countries of some 3,000 scientific, technical and professional journals. It also operates the Army's Terminal Homing Data Bank which involves collecting, analyzing, and disseminating scientific and engineering information. Storage and retrieval are completely automated and the service is available to users Army-wide.

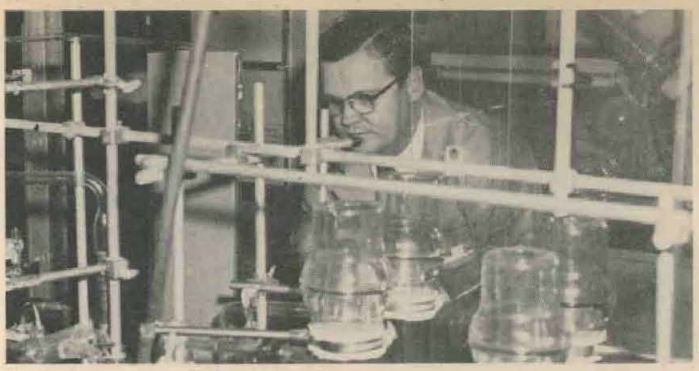
In addition, the center has access to a computer program that shows hundreds of millions of dollars spent annually in the Independent Research and Development Program, involving hundreds of contractors coast to coast. This program keeps MICOM informed about what is being done in advanced research and technology—and who is doing it.

One of the best-equipped and busiest small missile ranges in the country is among MICOM's facilities. At Test Area 1, a flat, restricted area some 27,000 feet long and encompassing about 10,000 acres, many of the missiles born in MICOM laboratories are put through their paces until engineers know they are ready to be put into the hands of soldiers.

More than 1,500 missiles and rockets are fired annually at Test Area 1, one of six missile test facilities at Redstone. Test Areas 1, 3, 4, and 6 are flight ranges. TA 2 has environmental labs where missiles and equipment are subjected to torture tests (sand, dust, heat, cold, salt spray and even fungus) prior to being fired. TA 5 houses static test stands where larger missiles can be fired, without leaving the ground.

Most missiles test fired at Redstone have a short to medium range, such as antitank and helicopter armaments like TOW, Dragon and Hellfire.

Studies begun at MICOM in the 1950s resulted in the 60s in the M–22, the first operational guided missile adapted to firing from a helicopter. Committed to combat in Vietnam in 1972, TOW became the first Army guided missile to be fired in combat by American soldiers.



PROPELLANT facilities enable MICOM personnel to expand technology through basic and exploratory research efforts.

From MICOM technology and know-how have come other familiar names such as Redstone, the granddaddy of all Army missiles; also, Redeye, Corporal, Jupiter, Pershing, Nike Ajax and Nike Hercules, Lance, Honest John, Little John, and Sergeant—just to name a few.

Redstone today is the sound of a tank rumbling across an open field, the churning of helicopter rotors skimming the treetops, the sharp crack of a missile, and a booming explosion as a missile finds its target.

New names are taking their place with the old—names like Dragon, Hellfire, Stinger, SAM–D. Some research programs are so new the missiles have not been named—identified only as hypervelocity rockets, suppression missiles, rockets with plastic airframes, infrared, radio frequency and laser-guided missiles. Dr. McDaniel terms these embryonic systems part of MICOM's pledge to the soldier:

"A good weapon today—a better weapon tomorrow."

Dr. Sanford Picked as Medical Dean for USUHS

Appointment of Dr. Jay Philip Sanford as dean-designate of the School of Medicine at the Uniformed Services University of the Health Services has been announced by Secretary of Defense James R. Schlesinger.

Authorized by Public Law 92-426 (Sept. 21, 1972), the new university will be constructed as a tri-service complex on the grounds of the National Naval Medical Center, Bethesda, MD.

Chartered to educate uniformed services medics in all of the health professions, the university will use as teaching institutions for clinical experience the Naval Hospital at Bethesda, Walter Reed Army Medical Center, Washington, DC, and Malcolm Grow U.S. Air Force Hospital, Andrews AFB, MD.

Development of the university is programed to extend over several years but it is hoped that a small class may be enrolled within the next year.

Dr. Sanford is professor of Internal Medicine at the University of Texas Southwestern Medical School and chief of the Bacteriology Laboratory at Parkland Memorial Hospital, Dallas, TX. A member of 22 scientific societies and associations, he is a native of Madison, WI.

Among the agencies he has served as a consultant are the U.S. Public Health Service, the Department of Defense, the Veterans Administration, The American College of Surgeons, the National Institutes of Health, and the Food and Drug Administration. He is on the editorial boards of four scientific journals and is the author of numerous scientific articles.

Expected to assume his new position effective May 1, 1975, Dr. Sanford has earned numerous honors, including being elected a Fellow of the American Academy of Microbiology and a Fellow of the American College of Physicians. He received his MD cum laude from the University of Michigan Medical School.

GUNNERS load an XM74 incendiary projectile into an XM202 66mm launcher during live-firing tests at the U.S. Army Jefferson Proving Ground (USAJPG), Madison, IN. Normally a shoulder-fired weapon, the launcher was mounted on a heavy-duty camera tripod for the special tests designed to observe functioning and/or recovery, disassembly and analysis of malfunctioning warheads.

R&D Correspondence Courses

The U.S. Army Logistics Management Center (ALMC), Fort Lee, VA, has announced that new enrollments for Army correspondence courses, relative to research, development, test and evaluation, have been temporarily discontinued.

The freeze action is explained by the rapidly changing doctrine in the RDT&E area, the numerous modifications to Army regulations which govern the courses, and rising material production costs.

Personnel enrolled in these courses prior to the ALMC announcement will be permitted to continue to completion. No on-site or resident instruction is affected.

ARMY M-109A1B self-propelled 155mm howitzer, equipped with flotation gear, is undergoing tests at Aberdeen Proving Ground, MD. The new tube, which is more than five feet longer than the one it replaces, has extended the weapon's range to 18,000 meters. Firing also will be held to demonstrate compatibility of a rocket-assisted projectile (RAP) with the howitzer, to further increase the range.

Fuze of the Future? Electro-Optical Initiator

Development of a new fuze initiation concept based on semiconductor circuits and the phenomenon of triboluminescence—emission of light through mechanical disruption of crystalline structures—was announced recently by U.S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, MD.

Dr. Coy M. Glass is credited with originating the concept of using a triboluminescent compound to coat the inside of a shell's ogive. Light emitted by the material when the shell strikes its target would trigger a photosensitive device to initiate the sequence of detonation operations in an armed contact fuze.

U.S. Army fuzes currently in service are considered generally as being either active or passive. Active types include proximity fuzes, remotely controlled fuzes, and mechanical or fluidic time fuzes. In the passive class are the contact-closure switch in a double-walled ogive, or a piezoelectric device in a point-detonating warhead.

Both passive types have certain undesirable characteristics. Double-walled ogives add to the over-all weight of a projectile; piezoelectric types add to a warhead's cost because several devices must be used to ensure initiation of the warhead should it strike at a large impact angle. Both types of passive fuzes cause the warhead's performance to be degraded, particularly in shaped-charge projectiles.

Dr. Glass considered how the triboluminescence effect could be used in the design of an improved fuze; here he defined improvement to be reliable operation—particularly at grazing angles, at lower weight and at lower cost than current fuzes. Thus in looking for ways to apply his ideas, Dr. Glass considered three primary elements: the circuit to fire the detonator; the power supply for the current to the circuit: the triboluminescence effect and the choice of a suitable light-emitting compound.

A schematic diagram of a prototype circuit developed by Dr. Glass and James Dante, also of BRL, appears in Figure 1, showing detonator in series with a silicon-controlled rectifier.

When the phototransistor is exposed to light, it becomes conductive and permits current to flow through the rectifier to the detonator, which then is initiated. Circuit components are all standard items, lightweight, and reasonably priced.

The prototype circuit has operated successfully in tests using an ARC–211 detonator and lead-azide boosters. A flashlight simulated the light source and power was provided by a direct current power supply. The ARC–211 detonator is relatively insensitive, requiring more than one-half ampere current before it will detonate. Tests of the circuit are continuing with more sensitive detonators.

Charged condensers, magnetostrictive devices, and self-contained energy sources were all considered for power supplies. The final choice is a thermal battery. Light in weight (1.5 ounces), small in volume (3.18 cm long and 1.92 cm diameter), the thermal battery is completely inert until activated by setback forces during launching, and has infinite shelf-life.

Once activated, the battery can provide 100 watts of power for more than 10 seconds. New fabrication techniques enable the thermal battery to withstand spin-rates of up to 500 rps.

The final question Dr. Glass considered was how to provide

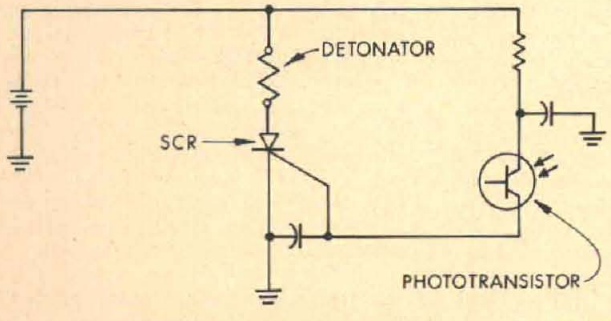


Fig. 1. Experimental Initiation Circuit

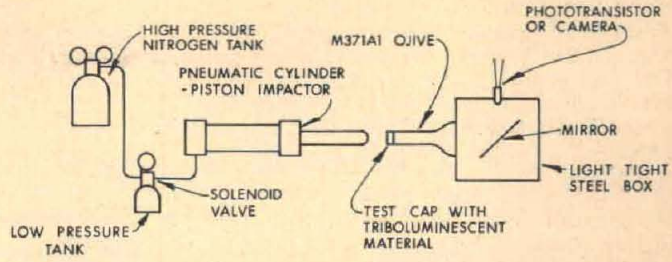


Fig. 2. Impact System for Testing Triboluminescent Materials

enough light through triboluminescence to trigger the phototransistor. Candidate triboluminescent materials included zinc fluoride: magnesium activated (ZnF_2: Mg); zinc sulfide: magnesium activated (ZnS: Mg); zinc sulfide, silver-actuated (ZnS: Ag); and calcium pyrophosphate, dysprosium-activated (CaP_2O_7: D_y).

Dr. Coy M. Glass

James Dante

An impact apparatus was built to evaluate the candidate materials (see Figure 2). Impact velocities up to five meters per second can be obtained. The light output generated upon impact can be photographed, and the response of the phototransistor can be measured as it is exposed to the light. The zinc sulfide, silver-activated material has been tested and it gives excellent results.

Currently, all fundamental problems involved in developing the concept have been solved. The next step will be the application of the initiator design to a shaped-charge warhead to demonstrate feasibility for use in a practical system, such as the LAW missile. If successful—and the probability for success is considered high by Dr. Glass—the following step will be to develop the necessary operational and production specifications for application of the initiation systems to LAW and advanced LAW.

Dr. Glass intends to apply for a patent for *Triboluminescent Initiation System.*

Army Testing Jojoba Oil for Lubricant Use

Plant life abundant in hot, arid areas of the Southwestern United States may help to save the sperm whale from the danger of extinction by whalers if research at the U.S. Army Frankford Arsenal establishes that jojoba oil can be substituted for whale oil lubricants. Results of the research also could provide a new source of industrial income for Indians living on reservations where the jojoba plant flourishes.

Research scientists Henry Gisser, Joseph Messina and David Chasan, employed at the Pitman-Dunn Laboratory, Frankford Arsenal, Philadelphia, PA, recently reported that extensive tests indicate that jojoba oil and sperm whale oil have almost equivalent qualities for lubrication requirements in many industrial and military applications.

Frankford Arsenal became involved in the research when the Office of Economic Opportunity (OEO), Washington, DC, provided a sample of jojoba oil for studies—in the hope that jojoba plants may become a new income crop for Indians.

Drilling and tapping tests, typifying shop metal-cutting operations, have shown that sulfurized jojoba oil performs as well as sperm oil, the research report shows. Consumption of sperm oil in the United States has averaged about 55 million pounds annually during the past decade.

About 50 percent of the sperm oil was used for automatic transmission fluids, metal-cutting operations, and automotive lubricants. Estimates indicate that stockpiles of the oil will last a few years, and that a substitute will become essential.

Military Posture Statements Justify Views on Budget Proposals

Military Posture Statements, presented annually to Senate and House Armed Services Committees of Congress by leaders of the Army, Navy, Air Force and the Joint Chiefs of Staff, are documents that detail changes in U.S. warfare capabilities vis a vis those of the Soviet Union as the major potential enemy. Presented when the defense budget proposals are being considered, the MPS are, in fact, justifications for upgrading, or maintaining at minimal required levels, U.S. military capabilities to assure the security of the nation against any emergency. This year, all defense leaders presented a foreboding view of the progress and huge expenditures of the USSR to build world military supremacy.

SECRETARY OF DEFENSE JAMES R. SCHLESINGER detailed the rationale of the FY 1976 and Transition Budgets, FY 1977 Authorization Request and FY 1976–1980 Defense Programs in his presentation to Congress. The DoD has requested FY 1976 total obligational authority of $104.7 billion and outlays of $92.8 billion. *Excerpts from his 44-page presentation follow.*

The Basic Budgetary Choices. In FY 1964, before the war in Vietnam had resulted in a major impact on the U.S. defense establishment, our military and civilian personnel totaled over 3.7 million people. For FY 1976, we plan fewer than 3.1 million people, even though the world has become only a slightly safer place in the ensuing 12 years.

For the first time since 1939 (two years before Pearl Harbor), our active fleet will consist of fewer than 500 ships. Our ships, aircraft and ground combat vehicles are aging. Perhaps most troublesome of all, the readiness of some forces has suffered as budgetary constraints have grown more severe.

There is, in short, no way that we can maintain force structure, modernization and readiness on the basis of declining budgets. Yet, if the effects of inflation and real pay increases are removed, the last four years have witnessed nothing but declining budgets. In such circumstances, the Congress and the country must face the main choices before us and the consequences that are likely to flow from their decisions.

One choice is to continue to review the Administration's budget and make cuts in such a way that the net reduction is no mores than 5% of the total. Consciences are then salved and no great damage is done in any particular year. The difficulty is that if this approach is followed year after year—as it has been in the recent past—the real military power of the defense establishment must inevitably erode. And as troublesome as erosion is the fact that decisions fundamental to the security of the United States are made by default.

Surely, if we want the shadow rather than the substance of first-class military power, we should make the decision explicitly rather than in a casual and impulsive fashion over a period of time.

A second choice is to recognize that there is a strong connection between the safety, interests, commitments and foreign policy of the United States on one hand, and the size, composition and deployment of our Defense Establishment on the other hand. This choice implies that, if the proposed Defense Budget is too high for the Congress and the country, it may well be that excessive demands are being made on defense.

Thus, if the Defense Budget is to be reduced, it should be done in clear recognition that we will not be able to fulfill our responsibilities.

James R. Schlesinger
Secretary of Defense

A third and more reasonable choice is to acknowledge that in a world where detente runs parallel with a number of dangers—some evident, some hidden and uncertain—in a world where the United States simply cannot escape great responsibilities, military power remains relevant (to the threat).

In these circumstances, a posture of deterrence will be seen as necessary to some measure of safety, collective security, and progress toward more enduring peace, even though the price is high but quite tolerable. Such a choice implies acceptance not only of the Administration's budgetary request, but of the strategic concepts on which it is based.

The Nature of the Challenge. Turning to "The International Situation and the Defense Establishment," Secretary of Defense Schlesinger continued:

Last year I quoted from *Proverbs* to the effect that "Where there is no wisdom, the people perish." The vision that I attempted to suggest then was one of peace among the great powers based on equality, civility, and prudence. This year, the principle of equality strongly supported by the Defense Department was established at Vladivostok.

But equality must be more than a principle. We would do well to recall, in that connection, that "When a strong man armed keepeth his palace, his goods are in peace." Perhaps we are no longer of "that strength that in old days moved earth and heaven," but we must still be "strong in will—to strive, to seek, to find, and not to yield."

To heed that advice, we must maintain military strength. But there remains the problem of defining our specific defense objectives and establishing efficient programs for their attainment. A French official once solved the problem very succinctly. He said that the Maginot Line began where it was required and ended where it was no longer needed.

However, we can and should do better than that. As a British statesman once asked: "Does it mean that because Americans allegedly won't listen to sense, you intend to talk nonsense to them?" The answer is: No. . . .

I am sensitive to the fact that national security is not a product that brings explicit and tangible benefits to us, although most of us are acutely aware when it is not present. As Sir John Slessor once noted: "It is customary in democratic countries to deplore expenditures on armament as conflicting with the requirements of the social services. There is a tendency to forget that the most important social service that a government can do for its people is to keep them alive and free. . . ."

. . . The issue before us is . . . how much defense of what kind we need to be reasonably confident of securing this nation and its myriad interests.

We live in an interdependent world economy, and our foreign economic interests are substantial. U.S. assets abroad amount to more than $180 billion. Annually, we export more than $70 billion in goods and services, and our imports are of an equal or greater amount.

The oil embargo of 1973 is only the most recent and pointed reminder that we have a keen and growing interest in distant lands, their markets and their products. Our foreign political interests are even more extensive. Within this century, we have participated in two great wars to ensure that Europe did not fall under the domination of a single power. We have a similar interest in seeing that Japan remains independent and that the other nations of Asia are free to choose their own destinies.

Our concern for the freedom of the Western Hemisphere from external domination now dates back more than 150 years. We have important economic and strategic interests in Western Europe, the Middle East, the Persian Gulf, and Asia.

Contrary to occasional suggestions, surely the right cure for what may seem an excess of commitments is not the blind and hasty abandonment of all commitments. Our objective, as a great power, is to display a somewhat greater degree of steadfastness.

Despite detente and its opportunities, the need for steadfastness is no less great than it was a decade or more ago. Putting aside the shibboleths of the cold war era, it is nonetheless the case that the world remains a turbulent place.

The military confrontation along the Sino-Soviet border continues. Both Washington and Moscow appear to agree that the situation in the Middle East is extremely volatile. Our allies in Europe and Asia find themselves in varying degrees

of economic and political difficulty. From the Azores, through Europe and the Mediterranean, to Japan, common objectives and policies remain to be formulated.

The conflict over Cyprus continues unresolved. In several countries with whom we have close association, succession crises are in the offing. The international waters are troubled and the temptation to fish in them to the detriment of U.S. interests cannot be entirely absent.

The Soviet Union and the PRC (Peoples Republic of China) have proved to be relatively prudent powers under their current leadership, although some of their client states appear to suffer from periodic excesses of revolutionary exuberance. Challenges may therefore arise even though the great powers do not wish to initiate them.

Whatever the case—and the future is clouded with uncertainty—there is no doubt about the very large military capabilities at the disposal of the USSR. What is more (important), these capabilities continue to grow.

In our prices, the Soviets now devote more resources than the United States in most of the significant categories of defense. In over-all Research and Development, they outstrip us by 20%; in General-Purpose Forces by 20%; in Procurement by 25%; and in Strategic Nuclear Offensive Weapons by 60%.

What is more, we are now beginning to witness in the Soviet Union the largest initial deployment of improved strategic capabilities in the history of the nuclear competition. How far it will go, we do not know; but there is no doubt that these new ICBMs (Intercontinental Ballistic Missiles)—with larger throw-weights, MIRVs (Multiple Interceptor Reentry Vehicles), and improved accuracies—combined with their significant improvements in their sea-based missile force, will give the Soviets a much more powerful strategic offensive force, even within the constraints of Vladivostok.

At the same time, the Soviets have continued to strengthen their general-purpose forces and provide large amounts of military assistance to other states. One of the more impressive feats performed . . . during the past five years is to have built up their forces in the Far East to a strength of more than 40 divisions, without any diminution of capabilities west of the Urals.

In fact, during the past year, there have been qualitative and quantitative improvements in the forces oriented toward NATO. The Center Region of the Alliance still faces a deployed force of about 58 Warsaw Pact divisions, with the possibility that at least 30 more could be added from the USSR alone within a relatively short period of time. The northern and southern flanks of NATO face smaller but nonetheless formidable forces as well.

While we have heard a great deal about U.S. forward-based systems with nuclear capabilities, remarkably little has been made of the large number of non-central nuclear systems that the Soviets deploy, some of which—under certain circumstances—would be capable of hitting parts of the United States, most obviously Alaska. It is noteworthy, in this connection, that the President was unwilling to compensate the Soviets for our forward-based systems in the negotiations at Vladivostok.

What we have to recognize, in sum, is that: *First*, the United States continues to have large and growing interests in an interdependent world even as it faces a number of problems at home; *second*, the areas of greatest interest to the United States are beset by a number of internal and external difficulties.

Third, despite detente, the sources of potential differences and conflict among the powers remain numerous; and *fourth*, large and diversified military capabilities remain in the hands of powers with whom our relationships have to some degree improved, but powers who have not traditionally wished us well or looked with cordiality upon our interests. . . .

SECRETARY SCHLESINGER turned, at this point in his presentation to the Congress, to a discussion of the U.S. role of being "alone as the superpower of the non-Communist world." His remarks included planning to perform this responsibility with maximum effectiveness, in concert with power of our allies, to achieve long-term deterrence of war by worldwide military balance.

Subject to three basic qualifications he detailed in depth, he stated: . . . if our naval modernization programs are approved by the Congress, I am reasonably confident that the United States, together with its allies, will remain able to defend the essential sea lanes in the Atlantic and Pacific, project power ashore under a wide range of circumstances, continue a strong deployed naval presence, and maintain the necessary maritime balance with the Soviet Union and its clients.

In conclusion, Secretary Schlesinger gave his views on "Trends in the Defense Budget" as projected through FY 1980. He said that underestimates of inflation during the past two years have prevented acquisition of "$10 billion in contracted goods and services authorized and approved by the Congress in FY 1975 and prior year budgets."

Further belt-tightening economies are planned, he said, citing among the "most severe" a reduction of 30,000 in military manpower and 9,000 civilian empolyes. Defense outlays over the 5-year period to 1980 are expected to "continue to decline as a percent of capacity Gross National Product (GNP)." Meanwhile, based on an FY 1976 projection of Soviet defense outlays "as much as 3% in real terms," this trend is expected to continue 2 to 3 percent annually.

GEN GEORGE S. BROWN, USAF, chairman, Joint Chiefs of Staff, devoted 202 pages to his first "United States Military Posture" statement to the Senate Armed Services Committee, comparing U.S. and USSR warfare capabilities.

The presentation covered intercontinental ballistic missiles (ICBMs), ICBM launchers, BM submarines and launchers, intercontinental bombers, operational strategic offensive delivery vehicles, strategic defense forces, significant initiatives on general-purpose forces systems, ground forces major weapons and equipment, cruise missile and attack submarines, and foreign source strategic materials.

GEN Brown's complete introductory remarks and selected excerpts follow.

I welcome this opportunity to discuss the military posture of the United States and to analyze with you the challenges which may confront our nation over the coming five to six years to which our budget actions now provide the means for response. Since we no longer possess that predominance of strategic power which, for over a quarter of a century, has protected the peace of the Free World and the security of the United States, this task takes on added dimensions of complexity and continues to be of undiminished importance.

In November of last year at Vladivostok, President Ford and General Secretary Brezhnev (USSR) established a framework for a future Strategic Arms Limitation Agreement. This framework is a significant milestone toward improving relations between the United States and the USSR, reducing the risk of war, and enhancing the chances of world peace.

GEN George Brown
Chm. Joint Chiefs

The framework not only limits the parties to an equal aggregate level of 2,400 strategic vehicles, 1,320 of which may be MIRVed, but also removes from the already complex bilateral negotiations the thorny multilateral issues of Forward-Based Systems and Soviet claims to compensation for allied strategic systems. Long and difficult negotiations with the USSR face us, both in structuring the agreement and in further steps toward reducing the burden of continuing strategic armament investments which the framework envisions.

The success or failure of these negotiations depends in large measure on our ability to demonstrate our determination to maintain military capability—second to none—across the total spectrum of foreseeable challenge. The USSR recognizes that efforts to obtain unilateral advantage are inconsistent with the objectives of reciprocity, mutual accommodation, and mutual benefit to which our nations are pledged. I doubt, however, that they would reject such an advantage if we, by default, offered it to them.

This, my first Posture Statement, is

(Continued on page 22)

Military Posture Statements Justify Views on Budget Proposals

(Continued from page 21)

designed to measure the balance of capabilities of the United States Armed Forces and the armed forces of our potential adversaries, today and as projected into mid-1980. It is subject to the following caveats:

• *First*, neither the size nor quality of a nation's arms provides a complete yardstick of its military power. Fond as we are of totaling up divisions, missiles, aircraft, and ships, this is not the full story. There is, to begin with, the obvious and basic fact that no weapon or system is more effective than the man who bears it or the crew which serves it.

More important, however, is the will of the people to make the sacrifices necessary to remain strong and free, which ultimately determines the security of a democratic nation. The actions of this Committee and the Congress as a whole are the measures of this indispensable element of national will and responsibility.

• *Second*, the criteria used for this statement are generally the same as those employed by my predecessors—U.S. force data are extrapolated from the currently projected Five-Year Defense Program. The USSR and PRC data are based upon my analysis of the latest intelligence estimates and projections.

There is a degree of uncertainty in any intelligence appraisal. The uncertainty is increased as the estimate moves from current capabilities to future ones, from quantitative to qualitative judgments, and from observable operational matters to concealed research and development.

• *Third*, I share with my predecessors the belief that it would be foolhardy to base the security of the United States on our ability to detect, observe and interpret the intentions of those who do not necessarily wish this nation and its people well.

"Intentions" are subject to obfuscation and instantaneous change; counter capabilities require years to develop and maintain. More often than not, political military intentions are, in fact, dependent upon perceptions of future opportunity which, in turn, may be created by a military posture based on misconceived, benign intentions.

We may never know what impact the reduction of our troop levels and the statements of our senior leaders may have had upon the North Korean decision to invade South Korea. I would suggest that these factors played a subtsantial role in the decision to employ North Korea's existing capability.

If we measure our strength only against the intentions of our would-be adversaries, we subject our future to their intentions as well. This is a risk I do not feel privileged to take, since I believe the American people demand that we be capable of remaining free and strong without regard to intentions of others. *Therefore, this statement attempts to measure real capability, not perceived intentions.*

• *Fourth*, and finally, you should be aware that there remains in all comparisons of one nation's military posture with that of another a measure of personal judgment. I have made every effort to produce a strictly objective appraisal. Overestimating the relative strength of a potential adversary may be detrimental to our national security, but not as detrimental as underestimating it. Overestimation undermines the confidence and resolve of our people and our allies in time of crisis, and could itself encourage military challenge to our interests in the world.

On the other hand, underestimation of our opponents' strength leads to complacency and a deteriorating will and resolve to pursue vigorous research and development, force improvement, and equipment modernization programs necessary to our security. I believe there is a consensus among my colleagues of the Joint Chiefs of Staff on the fundamental aspects of these comparisons, although some may differ in specific details.

Prior to presenting the first set of charts dealing with strategic forces, I would like to share with you two key judgments that I have made as a result of marshalling the evidence, synthesizing the data, and analyzing the comparative, but asymetrical, forces that preparation of this report required.

• *First*, the strategic balance today remains in dynamic equilibrium with the Soviet numerical edge, by some indicators, offset by the United States' qualitative advantage. The USSR, however, has embarked upon a massive program of major strategic force improvements and deployments which, if not constrained by the negotiating process, or balanced by major U.S. arms initiatives, will by the negotiating process, or balanced by major U.S. arms initiatives, result in serious superiority over the United States in the years ahead.

• *Second*, across the spectrum of warfare from strategic exchange to the lowest intensity of conflict, our military forces, together with those of our allies, possess today the capabilities to meet any foreseeable provocation with precision, discrimination, and restraint appropriate to the circumstance.

We currently retain but must seek to improve the ability to employ a range of options, preferably conventional (force) in any confrontation when such is necessary to preserve interests indispensable to our nation.

Our present strength is not so sufficient that we can be complacent. Our important interests can be threatened in the years ahead unless positive steps continue to be taken to improve the quality of our forces. In a very real sense, we have today an unequaled opportunity, by improving the war-fighting capabilities of our conventional force, to increase substantially our ability to deter aggression and, at the same time, raise the threshold of nuclear conflict.

The achievement of these objectives, however, will require not only the capability of meeting and defeating direct challenges to our interests and those of our friends and allies on land, on the sea, and in the air, but also a manifestation of a clear and evident resolve to do so. Should we fail to take those steps and to display this resolve, others may be encouraged to abandon reason and risk the peace of the world.

STRATEGIC FORCES. Over the years, the Secretary of Defense and my predecessors have noted that the relative U.S. strategic power had peaked and was on the decline; that we were approaching parity; and finally, that the balance was in dynamic equilibrium.

The static measures of relative military strength today remain in rough equilibrium. But in a technological era marked by giant strides in both science and engineering, we must approach the future with firmness and caution—firmness in our resolve to stabilize the static balance and caution in minimizing the chance of technological surprise.

There is mounting evidence that the Soviet Union is pressing forward vigorously with massive programs for near-term deployments involving every facet of offensive strategic power. At the same time, it is improving appreciably, at a more gradual rate, capabilities for strategic defense and pursuing with firm determination development of advanced technology appropriate to the entire strategic equation.

The Soviet Union's focus is not simply on maintaining the current advantage in terms of megatonnage and throw-weight, but it applies as well to accuracy, flexibility, survivability, and MIRVing intercontinental missiles.

GEN Brown turned, at this point, to a discussion of U.S. and USSR strategic forces, including the efforts of the Soviets to upgrade, on a major scale, all-around capabilities of intercontinental missiles. He detailed the performance capabilities of each of the known USSR missiles, as gleaned from current intelligence reports, and comparative U.S. missiles.

Attention also was directed to strategic forces of the Peoples Republic of China. "A modest, but credible, nuclear retaliatory capability against the USSR has been achieved, and this undoubtedly has influenced the decision to move ahead slowly. . . . Emphasis is clearly on programs with long-range implications . . .," GEN Brown said.

In reporting on U.S. and USSR capabilities of submarine-launched ballistic missiles, types of launchers, and over-all qualities of the submarines, GEN Brown devoted eight pages of his Posture Statement to this combat force.

Similar detailed attention was given to strategic bomber forces, air-to-surface missiles and launchers, missile defense systems, and other air defense weapons

against nuclear attack, including the U.S. Safeguard System and its USSR counterpart. PRC capabilities in these areas also were reviewed briefly.

Sixty-five pages of the Posture Statement were directed to General Purpose Forces comparison, including personnel strength, aircraft, naval forces, artillery, mortars, tanks and other ground assault vehicles, and missiles.

GEN Brown also reviewed capabilities in the area of Chemicals and Biological Agents. He cited the U.S. Senate Dec. 16, 1974, "advice and consent to the ratification of the Convention on the Prohibition of Development, Production, and Stockpiling of Bacteriological (Biological) and Toxic Weapons and Their Destruction (BW Convention) and the 1925 Geneva Protocol."

Modernization of the U.S. chemical warfare deterrent/retaliatory stockpile, he said—after reporting on a USSR "well-developed capability to employ a wide variety of effective munitions for ground, sea or air delivery of toxic chemical agents"—can be accomplished by either upgrading the present stockpile within the limits of agents already available, or by converting the stockpile to binary munitions. Binaries offer a feasible, economic, safe and more desirable alternative. . . .

The remainder of GEN Brown's statement was devoted to *Regional Perspectives*, that is, a discussion of U.S. worldwide interests and the global challenges to those interests on a regional basis. This portion of his report was detailed over a spread of 81 pages. In concluding his justification for the President's FY 1976 Defense Budget Proposal of $92.8 billion, he stated, "that the Joint Chiefs of Staff believe it is an austere and essential request and urge your full support. . . .

"As we contemplate the demands that liberty makes upon us, it is well to remember the words of Tom Paine 200 years ago: 'Those who expect to reap the blessings of liberty must . . . undergo the fatigue of supporting it.' "

SPACE AVAILABLE IN THIS EDITION does not permit coverage of the Posture Statements presented to the Senate and the House Armed Services Committees in support of other RDT&E FY 1976 budget proposals. Director of Defense Research and Engineering Dr. Malcolm R. Currie's massive (inch thick) report, dated 21 February, was released to the editorial staff at press time.

The Table of Contents alone takes up 12 pages and the report is divided into 10 chapters, 9 of which are supported by introductory comments. Stated in the report's introductory paragraph is that the projected Department of Defense Research, Development, Test and Evaluation Program is based on funding requirements of $10.236.6 billion, as compared to $8.615.5 billion for FY 1975.

Most of the increase proposed is drained off by scheduled salary increases for military and civilian personnel and anticipated continued inflation—leaving what is termed a minimal real-value boost to sustain efforts to retain scientific and technological superiority against a greatly expanded RDT&E program by the USSR and Warsaw Pact nations.

Dr. Currie's report, along with the reports submitted to Congress by Secretary of the Army Howard H. Callaway and Chief of Staff GEN Fred C. Weyand, are scheduled for publication in the next edition of the *Army R&D Newsmagazine.*

Statements by Assistant Secretary of the Army (R&D) Norman R. Augustine and Deputy Chief of Staff for Research, Development and Acquisition LTG Howard H. Cooksey had not been released for publication at press time.

SAM-D Intercepts Drone In Test of TVM Guidance

A SAM-D missile intercepted a Firebee drone flying subsonically at medium range and altitude during the first engineering development test of its Track-via-Missile (TVM) guidance system at White Sands (NM) Missile Range.

In the first of two checkout firings to demonstrate the complete weapon system compatibility, the test validated ground equipment, prelaunch checkout and countdown procedures, missile acquisition, midcourse guidance and activation of TVM guidance hardware.

SAM-D's group-base fire control group, through its phased-array radar, acquired the target, tracked and illuminated it. Acting as an "eye," the missile picked up radar energy reflected from the target and relayed it to the ground for real-time digital processing.

Tracked simultaneously by the phased-array radar, the missile received guidance commands from the ground and assisted in the guidance phase. Although the missile did not actually strike the target, the miss distance was well within the SAM-D warhead's lethal radius.

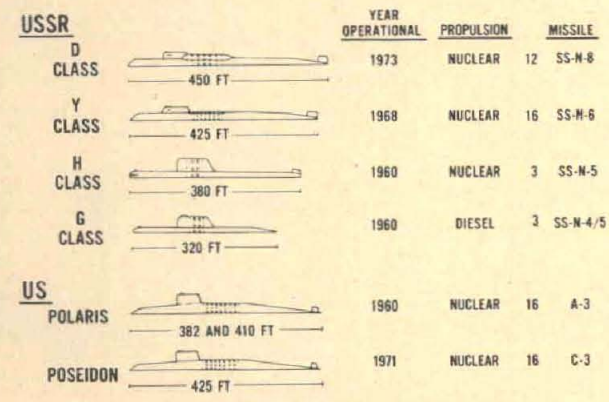
Success of the first engineering development test culminates months of testing components and subsystems in both static and flight environments. Project Manager BG Charles F. Means said the flight demonstrated SAM-D's system performance and that results ". . . serve as the baseline for the proof-of-principle program and the TVM guidance concept."

TVM guidance, which employs a phased-array radar and ground-based digital computers to track, guide and command the SAM-D missile in flight is expected to provide a substantial increase in air defense performance against multiple and maneuvering targets in an electronic countermeasures environment.

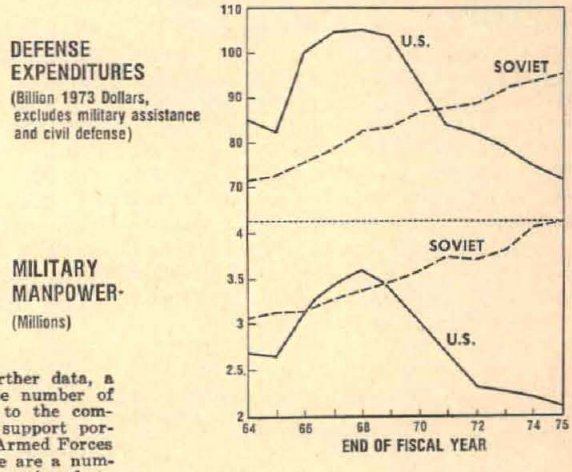
After one more dynamic test of radar and weapon control computer, launcher and missile compatibility, SAM-D is scheduled for advanced testing against maneuvering targets and targets flying in formation at various speeds and altitudes. Being developed for defense against aircraft of the 1980s and beyond, the highly mobile, all-weather system is believed the only air-defense weapon of its kind under development in the Free World.

	USSR	US	PRC
MED TANKS	40,000	9,000	8-9,000
APC & FIGHTING VEH.	30-40,000	22,000	3-4,000
ARTILLERY	15-20,000	6,000	15-16,000
HEAVY MORTARS	5-10,000	3,000	5-6,000
HELICOPTERS	2,000	9,000	500-1,000

Ground Forces—Major Weapons & Equipment (Jan. 1975)

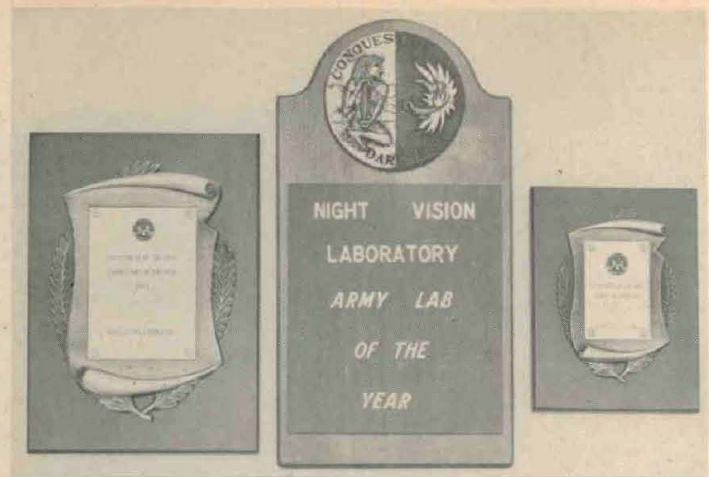


Operational Ballistics Missile Submarines



*As a result of further data, a new analysis of the number of personnel assigned to the command and general support portions of the Soviet Armed Forces is under way. There are a number of individuals assigned to supply, research, and training elements for whom we have not yet accounted.

Soviet-U.S. Defense Expenditures & Military Manpower



ASA (R&D) Norman R. Augustine (left), who presented the first "Army Laboratory of the Year" Award to the U.S. Army Electronics Command's (ECOM) Night Vision Laboratory (NVL), looks on as AMC Deputy Commander LTG W. W. Vaughan presents an Award for Excellence to NVL Director Donald J. Looft. At right is Dr. Robert S. Wiseman, director of Research, Development and Engineering, ECOM.

DIGNITARIES attending ceremonies at NVL included MG Hugh F. Foster Jr., ECOM commander; Norman L. Klein, AMC deputy for Science and Technology; and COL Tenhoe R. Hukkala, MERDC commander.

Assistant Secretary of the Army for R&D Norman R. Augustine presented the first "Army Laboratory of the Year" Award to the U.S. Army Electronic Command's Night Vision Laboratory (NVL), Fort Belvoir, VA.

NVL Director Donald J. Looft accepted this award, consisting of a wall plaque and citation, and a second award presented by AMC Deputy Commander LTG W. W. Vaughan as the best laboratory in the Army Materiel Command in 1974.

Looft lauded NVL personnel for their individual contributions to winning of the award, initiated by Augustine to recognize and upgrade performance of all Army inhouse labs.

The citation states in part, that the NVL "developed from earliest inception the techniques basic to observation and enhancement of restricted or infrared background light . . . achieved international acclaim and recognition as the leader in the field . . . successfully delivered on a timely basis prototype and production elements to the Army for systems requiring operation under limited visibility conditions."

Also participating in the presentation ceremonies was Victor Frederick, Deputy for Communications and Automatic Data Processing, Office, Assistant Secretary of the Army (R&D).

1974 'Most Improved' Army R&D Laboratory

The U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL, recently was presented the Army Special Award for Accomplishment as the most improved Army R&D Laboratory based on its 1974 progress.

Assistant Secretary of the Army for R&D Norman R. Augustine presented the award to COL Robert W. Bailey, USAARL commander, pictured at right.

Accomplishments contributing to the award include development of the SPH–4 aircrew helmet, acclaimed as one of the world's most efficient in term of acoustic and crash protection; also, the tanker's helmet, credited with virtually eliminating hearing loss during combat and test firings.

Cited also in the justification for the award is development of "anti-shock" trousers as a life-saving device to prevent shock in patients during the critical period of evacuation to a medical treatment facility; and many other projects related to the health, safety, welfare and efficiency of the soldier.

NVL Recognizes Scientific Achievement, Leadership

The "Best of the Best" in scientific and technical leadership categories received the first Outstanding Achievement Awards presented for R&D by the U.S. Army Electronic Command's Night Vision Laboratory (NVL).

In Feb. 21 ceremonies at Fort Belvoir, VA, Dr. Stuart B. Horn and Buford T. Walters received the Outstanding Scientific Achievement Award from NVL Director Donald J. Looft, for joint development of a miniaturized split-cycle cryogenic cooler for thermal imaging night-vision devices.

The cooler of a thermal imaging system lowers the temperature of the detector, making it sensitive and operational. Previous coolers were large, heavy and noisy, and consumed quite a bit of energy.

According to their citation, Horn and Walters made a state-of-the-art advancement in the cryogenic cooler field which "significantly impacts design and cost of lightweight night-vision devices. . . . This cooler development has made NVL the Department of Defense leader in cryogenic coolers."

In the leadership category, Dr. Louis M. Cameron was cited for technical leadership of the Army's Common Infrared Module Program. Dr. Cameron's "superb technical judgment," his citation states . . . (and) "outstanding managerial talent are responsible for establishing a viable program with considerable impact on the cost-effectiveness of future thermal imaging systems for the Army, and indeed, for more general Department of Defense systems applications."

Other nominees for the NVL awards were James R. Adamson, Bryan W. Butler, Stanley L. Carts, Edward J. Efkeman, Mack R. Farr, James R. Geyer, William A. Gutierrez, Carl W. Hoover, Donald H. Jenkins, Clarence A. Johnson, Howard M. Kessler, Isadore Kessler, Roger N. Koren, C. E. Lowe, William P. Markey, Robert L. Migliorini, Brian S. Miller, James K. Miller, Walter B. Borrow, Joseph R. Moulton, Edward P. Novak, Robert E. Nystrom, Calvin C. O'Rourke, Jeffrey L. Paul, John J. Pupich, John Rennie, Conrad W. Terrill, Charles L. Thompson, Roland R. Uhler, Paul M. Weaver, Joseph J. Wiedmann, Herbert L. Wilson, James T. Wood, Edward M. Yee.

NVL Leadership award winner Dr. Louis M. Cameron is employed in NVL's Systems Development Technical Area.

NVL Outstanding Scientic Achievement award winners Dr. Stuart B. Horn (left) and Buford Walters, both with NVL's Far Infrared Area, flank NVL Director Donald J. Looft.

ISEF Military Winners See JSS Awards, Nobel Prize Ceremonies

JSSFA winners and escorts during visit to Camp Zama. From left are COL John D. Marshall, commander, U.S. Army R&D Group (Far East); Jewel Anne Jurovich, Army winner; Larry Wiedman, Navy winner; Mrs. Katsuko Shoji, Yomiuri Shimbun; Dr. G. Bushey, Army escort; Carrie Levandoski, Science Service.

Japan Student Science Awards (JSSA) and Nobel Prize Award ceremonies were observed recently by five young student scientists as winners of top awards at the 25th International Science and Engineering Fair (ISEF).

Designed to popularize science in high schools and to stimulate gifted studnets to pursue science or engineering careers, ISEF is administered by Science Service, a nonprofit organization supported by U.S. Government agencies, major professional scientific societies and industrial organizations.

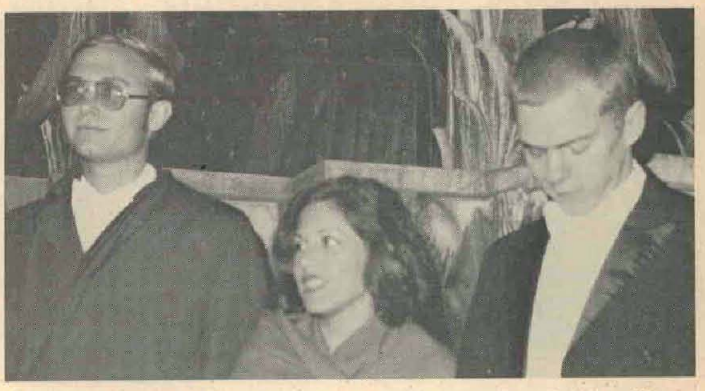
OPERATION CHERRY BLOSSOM, the Japan trip, was initiated in 1963 by the tri-services and continued until 1973. Only the Army and General Motors Corp. (GMC) sponsored one winner each in 1974. This year the Army and the Navy each sponsored one winner.

Jewel Anne Jurovich and Lawrence A. Wiedman, winners of this year's trip, were escorted by Science Service representative Miss Carol Levandoski nad Dr. Gordon Bushey, U.S. Army Materiel Command. At the U.S. rendezvous point in Seattle, the students received a special tour of the Pacific Science Center, reached by a mile-long monorail.

The group was met in Japan by COL John Marshall, commander of the U.S. Army R&D Group (Far East), and Mrs. Katsuko Shoji from the Yomiuri Shimbun, the newspaper that sponsors the JSSA and invites U.S. students to participate. They toured the Yomiuri Shimbun building and observed the newspaper's complete computerized printing process.

During the 18th Japan Student Science Awards, the U.S. students were recognized by presentation of certificates for their research exhibits and conversation with Their Imperial Highnesses, Prince and Princess Hitachi.

THE INSTITUTE OF SURGICAL RESEARCH at Brooke Army Medical Center, Fort Sam Houston, TX, received the Department of Army Award for Excellence, in a new Laboratory of the Year Selection Program, for its chemical research and treatment of burns during 1974. Commander of the U.S. Army Health Services Command, MG Spurgeon Neel, in presenting the award to COL Basil A. Pruitt, commander-director of the Institute, noted that the Institute was second only to the Night Vision Laboratory in judging among all Army R&D Labs.



NOBEL PRIZE AWARD ceremonies were attended by (from right to left) Christopher S. Willson (Army), Denise Anne Miller (Navy), and Richard J. Foch (Air Force).

Also attending the Awards Day ceremonies were the two Japanese student winners who will participate in the 26th ISEF which is scheduled for Oklahoma City this May.

Following the ceremonies, the itinerary included visits with Myron Kratzer, counsellor for Scientific Affairs, and U.S. Ambassador to Japan James D. Hodgson at the U.S. Embassy, and with COL Marshall and COL Herbert Duke, Public Affairs officer, U.S. Army, Japan.

On the trip home, the tri-service representatives stopped over at the Hawaiian Islands where they toured the University of Hawaii and cruised Pearl Harbor to the Arizona Memorial.

Army student representative Jewel Anne Jurovich was awarded the Japan trip for her ISEF exhibit, "Isolation and Characterization of an Antibacterial Agent From *Bacillus circulans*." Navy selectee Lawrence A. Wieldman displayed "Hydrodynamics and Littoral Current vs Floating Barrier."

NOBEL PRIZE AWARD ceremonies were attended by Christopher S. Willson (Army), Denise Anne Miller (Navy) and Richard J. Foch (Air Force). Escorting the students to Sweden were Science Service representative Miss Carol Levandoski and Russell Greenbaum, Office of Naval Research.

On their way to Stockholm, the students visited the Royal Institution in London, England's first scientific institution, founded in 1799. It was here, in a basement laboratory, that Michael Farraday conducted experiments that were responsible for development of electric power. The students also visited the European scientific research offices of the services they represented, and the Tower of London.

In Stockholm, the ISEF winners were met by Swedish students who served as escorts. They visited with Swedish Deputy Minister of Education Miss Lena Hjelm-Wallen, and were taken on a tour of the Swedish Parliament by Miss Anna Eliasson, a 26-year-old member of Parliament who has been serving since she was 20, the minimum age.

The students viewed Nobel Awards ceremonies attended by 28-year-old King Carl XVI Gustaf and the Royal Swedish Family. Among the 1974 Nobel Prize laureates was Alexander Solzhenitsyn, winner of the 1970 Nobel Prize in literature, who was unable to receive the award at that time.

While attending a luncheon at the home of U.S. Ambassador to Sweden Robert Strauz-Hupe, the students met American Nobel Laureate Prof. Paul Flory, winner of the chemistry prize, and a surprise guest, entertainer Danny Kaye.

Christopher Willson was selected by the Army as an ISEF winner for his exhibit titled "The Synthesis and ^{19}F Nuclear Magnetic Resonance Analysis of Fluorinated Oxetanes," Denise Anne Miller's exhibit was titled "Enhancement of the Activity of Cryogenically Treated Macrophases." Richard Foch was selected for "Kline-Fogleman Airfoil."

The Army, Navy and Air Force have joined in their top student winner of the ISEF to the annual Nobel Prize ceremonies in Stockholm since 1972.

Project Managers: The New Breed

Materiel Command Briefs Industry on Selection Criteria

"Project Managers: The New Breed," discussed by Sally Clements when she addressed the recent 2-day, top-level Army-Industry Atlanta II Conference, implies evolutionary changes in selection of 40-plus officers responsible for acquisition of major materiel systems.

The changes are factual and Mrs. Clements, assigned as assistant chief, Office of Project Management, U.S. Army Materiel Command, has considerable influence for effecting them.

Mrs. Sally Clements

In the wonderful world of women during these days of "liberation," Sally is somewhat of a phenomenon—the first female to achieve prestigious GS–15 status, over a decade ago, within AMC.

Sally also is president of the Federal Executive Institute Alumni Association, comprised of about 1,000 high-level executives, women and men—in federal agencies, academia and industry—who have graduated from the Federal Executive Institute. Virtually all are GS–16 or above (or equivalent).

Responsibilities of AMC project managers currently involve expenditure of about $1.5 billion annually. That is roughly 23 percent of AMC's total budget as the largest and most powerful organization of its type ever established.

AMC PMs are of two types: those chartered, by signature of the Secretary of the Army, to coordinate with other participating major commands; those with a charter reflecting interfaces internal to AMC, signed by the AMC commander.

Materiel development and acquisition projects may become project managed for various reasons—mandatorily when a project's funding involves $50 million Research, Development, Test and Evaluation or $200 million or more Army Procurement Authority as a major system of the Department of Defense. Decisions to start, stop or redirect the PM's efforts are made by numerous higher echelons of Department of the Army, Defense, or Congress.

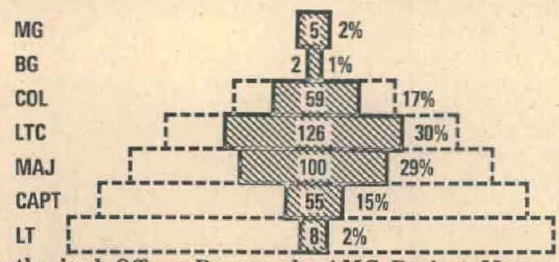
How well PMs are doing their job is evaluated during quarterly in-depth reviews, known as RECAPS, by the appropriate major subordinate commanders and by the AMC commander or one of his deputies. Evaluations of performance also are made by the Army Systems Acquisition Review Council (ASARC), and Defense Systems Acquisition Review Council.

Major decision points in the review process are: 1) project initiation and validation; 2) full-scale engineering development; 3) as necessary, low-rate initial production; and, 3a) full-scale production/deployment.

Some of the larger projects (currently 14) may also require Selected Acquisition Reports (SARS). These are made quarterly, reviewed at Department of the Army and Office of the Secretary of Defense level, and then forwarded to Congress.

A Department of the Army Program Review (DAPR) includes 20 major programs and is made quarterly to the Army general staff and secretariat. Selected systems, normally two to three a month, are given as formal briefings.

AMC established the PM program in 1962, soon after the AMC was activated in August as a merger of six of the seven Army Technical Services materiel acquisition functions.



Authorized Officer Personnel—AMC Project Managers

COL W. C. Rudd

COL R. B. Craig

MG R. J. Baer

Initially, 30 PMs were selected and the peak was reached with 68 PMs in 1968. Currently, the total is 43, including three recently established: HELS (High Energy Laser Systems); CH–47 Modernization Program (helicopters); and M60 Tank Production.

SELECTION CRITERIA FOR PMs. Actions to upgrade qualifications of Project Managers include the recent establishment of an Army Project Manager Selection Board. It must be comprised of no less than five general officers (currently seven), representing the Department of the Army and AMC.

MG George Sammet Jr., AMC Deputy Commander for Materiel Acquisition, is president of the board, four members of which are either currently serving or formerly served as PMs. The two DA staff members represent disciplines associated with materiel acquisition.

Board meetings usually will be held twice a year or more often to fill unprogramed PM vacancies. PMs are selected for 12 to 18 months in advance of scheduled requirements and the board of review of the records of eligible officers results in a rank-order listing. From this list the board identifies those best qualified for a position (principal, 3 alternatives).

Names of officers selected for PM assignments are published in a DA circular, along with those selected for command assignments. Duty as a PM is no bar to Command assignments. The same outstanding officers are considered by both Command and PM boards. Conflicts (selection by both boards) are decided on a case-by-case basis by the Department of the Army.

Indicative of the high caliber of those selected for PM assignments is the most recent list—only 10 selectees from about 4,000 colonels, of which 220 were identified as prime candidates Three have reported for duty and the other seven are scheduled for PM duty by the end of October.

Officers selected for PM assignments without prior experience in PM duty are assigned, to a different project than eventually intended, for training for up to six months. Training is given at the same duty stations as the jobs for which they have been selected.

For example, the new PM for M60 Tank Development, COL Dan Williamson, was assigned to the XM–1 Tank Project under PM MG Robert J. Baer. If possible, the selectee also is given a short period of overlap duty with the departing PM.

Emphasis on selection of top Army management talent for PM duty has included consideration of longer tenure assignments. PMs are now assigned for a minimum of three years. The goal is four, and one PM has served more than six years.

Army authorities recognize that the pool of available talent for PM office assignments currently is considerably smaller than is desirable. Only 355 officer spaces exist for 43 PM offices, with 66 already colonels or above. Efforts to get additional spaces are complicated by a shrinking total force.

Job descriptions for each PM position specify educational qualifications as well as military background and experience required. Under unusual circumstances, depending on the project and the candidate, a specific criterion may be waived.

Criteria for selection of PMs will, as soon as practicable, include graduation from Defense Systems Management School.

Established by the Secretary of Defense in September 1970 for all U.S. military forces, the DSMS at Fort Belvoir, VA, attracts top talent of the DoD and industry.

The PM long course, 20 weeks, is open to Army officers from captain through lieutenant colonel as well as civilians from industry and U.S. Civil Service. The short course, 3 weeks,

is the executive refresher course, attended by PMs as well as key civilian personnel from PM offices.

PMs and ranking civilians are eligible for a 2-week Industrial Financial Management Course at the DSMS. Another phase of the PM Career Development Program is training with industry, for which only 15 spaces are now approved.

During this year-long industrial assignment, the Army pays the officers' salaries and attaches no strings to industry on their use. Selectees are "the best young officers" obtainable and must have a master's degree in the "hard sciences." The goal is to give them understanding of how industry works.

Gun ballistics and how to design weapons and ammunition are skills not currently taught in either military or civilian educational institutions in the United States. Consequently, the PM training program offers two officers a year the opportunity to attend the United Kingdom Royal Military College of Science at Shrivenham, England.

The U.S. Army Materiel Command presently has a commissioned officer strength of about 3,500 and 1,500 of the positions they hold have been identified as potential PM development opportunities. Further development positions are being cited by the Department of the Army staff, the U.S. Army Training and Doctrine Command (TRADOC), and the Operational Test and Evaluation Agency (OTEA). Currently 320 of these officers have applied or been nominated and only 236 approved for the PM Career Development Program.

All of those who are selected for the program will be thoroughly prepared, before they assume that prestigious distinction, for what is termed "one of the most challenging jobs in the Army"—that of Project Manager.

13th National JSHS . . .

Renowned Nuclear Scientist Returns as Speaker

Internationally renowned nuclear scientist Dr. Edward Teller, who gave the keynote address at the first National Junior Science and Humanities Symposium in 1963 at the United States Military Academy, will address the 13th NJSHS, again at the Academy, May 1-3.

Dr. Edward Teller
(As pictured at 1963 NJSHS)

Long a staunch supporter of the Army JSHS Program, Dr. Teller spoke on "An Optimist's View in the Atomic Age" when he addressed the 1963 symposium. His subject this year has not been announced.

Another featured 13th NJSHS speaker will be Norman J. Doorenbos, chairman and professor, School of Pharmacy, University of Mississippi. His claims to distinction are numerous but one is believed unique. He is believed the only U.S. Government scientist licensed to grow "grass" for studies of physical and psychological effects of marijuana.

Programed as an innovation is a featured presentation by CPT James H. Steith, faculty member, Department of Physics at the U.S. Military Academy. When he speaks on "Science in the 1980s," he will become the first USMA faculty member to make a major address at the NJSHS. Two multipaper presentations also will be made by USMA cadets on "The Good Earth" and "Educating for Leadership."

Don Rollins, who has administered the National JSHS and the JSHS Program since 1969, said he has extended invitations to several other nationally known scientists to make presentations during the 13th NJSHS but had not received letters of acceptance at press time.

Five students will be selected by a panel of senior scientists, based on presentation of technical papers at the symposium, to participate in the 2-week International Science Fortnight in London, England. Thirty-seven students representing many regional JSHS conducted during the past year, are programed to report on their research accomplishments.

Foreign science student representation is anticipated from the United Kingdom, Canada and possibly the Federal Republic of Germany. A total of about 300 students, science students and regional JSHS regional directors will participate.

THE NEW BREED

Research Review Theme:

Earth's Geophysical Properties and Materials

"Geophysical Properties of the Earth and its Materials" is the basic research program theme scheduled for review by the Army Research Office, Durham, NC, at the Army Engineer Waterways Experiment Station, Vicksburg, MS, Apr. 22–23. One purpose of the review is to assure that basic research proposals supported through ARO are of scientific merit relevant to Army needs.

Papers concerning properties of soils and rocks, and the processes at and below the earth's surface which alter them, will be presented during the Military Theme Review.

Programed for presentations are scientists from WES; Cold Regions Research and Engineering Laboratories (CRREL), Hanover, NH; Engineer Topographic Laboratories (ETL), Fort Belvoir, VA; and the Construction Engineering Research Laboratory (CERL), Champaign, IL.

Academic investigators scheduled to review their research supported by ARO include Dr. C. V. Clemency, State University of New York; Dr. A. W. Fleming, University of Cincinnati; Dr. C. M. Sliepcevich, University of Oklahoma; Dr. A. L. Washburn, University of Washington; Dr. W. C. Isphording, University of South Alabama; and

Dr. R. A. Lohnes, Iowa State University; Dr. J. R. Steidpmann, University of Wyoming; Michael Foley, California Institute of Technology; Dr. Arvid Johnson, Stanford University; Dr. W. F. Brace, Massachusetts Institute of Technology; Dr. L. P. Long, Georgia Institute of Technology; Dr. R. D. Rechpien, University of Missouri. Dr. H. R. Pratt of Terra Tek, Inc., also will report on ARO-supported research.

"Geophysical Properties of the Earth and Its Materials" is a theme of major interest in the ARO terrestrial sciences support program. Biannual review of research in the terrestrial sciences, like reviews of other basic research themes under which ARO organizes much of the work it supports, allows Army and ARO-supported academic and industrial scientists to interact. Scientists from the U.S. Navy and Air Force, and from civilian agencies that have an interest in the research, are invited to attend the meetings.

Abstracts of all presentations and summaries of discussions will be published by ARO, under the title "Proceedings of the Chief Investigators Conference and Theme Review 'Geophysical Properties of the Earth and Its Materials.'"

Abstracts and summaries of the previous terrestrial sciences review, "Military Geographical Analysis," also are available upon request. For further information, contact the Geosciences Division, U.S. Army Research Office, Box CM, Duke Station, Durham, NC 27706, or call AUTOVON 395–3331/3332.

Traces Rapid Rise to 'Stand Tall' Advice

AMC Deputy Commander, GEN Woodrow W. Vaughan congratulates James Maclin Jr., accompanied by his wife Gail.

Texas or Oklahoma style, "stand tall!" means to stretch to the maximum a lean, broad-shoulder frame (somewhere between six and seven feet elevation) augmented by high-heeled cowboy boots and a broad-brimmed, high-crown hat—that is, tower as high as possible on the horizon.

The U.S. Army Materiel Command's newest supergrade GS–17 Civil Service employe, installed in February in a new position of assistant deputy and principal adviser to the Deputy Commander for Logisitcs Support, is James Franklin Maclin Jr. To him, at age 38, "stand tall" is a way of life.

Physically, he can elevate himself, by maximum effort, to 5' 10½" but his husky frame hints of his four years of football as an offensive guard and defensive linebacker on a gridiron scholarship at the University of Tennessee. Meanwhile, he was usually a Dean's List honor student.

One of his most memorable motivations came as a student at Central High School in Chattanooga when the principal advised him: "Don't let people beat you. Mentally, spiritually, physically—stand tall!" Earnest response to that admonition carried Maclin from a GS–7 rating as an industrial engineer in 1959 to his new AMC GS–17 position.

Along the way of that rather unusual advance, he acquired a wife, four children, an MS degree in governmental administration from George Washington University, and various honors, a total of 12 to be exact. Presenting agencies include the Army, Navy, Air Force, U.S. Government Accounting Office and the University of Tennessee.

Currently, he is working toward his doctorate in public administration, by night school classes, as he did while earning his master's degree. He also completed a correspondence course on "Management in the Department of Defense" at the Industrial College of the Armed Forces, Washington, DC.

During his climb up the governmental career ladder, Maclin served as a staff industrial engineer for the Army with the Military District of Washington, assistant technical director at HQ Air Force Systems Command, and deputy director, Inventory Analysis and Finance Division at HQ Naval Supply Systems Command, and two years prior to his new job as deputy director for supply, HQ AMC.

Like many an eminently successful man, Maclin credits his wife with an all-important role. He married Gail in his junior year at the University of Tennessee and her motto became: "Put hubby through college." That mission was complicated by three of their four children while he was studying for his master's degree. To him, that is "her gift of all gifts!"

USMA Assignment Points Up MRC Career Aid

Career opportunities for military officers and civilian employes at Army activities in the field of mathematics are pointed up by LTC James W. McNulty, new permanent associate professor of mathematics at the U.S. Military Academy.

LTC McNulty was serving as commander of the 3d Battalion (Specialist), 4th AIT (Advanced Individual Training) Brigade, Fort Leonard Wood, MO, as this edition of the *Army Research and Development Newsmagazine* went to press.

In preparation for assumption of his new assignment, he will enter advanced studies in pure mathematics at the University of Wisconsin Mathematics Research Center.

The MRC offers opportunities for extended periods of training as research residents to officers and civilian personnel at Army activities, in a program termed in-service education. Residency gives students the benefit of continuing and extended discussions with MRC staff members, and formal or informal study of problem areas. The research fellows continue to receive military salaries during the training period.

Further information regarding this program may be obtained from: Director, Mathematics Research Center, University of Wisconsin, 610 Walnut Street, Madison, WI 53706, or from the Mathematics Division, U.S. Army Research Office, Durham, NC 27706.

R&D Officer Coordinates Army/Navy Efforts

LTC S W. Patellos

Effective interface of ongoing research and development efforts between the U.S. Army and Navy is the assigned function of LTC Samuel W. Patellos, U.S. Army R&D liaison officer in the Office of the Deputy Chief of Navy Material for Development.

Enrolled in the Army Research and Development Officer Program, LTC Patellos' career includes four years with the Office of the Chief of Research and Development, HQ Department of the Army, redesignated as the Office of the Chief of RD and Acquisition effective May 20, 1974, and recently changed to Deputy Chief of Staff for RDA.

In his current assignment he can be reached by telephone, OX 21136/21138, or AUTOVON 22–21136/21138. His mailing address is: HQ NAVMAT, ATTN: MAT Code 03AR, Washington, DC 20360.

Army-Navy cooperation in joint service programs including exchange of technology information has resulted in mutual benefits in RDT&E and procurement activities. One example of Army adaptation of Navy technology is the Fuel Air Explosive used in the FAESHED system being developed by the Mobility Equipment R&D Command.

Headquartered in the Crystal City complex of Alexandria, VA, a suburb of Washington, DC, the Naval Material Command (NAVMAT) and its five major subordinate commands are similar in structure to those of the Army research, development, test, evaluation and procurement organization.

NAVMAT consists of the Naval Air Systems, Naval Electronic Systems, Naval Sea Systems, Naval Supply Systems and the Naval Facilities Engineering Commands. Seven project officers are assigned to HQ NAVMAT.

More than 20 scientific and engineering laboratories and 15 test and evaluation activities participate in accomplishing the NAVMAT mission. NAVMAT command laboratories are defined in a 3-dimensional matrix—technologies, platforms (aircraft and ships), and warfare areas.

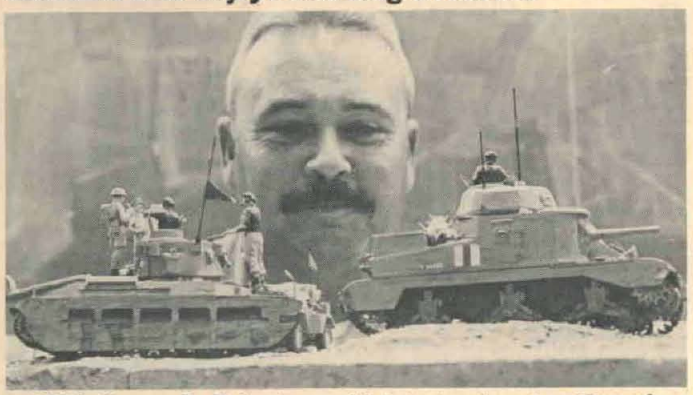
MICOM Initiates TSQ-73 Training Course

Initiation of a 19-week software training course for a broad spectrum of missile systems has been announced by the U.S. Army Missile Command, Redstone Arsenal, AL. About 20 students are in training to operate the TSQ–73 (Missile Minder), an air defense system that coordinates and controls U.S. Army Hawk and Nike Hercules missile battery operations.

The first 16 weeks of the course, taught at Redstone Arsenal, provide training relevant to air defense doctrine and the TSQ–73 system. The final three weeks are devoted to on-the-job training on the TSQ–73 computer at Van Nuys and Fort MacArthur, CA. Basic techniques taught in the course may be applied to future missile systems.

The Missile Minder program is directed by the project manager, Army Tactical Data Systems, U.S. Army Electronics Command. Data Systems Division of Litton Industries, prime contractor for the system, is conducting the MICOM course.

Redstone Man Enjoys Modeling Avocation



MSG James J. Robertson, chief instructor for Hazardous Devices training at the U.S. Army Missile and Munitions Center and School, Redstone Arsenal, AL, is a materiel modeler.

Robertson specializes in building painstakingly precise plastice minatures of World War II military vehicles and weapons.

Most of the 35-year-old artist's creations are 1/48 or 1/35 scale. Some of the largest tanks used during the 1940s have been reduced to the size of a pack of 100-millimeter cigarettes. Dioramas are often used to place the models in proper perspective and add realism.

A member of the Huntsville (AL) Scale Modelers Association, and the International Plastic Modelers Society of America, Robertson does a great deal of research swapping with his peers. Some of his best resource materials are old Army and weapons manuals published by modeling societies.

After completing all research, Robertson acquires his model, which comes out of the packing box in the form of a "tree," the way parts are removed from the mold. He paints it the first time while it still remains intact on its frame. He then proceeds with basic assembly, carefully trimming any irregular parts. Toothpaste, auto putty or commercial goop are quite often used to fill in holes or chips.

The factory-fresh appearance of the model after final assembly is not realistically good enough for Robertson, who explains: "In combat that condition just don't exist—at least not for long"—so he carefully damages his creations. He meticulously produces bullet holes, marks of deflected artillery rounds, and collision damage. Various types of grime also add to the desired weathered effect. Water colors often help to recreate effects of a particular environment.

Robertson really lets his imagination roam when designing the diorama. Paper mache and plaster of paris provide hills and gullies; his back yard yields rocks and vegetation.

Many of his settings are designed to be used more than once. One diorama was used for a German Army engineer unit, a reconnaissance unit, and currently as a battle scene depicting an encounter between German 75mm gunners and an American Sherman tank crew.

ABMDSC Engineer Relaxes in Creative Artwork

Whittling away the evening is a pleasurable and rewarding pastime for Richard Sanders, a mechanical engineer with the Ballistic Missile Defense Systems Command, Huntsville, AL.

Unlike many of the oldtime whittlers who sat on the corner to pass the time of day, Sanders does his best whittling while sitting in front of the television. He unwinds from the pressures of the day by grabbing his knife, a piece of wood, and oozing down into an easy chair. His wife has no objection to his hobby as long as he cleans up the mess.

Included among his creations are a totem pole, horses, oxen, birds, fish and elephants. He has even fashioned a solemn choir scene to complement Christmas decorations. Though he rarely sells any of his work, Sanders has given some of the art to his school-age sons for use at fund-raising bazaars.

His love of whittling dates back to his youthful days as an airplane modeler. Although his interest in airplanes has since disappeared, he feels that most people definitely need some type of hobby to keep them occupied.

In addition to whittling, he enjoys oil painting. Several of his still lifes are hanging in his home. He also does mechanical work on his four automobiles—two almost antiques.

Army VE Program Saves $138.4 Million

Cost reduction methodology applied in three major commands as part of the U.S. Army Value Engineering Program saved American taxpayers $138.4 million during FY 1974.

VE statistics for these agencies were cited during recent Department of the Army Awards for Exceptional Performance, presented by LTG John A. Kjellstrom, Army Comptroller, at ceremonies in the Pentagon, Washington, DC, as follows:

U.S. Army Ballistic Missile Defense Program Office. Seven contractor proposals and 14 in-house VE proposals accounted for savings of $18.4 million. This total exceeded the initial projected goal by more than 310 percent.

U.S. Army Materiel Command exceeded the assigned goal by more than 159 percent wth reported savings of $95.4 million. Contractors originated 616 VE suggestions while Army in-house atcivities contributed 1,535 proposals.

U.S. Army Corps of Engineers savings of $24.6 million were realized by adoption of 241 contractor change proposals and 226 Army in-house VE achievements. The goal was exceeded by more than 245 percent.

Noted Ecologist Wins $150,000 Tyler Award

What is believed to be the world's largest individual monetary prize, the $150,000 John and Alice Tyler Ecology Award, was presented recently to Dr. Ruth Patrick, chairman of the Board of the Academy of Sciences, Philadelphia, PA.

Administered by Pepperdine University, CA, the Tyler Award was established by the late John C. Tyler, cofounder of the Farmer's Insurance Co., and his wife Alice.

Described as one of the foremost authorities on fresh water diatoms (algae) studies, Dr. Patrick is credited with having had a profound impact in solving water pollution problems. She was selected from nominees of 15 countries as the 2nd annual Tyler Award recipient by a committee of scientists representing eight American universities.

AVSCOM Meet Considers Forging Processes

Objectives of a 3-year Manufacturing Methods and Technology program, entitled "A Study of the Mechanics of Closed-Die Forging," were considered in the first of a series of implementation conferences at the U.S. Army Aviation Systems Command (AVSCOM), St. Louis, MO.

More than 75 government and industrial representatives participated in discussion of technology information transfer and application problems and procedures for improving efficiency and productivity in design, and control of forging.

Included among formal presentations by industrial and contract agency representatives were: "Forging Technology and its Contribution to the Industry"; "Modern Equipment for Forging"; Instrumentation of Forging Presses"; "Predicting Load Energy in Forging"; and "Design and Manufacture of the World's Largest Mechanical Press."

Speakers from the sponsoring command (AVSCOM), and the supervisory agency, Army Materials and Mechanics Research Center (AMMRC), as well as the principal investigators related results of this program. An open panel discussion following the formal presentations allowed for an in-depth interchange between the audience and speakers.

Personnel Actions . . .

Dr. Bennett Named Principal Deputy to ASD (I&L)

Dr. John J. Bennett

Dr. John J. Bennett is the new principal deputy assistant to Arthur I. Mendolia, Assistant Secretary of Defense (Installations and Logistics). Dr. Bennett succeeds Hugh Witt, newly appointed head of the Office of Federal Procurement Policy in the Office of Management and Budget.

Prior to retiring from the Air Force in 1969, Dr. Bennett served as an assistant to the Assistant Secretary of the Air Force (Manpower) and to the Deputy Chief of Staff, Personnel, HQ USAF.

Dr. Bennett has assisted Aerospace/Defense contractors as a consultant in implementing the DoD Cost and Schedule Control Systems Criteria for project planning and control on major system acquisition contracts. He has also provided marketing and business analysis consulting services to the computer industry and several small electronic companies.

As a management consultant for Peat, Marwick, Mitchell and Co., Dr. Bennett helped establish the 20-week Program Managers Course at the Defense Systems Management School (DSMS), Fort Belvoir, VA. He also developed the 2-week DSMS Executive Refresher Course.

Dr. Bennett has a master's degree in business administration from Michigan State University and a doctorate in the same field from George Washington University. He also is a graduate of the Industrial College of the Armed Forces.

Dr. Buchsbaum Reappointed as DSB Chairman

Reappointment of Dr. Solomon J. Buchsbaum as chairman of the Defense Science Board, effective through December 1976, was announced recently by Secretary of Defense James R. Schlesinger, along with appointment of Dr. John D. Baldeschwieler as vice chairman.

Dr. Solomon J. Buchsbaum

Dr. Buchsbaum was appointed a member and chairman of the Defense Science Board on July 1, 1973, and is executive director of the Research, Communications Sciences Division, Bell Laboratories, Holmdel, NJ.

Dr. Buchsbaum has BS and MS degrees from McGill University and a PhD from Massachusetts Institute of Technology. He served on the President's Science Advisory Committee.

Twenty-four appointed civilian members compose the Defense Science Board, the Department of Defense's Senior Technical Advisory Board. Its chartered function is to advise the Secretary of Defense, through the Director of Defense Research and Engineering, on scientific and technical matters.

Guthrie Commands IX Corps, Promoted to LTG

LTG John R. Guthrie, deputy chief of staff under the Commander-in-Chief, Pacific, HI, has been assigned as commander, IX Corps/United States Army, Japan. He was promoted to lieutenant general effective Mar. 1.

LTG Guthrie was deputy commander for Materiel Acquisition, U.S. Army Materiel Command when he was assigned to the Pacific Command in October 1973. He had served with the AMC since 1968, initially as deputy director for Development and Engineering and then as director of RD&E.

Other assignments in recent years have included: assistant division commander, Maneuver and Support, 2d Infantry Division, Korea, 1967; director of Developments, Office of the Chief of R&D, HQ DA, 1966–67; Requirements and Development Division, Office of the Joint Chiefs of Staff, 1965–66; commander, 602d Field Artillery Bn, Fort Sill, OK.

LTG Guthrie has an AB degree in history from Princeton University. He is a graduate of the Army Command and General Staff College, and the National War College.

LTG John R. Guthrie

Dr. Statler Chairs NATO Flight Mechanics Panel

Dr. Irving C. Statler, who heads the Ames Directorate, U.S. Army Air Mobility R&D Laboratory (AMRDL), Moffett Field, CA, has been elected chairman of Flight Mechanics, one of eight panels of NATO's Advisory Group for Aerospace R&D.

AGARD was established as a NATO Military Agency in 1952 to provide scientific and technical support relating to aeronautical research and development. Panel members recommend uses of NATO R&D capabilities, provide assistance to military committees and stimulate technical advances through international cooperation.

NATO nations provide more than 600 scientists and engineers annually to address current problems and issues with the alliance relating to aerospace R&D.

Ruane Selected as OEO Deputy Director

Thomas P. Ruane, an economic adjustment specialist with the Office of Economic Adjustment (OEA) since 1970, has been appointed deputy director of the OEA, Office of the Assistant Secretary of Defense (I&L).

In July 1971 he was selected as special assistant to the OEA director, and in March 1973 became director of Program Development, with responsibility for formulating economic recovery policies for communities affected by DoD changes.

Ruane directed the OEA staff in initial community visits, follow-on research and program development to analyze the DoD impact, and effecting procedures to offset this impact.

Before joining the Department of Defense, Ruane was associated with the Institute of Public Administration at the Pennsylvania State University. He served in the Marine Corps during the Vietnam War.

Ruane holds a master's degree in public administration from Penn State University and is completing studies in public administration at George Washington University.

MRC Lectures to Address Variations/Control Theory

Fifteen invited lectures dealing with "Calculus of Variations and Control Theory" will be presented during a Sept. 22–24 symposium at the Mathematics Research Center, University of Wisconsin, arranged to honor retiring Prof. L. C. Young.

Members of the program committee include Profs. D. L. Russell (chairman), T. J. Higgins, D. J. Patil, V. Rideout and D. Rudd. A detailed program and information on registration and accommodations will be available about July 15.

Requests for the program and any additional inquiries may be directed to Prof. D. L. Russell, Mathematics Research Center, University of Wisconsin-Madison, 610 Walnut St., Madison, WI 53706.

Air Force 'Eagle' Sets New World 'Time-to-Climb' Record

All existing world time-to-climb aircraft records are believed to have been broken recently during tests of a U.S. Air Force F–15 "Eagle" at Grand Forks AFB, ND. The U.S. Navy and the Soviet Union previously were credited with the eight records.

The National Aeronautics Association officiated during the test flights. However, the new figures must be verified by the Federal Aeronautics International in Paris, France, before declared official. The F–15 is the first Air Force operational fighter aircraft with a thrust-to-weight ratio greater than one, thus enabling it to accelerate even while in a vertical climb.

The F–15 is the first Air Force operational fighter aircraft with a thrust-to-weight ratio greater than one, thus enabling it to accelerate even while in a vertical climb.

Edgewood Chemist Shows . . .
Opportunities for Career Advancement

Susan K. Luckan

Advancement opportunities for women in Army science, particularly those fresh out of universities with degrees in fields related to research and development, are attractively illustrated by Susan K. Luckan.

Mrs. Luckan was exposed initially to Federal Civil Service while assigned as a physcial science aid at Edgewood Arsenal, MD, during the summers of 1967–68. She became a permanent employe in 1969.

After graduating from the College of Notre Dame in Maryland with a bachelor of science degree in chemistry, she was assigned to the Edgewood Arsenal Weapons Development and Engineering Laboratory. Currently she is working in the Defense Systems Division, Directorate of Development and Engineering.

Included among published technical papers reporting on her studies are "Analytical Procedures for Ambient Sulfur Hexafluoride," "Reaction of Carbon Monoxide with Impregnated Carbons," and "Reaction of Carbon Monoxide with Whetlerite Charcoal." She was consulted recently by the Army Environmental Hygiene Agency (AEHA) on the use of sulfur hexafluoride as tracer material in an air quality optimization study. She also has presented papers for the U.S. Army Medical Environmental Engineering Research Unit.

Among the honors she has received is a Special Act Award for participation as a science instructor in an Upward Mobility Program, and an Achievement Award for successful completion of a sulfur hexafluoride project and contributions to a pesticide disposal project.

Mrs. Luckan is a member of the American Chemical Society, Water Pollution Control Federation, American Defense Preparedness Association, and the National Honor Society. As a university student, she was a finalist in the National Merit Scholarship Program.

Environmental Concern . . .
Leads to Rewarding Career for APG Chemist

Long before she became an environmental scientist at the U.S. Army Test and Evaluation Command (TECOM), Aberdeen Proving Ground, MD, JoAnn Carroll was deeply involved in doing her bit to maintain viable environmental quality by protective or corrective action.

Mrs. JoAnn Carroll

Assigned to TECOM's Environmental Quality Office, Mrs. Carroll embarked on a career in science by happenstance. As a high school student she had no intention of becoming a scientist. She took a physics course during her senior year only because of academic requirements.

"I discovered that science is intriguing," she says, "and decided to major in physics in college, but the school I selected offered a degree only in chemistry."

Mrs. Carroll received her undergraduate chemistry degree from Texas Women's University. Her MS degree in physical chemistry was earned from the University of Delaware, where she is also completing requirements for her PhD.

Her current Army research involves monitoring the environmental impact of TECOM operations at 14 installations and activities. Recently, she has been preparing and staffing Memorandum 200–1, dealing with environmental quality.

Another research area which is attracting Mrs. Carroll's interest is solar energy investigations. "It is a hope of mine," she says, "that a program somewhat like the space program will be developed to make our country independent of foreign sources of fuel."

Previously employed as a research chemist in APG's Coating and Chemical Laboratory, disestablished during the 1973 widespread Army reorganization, Mrs. Carroll received a patent for a metal panel holder used for securing test panels for cleaning. Her technical paper on "Evaluation of Corrosion Inhibitors," derived from her master's degree thesis, is scheduled to appear in *Corrosion*, a publication of the National Association of Corrosion Engineers.

Mrs. Carroll is a member of the American Chemical Society, National Association of Corrosion Engineers, American Society for Testing Materials, and the Institute of Environmental Sciences. As a member of Toastmasters International, she recently spoke on the defensive role of the contemporary scientist, and also is a member of the National Organization for Women (NOW).

An avid believer in natural food diets, she enjoys preparing for her husband, 15-year-old son and 12-year-old daughter gourmet meals from mushrooms and other delicacies that grow wild on the forested four acres surrounding their home. Additionally, she and her husband dabble in making wine from grapes in their vineyard. They also have six bee hives to produce honey for home cosumption. Her husband is a mathematician in the Army Materiel Systems Agency.

Reader's Guide...

New Book Stresses Support of American Soldier

An examination of the behavioral characteristics, attitudes and public image of the American soldier is the subject of a recent published book, titled *Against the Tide—An Argument in Favor of the American Soldier.*

Authored by Army LTC Peter B. Petersen, this publication is the result of six years of research, including information gathered from more than 4,000 soldiers. The subject matter is primarily a response to critics of the Army. LTC Petersen solicited the attitudes of soldiers before, during and after their exposure to the military environment.

Among the key topics discussed are: "What makes some men choose the Army as a career?," "How do their attitudes differ from those of civilians?," "What attitudes must the soldier develop to make it through Officer Candidate School?," "Do these attitudes remain after he leaves training?," and "Does combat twist the infantryman?"

LTC Petersen emphasizes that a sincere effort should be made to dispel many of the negative misperceptions of the American soldier. Intensive training, he believes, should encourage racial harmony, result in rejection of drug experimentation and crime in the barracks, and stimulate development of pride in teamwork and respect for discipline.

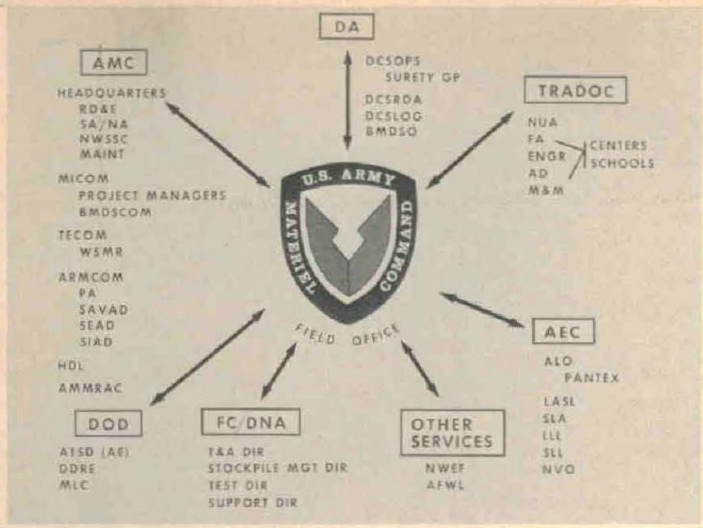
Selection and training of recruits to become infantrymen, the author states, should stress psychological fitness; give priority to individuals who are most likely to reenlist; and development of Army policies and procedures to accommodate harmoniously and effectively the various ethnic and status groups within the Army environment.

EPA Publishes R&D Research Bibliography

A cumulative list of about 1,100 reports issued by the U.S. Environmental Protection Agency's Office of Research and Development is now available in a new publication.

Titled *Indexed Bibliography of Office of Research and Development Reports*, the publication lists reports from 1966 through June 30, 1974, grouped into six categories: "Environmental Health Effects Research," "Environmental Protection Technology," "Ecological Research," "Environmental Monitoring," "Socio-economic Environmental Studies," and "Miscellaneous."

Copies of the bibliography, including source information on all reports, may be obtained from: Publication Staff (RD–674) Office of Program Management, Office of Research and Development, Environmental Protection Agency, Washington, DC.



AMCFO at Kirtland AFB

Nuclear Weapons R&D Liaison

Maintaining an effective information interchange between the U.S. Army and the nuclear development community pertinent to weapons related activities is a primary function of the U.S. Army Material Command Field Office (AMCFO), Kirtland Air Force Base, Albuquerque, NM.

AMCFO is a Class II Activity functioning under operational control of HQ AMC's Research, Development and Engineering Directorate. AMCFO Commander COL Jerry A. Berrier, a veteran ordnance officer, has a staff of four military and three civilian personnel.

AMCFO is collocated with the Air Force Special Weapons Center; AF Weapons Laboratory; Naval Weapons Evaluation Facility; Albuquerque Operations Office of the Energy R&D Administration (ERDA); Sandia Laboratories (a prime contractor to ERDA); and the Defense Nuclear Agency Field Command.

Further favoring accomplishment of AMCFO's assigned activities is the availability of the Los Alamos Scientific Laboratory, 90 miles away, and the Lawrence Livermore Laboratory Complex, 2½ hours distant by air.

Privy to considerable advance information through this complex of scientific resources, which allows rapid response to matters of AMC concern, AMCFO provides on-site AMC and Army representation at the "hub" of the nuclear development community.

Potential problem areas, ranging from the technical to the general, often involve AMCFO participation in feasibility studies, joint task groups, design review and acceptance groups, joint configuration working groups, the Joint Atomic Weapons Publication System, product change proposals and weapon retrofits, and joint ERDA/DoD project officer groups.

Preceded by the Ordnance Liaison Office (1952) which became the Special Weapons Command LO (1959) and the Army Munitions Command LO (1962), AMCFO has since 1963 routinely provided an effective and necessary liaison link between ERDA(AEC) and Army agencies. Typical actions include weapon system agreements and procedures, and product schedules and quality assurance activities.

AMCFO's advantageous collocation with other major agencies dealing with similar areas of concern facilitates monitoring and reporting of a wide range of activities while they are in concept or early development stages, and thus to effectively serve U.S. Army interests.

RESEARCH CONTRACT. A 3-year contract to study workable cancer patient employment problems has been awarded the Human Resources Research Organization (HumRRO) by the National Cancer Institute. This information will be collected and analyzed to provide potential employers with knowledge on how best to hire and place cancer patients.

Army R&D—10 Years Ago

The Army R&D Newsmagazine reported on . . .

Army Unveils MUST at Brooke Medical Center

MUST (Medical Unit Self-contained Transportable), the Army's radically new concept of field hospitalization, was demonstrated to several hundred key Department of Defense (DoD) and federal medical, civil and industrial leaders at Fort Sam Houston, TX.

Top-level DoD and Army officials who witnessed the demonstration included Secretary of the Army Stephen Ailes, Assistant Secretary of the Army (R&D) Willis M. Hawkins, The Surgeon General of the Army LTG Leonard D. Heaton, U.S. Army Combat Developments Command Commander LTG Dwight E. Beach and Army Deputy Chief of Staff for Personnel LTG James S. Richardson.

Army Relays 7 TV Channels on Laser Beam

Successful use of a single pencil-thin laser light beam to relay simultaneously the signals received from all seven of the television channels broadcast from New York's Empire State Building was announced by the U.S. Army Electronics Command, Fort Monmouth, NJ.

The achievement was viewed as a significant step toward realizing the potential of lasers to relieve overcrowded portions of the radio spectrum, thereby providing a needed enlargement of communication capabilities for military and public use.

Clearinghouse for STI Dedicates New Headquarters

The Clearinghouse for Federal Scientific and Technical Information (formerly the Office of Technical Services) of the National Bureau of Standards, U.S. Department of Commerce, dedicated its new facility near Springfield, VA.

At the dedication, U.S. Senator John L. McClellan (AK), who heads the Senate Committee on Government Operations, and Secretary of Commerce John T. Connor commented on the govrnment's awareness of science's role in the nation's development and stressed the importance of the Clearinghouse in the dissemination of scientific and technical information.

Drug Resistant Malaria in Asia Prompts Research

Increasing incidence of drug-resistant malaria among U.S. and allied forces in Southeast Asia has prompted a marked acceleration of the U.S. Army's malaria research program.

Through an acceleration of the malaria research program, U.S. medical research personnel hope to find means to cope with a previously unrecognized type of falciparum malaria that is not responding promptly to any known prophylactic or therapeutic measure. The ultimate solution will depend upon mastering the fundamental mechanisms of the drug resistance.

NASA, Army Approve Joint Research Plan

An agreement was announced providing for Army participation directly in support of National Aeronautics and Space Administration (NASA) low-speed aeronautical research in which a mutual interest exists.

Joint use and support of NASA facilities involved at the NASA Ames Research Center, Moffett Field, CA, is expected to achieve tangible economies and make possible more comprehensive study of aerodynamics problems of subsonic aircraft, particularly the V/STOL aircraft of primary Army interest.

NATO Joint Field Trial on Air Defense Site Camouflage

By CPT James R. Carney

CPT JAMES R. CARNEY has been active in countersurveillance R&D at the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA, since 1968. Assigned as the principal United States representative to NATO panel AC/243, Research Subgroup 1 during the feasibility study. He is now the U.S. senior technical representative.

CPT Carney (USAR) has a BS degree in civil engineering from the University of Arkansas, an MS degree in engineering management from the University of Missouri at Rolla, and is a registered professional engineer in Virginia. This article was written during a 2-week active duty assignment to the International Development Branch, HQ AMC.

James R. Carney

The NATO Joint Field Trial (JFT) on Air Defense Site Camouflage was conducted to collect quantitative field data which would be directly applicable to a European environment. Realistic field testing of the effects of large countersurveillance applications requires many resoures. The concept of a joint test was proposed by the NATO Research Study Group on Camouflage and Deception (RSG-1), subsidiary to the Special Group on Land-Based Air Defense, Defense Research Group (AC/243).

The project was initiated in June 1971. During August through March 1972, an Ad-Hoc Planning Group composed of seven NATO countries completed a feasibility study funded by NATO.

Based on the ensuing feasibility plan, five countries (Denmark, Federal Republic of Germany, United States, United Kingdom, Netherlands) signed a Memorandum of Understanding to participate in the detailed planning phase, January through August 1973. An Addendum was signed by the same five countries in September 1973, formally approving the Implementation Phase (November 1973 through January 1976) including services in kind. Major implementation activities included conduction of the trial, national analysis of data, and final report preparation. Objectives of the JFT are:

- Analysis of the vulnerable properties of air defense systems to include ultraviolet, visual, near infrared, far infrared and radar.
- Evaluate military effectiveness of existing camouflage material and techniques on the existing (Hawk) air defense sites, and various locations and configurations for future AD systems.
- Determine the potential camouflage measures that can be applied to air defense installations, and recommend improvements. Test available camouflage models, photo simulation techniques, and photointerpreter analysis for further development.
- Develop recommendations for areas of future research required to reduce the vulnerability of air defense sites, and establish guidelines for nations on which programs can be based.

The JFT over-all objectives are controlled by a AC/243 RSG/1 management group and a Joint Field Trial staff is responsible for detailed planning and trial implementation. The mission of this multinational trial team is to plan and conduct tests that will meet listed objectives within the scheduled time frame.

The United States furnished five personnel to the JFT staff, provided by the Army Mobility Equipment R&D Center (MERDC), Army Materiel Systems Analysis Activity (AMSAA), the Army's Natick (MA) Laboratories, and U.S. Air Force Europe (USAFE). MERDC provided the Senior Technical Representative, who has the responsibility to direct and coordinate all technical matters, and the Federal Republic of Germany (FRG) assigned a Project Director charged with the over-all operational responsibility.

The test sites that were used in the implementation phase are located in Germany, and are an integral part of the FRG Air Defense System. The main site, occupied by a German Hawk unit deployed in a permanent installation, is laid out according to NATO specifications. The additional mobile SAM Site occupied various positions in the surrounding countryside during the trial to date and its' proposed equipment was simulated by wooden mockups.

Emphasis was given to the operational/mission requirements of the equipment, and the influence of seasonal changes on the background, in finalizing a camouflage concept for the main site. The plan included several stages or levels to measure the effectiveness of various degrees of camouflage. Camouflage materials and techniques effective in the visual, near infrared, far infrared and radar bands were incorporated.

Additional mobile SAM Site equipment was painted olive drab and covered with camouflage nets in a tactical manner. The degree of camouflage nets depended upon the hardware being deployed in the open or adjacent to a tree line. This camouflage condition was the same for all levels listed under JFT objectives. The only controlled variables were the site locations, equipment configurations and tactical deployment.

Four camouflage levels were incorporated into the final plan for the main site. During the first level, baseline, no camouflage was applied. Level two was tonedown—to suppress brightness contrast with tonedown materials, using primarily paint on roadways, buildings, and fences.

Level three investigated the effects of decoy on target detection and weapon release. Decoys of the Hawk radars, missile launchers, and battery control center were employed in an open area.

Level four was the full camouflage level. Tonedown techniques of level two and camouflage measures were used to extend and blend the surrounding physical characteristics (textures, patterns, colors) into the site.

Approximately 100 simulated fighter bomber attack missions and 50 reconnaissance missions were flown during each camouflage level. The attack missions were split 50-50 between the United States and Federal Republic of Germany.

The highest priority in the flight plan was given to the visual part of the electromagnetic spectrum. A key part of this effort was establishment of the flight profiles and realistic briefings.

The attack profile selected for the tests was a low-altitude approach, pop-up, and dive attack. Two attack directions were selected to take into account the different sun angles. A tactical briefing was prepared, including photographs of the target and prominent ground landmarks and coordinates.

Scientific instruments provided by participating nations were used to measure the environmental and physical variables that affect detection and identification in the visual, infrared and radar bands.

A small-scale trial was performed in March 1973 to evaluate the plan for the trial and collect winter data. The main emphasis was placed on testing the tracking system, examining different camouflage materials and techniques, and evaluating the existing flight parameters.

The Summer Trial was conducted May through September 1974. Each level contained physical and reference measurement periods and a flight period. Reference measurements were made in parallel with the flight missions. Physical measurements were performed mainly during the last week of camouflage installation.

Approximately 90 percent of the raw data has been sent to participating countries for national analysis, and distribution. A final report is due in December.

The Joint Field Trial has been, to date, the largest test and evaluation effort in camouflage since World War II, is on schedule, has stayed within its financial restraints, and has met all test objectives.

Benefits of this trial to NATO are:

- A large amount of quantitative data is provided upon which recommendations to North Atlantic Organization can be provided for the design and camouflage of existing and future AD Systems.
- Accurate evidence is given as to the technical and military performance of current national camouflage materials, absolutely and compared to other nations.
- A means is developed to gain first-hand experience and insight into the thinking/doctrine/techniques of the top NATO camouflage and deception staffs.
- Quantitative data are collected upon which guidelines for future research in countersurveillance can be established.

GEN Deane Assumes Command of Army Materiel Command

Howard H. Callaway
Secretary of the Army
Extends congratulations

FOUR GENERATIONS OF DEANE FAMILY are represented in this picture. Shown (left to right) are Richard Deane, one of GEN Deane's five children; Nancy Deane Kreitler, holding grandson Deane, with husband Carl; Miss Lisa Deane, daughter; MG John R. Deane, Sr.; John R. Deane IV, grandson; Mrs. Deane, GEN Deane and mother; Margaret Deane, daughter; Vice Admiral Douglas C. Plate, brother-in-law, and Mrs. Plate; Robert Deane held by daughter-in-law, and John R. Deane III. In his acceptance-of-promotion and assumption-of-command comments, GEN Deane paid tribute to numerous friends of long standing who turned out to honor him. One of the human interest acknowledgements was the role of BG Charles H. Royce (USA, Ret.), shown at lower right, and his wife who now reside in Washington, DC. GEN Deane recalled that the Royces were almost life-long friends of his father (they served together at the Infantry Center, Fort Benning, GA, and later, in the 1930's, with the 15th Infantry in China.) Mrs. Royce taught the new AMC Commander the rudiments of ballroom dancing at Fort Benning and the general taught him the fundamentals of polo. GEN Deane played on the U.S. Military Academy polo team.

GEN Fred C. Weyand
U.S. Army Chief of Staff
Swore in New 4-Star General

"I LIKE YOUR OFFICE, Grandfather" is evident as Robert Deane makes the rounds on an inspection tour.

OLD FRIENDS MEET as BG Charles H. Royce clasps the hand of a man he remembers from over 45 years ago.

Ceremonies to install GEN John R. Deane Jr. as commander of the U.S. Army Materiel Command, concurrent with promotion to 4-star rank as successor to GEN Henry A. Miley, involved Secretary of the Army Howard H. Callaway, Army Chief of Staff GEN Fred C. Weyand and numerous high-ranking dignitaries.

GEN Deane was Deputy Chief of Staff for Research, Development and Acquisition until GEN Miley retired after serving since Nov. 1, 1970. Currently employing 119,400 civilians and 10,800 military personnel, AMC includes 66 military installations and 73 activities.

Among GEN Deane's responsibilities are the management of an annual budget of about $10 billion for research, development, test, evaluation and acquisition of military personnel; also, an inventory of about $12 billion in depots within the Continental United States plus about $17 billion in ammunition and other major items in the hands of troops or at oversea depots.

More than 80 percent of Army in-house laboratories and support facilities are under AMC management. The Chief of Engineers, the Surgeon General and the Deputy Chief of Staff for Personnel control the remainder of the laboratories.

PROMOTION CEREMONIES in GEN Deane's HQ AMC offices were hosted by Army Chief of Staff GEN Weyand, who paid high tribute to AMC achievements and ongoing programs under GEN Miley. GEN Weyand shared with Mrs. Deane in pinning the new AMC commander's insignia of rank.

Army Adjutant General MG Verne L. Bowers read the promotion orders and AMC Deputy for Materiel Acquisition MG George Sammet Jr. directed ceremonies, attended by four generations of the Deane family including MG J. R. Deane Sr.

Additional invited dignitaries included Army Vice Chief of Staff GEN Walter T. Kerwin, Jr., Under Secretary of the Army Herman R. Staudt, Assistant Secretary of the Army (R&D) Norman R. Augustine, ASA (I&L) Harold L. Brownman, ASA (Manpower) Hadlai A. Hull, Deputy Under Secretary of the Army for Operations Research Dr. Wilbur B. Payne, and LTG Woodrow W. Vaughan, AMC deputy commander.

Other high-ranking invitees included six General Staff 3-star and three 2-star generals, and personal friends of GEN Deane. Among the latter were former Assistant Secretary of Defense Dr. Eugene Fubini, former Secretary of the Army Frank Pace, GEN Bruce Palmer (USA, Ret.), former Under Secretary of the Army Kenneth E. BeLieu, New York Governor Hugh L. Carey, and Senator Thomas J. McIntyre.

GEN Deane's recent deputy, LTG Howard Cooksey, promoted Mar. 10 to 3-star rank to succeed him as Deputy Chief of Staff for Research, Development and Acquisition, was in attendance. AMC military staff directors and top-level civilian employes also were on the guest list.

GEN DEANE'S BIOGRAPHY. Graduated in 1942 from the United States Military Academy at West Point, NY, the new AMC commander became a highly decorated Infantry officer in World War II, Korea and Vietnam. He served on the Military Armistice Commission in Korea as chief of plans.

During the Vietnam War, after serving as assistant commander of the 1st Infantry Division, he was commanding general, 173d Airborne Brigade and then was commander of the 82d Airborne Division at Fort Bragg, NC.

Other assignments have included: deputy director, Defense Intelligence Agency, immediately prior to being selected as Army Chief of Research and Development; Deputy Assistant Chief of Staff for Force Development (July-August 1972); director, Defense Special Projects Group, 1971-72; director, Defense Communications Planning Group, 1970-71; director, Doctrine and Systems, Office of the ACS for Force Development, 1967-68; and executive assistant, Office of the Director of Defense Research, and Engineering, 1962-65.

GEN Deane has a master's degree in business administration from George Washington University (1964), has completed the Advanced Management Studies at Harvard University (1963), and is a graduate of the Armed Forces Staff College and the National War College.

Among decorations bestowed upon GEN Deane are the Distinguished Service Cross with Oak Leaf Cluster, Distinguished Service Medal with OLC, Legion of Merit with 3 OLC, Air Medal, Army Commendation Medal, and the Purple Heart.