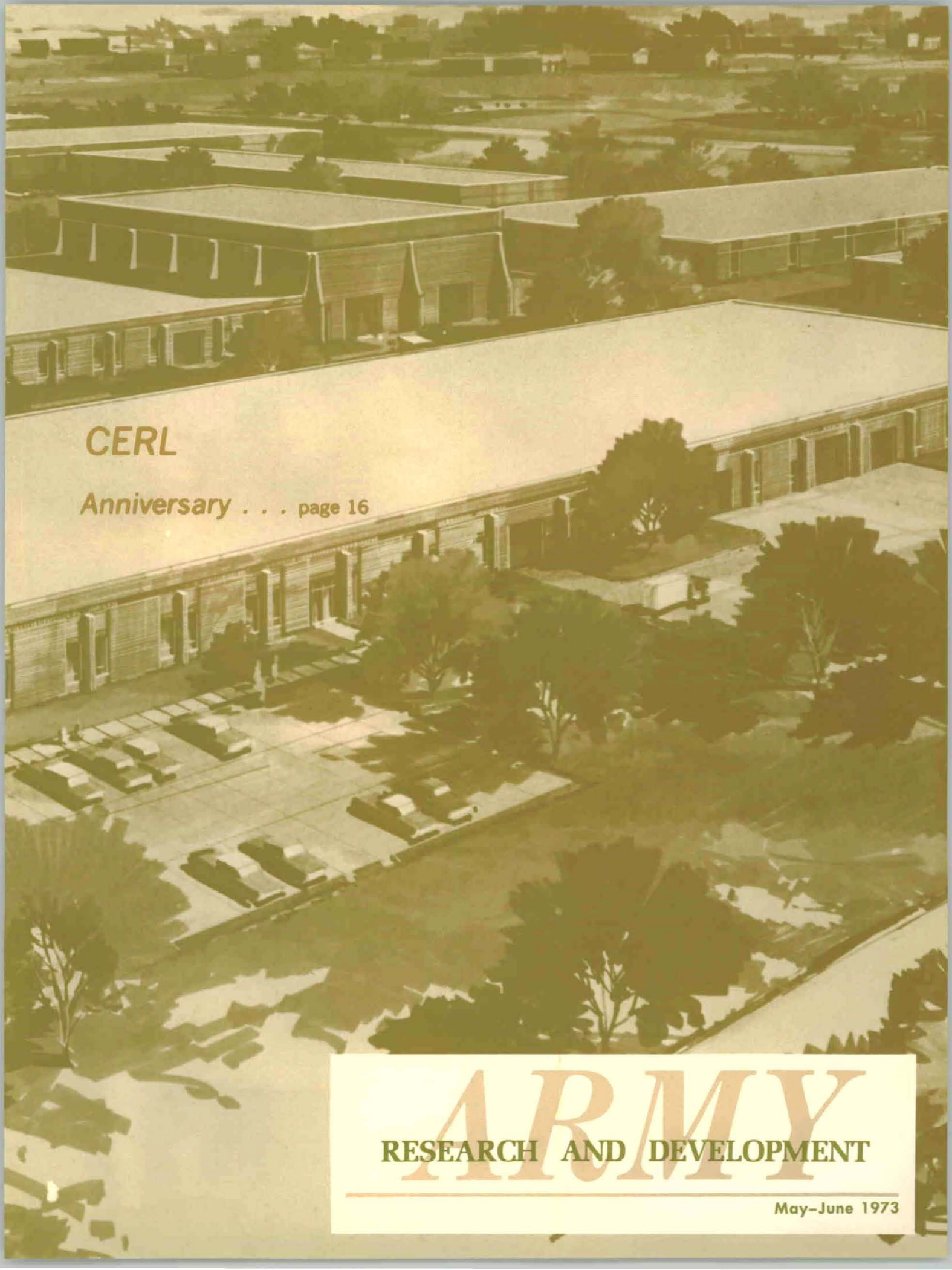


CERL

Anniversary . . . page 16

ARMY RESEARCH AND DEVELOPMENT

May–June 1973

SPEAKING ON . . .

Improving National Defense Posture Within Severe Budgetary Constraints

LTG Robert E. Coffin

Attendees at a recent Defense Management Symposium in New York City listened to Deputy Director of Defense Research and Engineering (Engineering and Management) LTG Robert E. Coffin, former Army Deputy Chief of Research and Development, present a penetratingly thoughtful consideration of a difficult problem—that of implementing policies to achieve an improved national defense posture within severe budgetary constraints.

I am very pleased to have this opportunity to discuss with you our Defense needs, problems and projections in terms of our budget. We in the Department of Defense always welcome the chance to engage in meaningful discussions with associations, companies or individuals engaged in the vital task of supporting our Armed Forces.

The better you understand our requirements, the factors affecting our decision-makers, and the better we understand your requirements and problems, the better each of us can solve his part of our mutual problem—how to improve our national defense posture.

To set the stage for our question and answer session, I would like to spend about a half-hour discussing our Fiscal Year 1974 funding request as compared to past budgets, examining some of the factors influencing our defense systems planning, and taking a look at the future.

I think we all recognize that the President's efforts to achieve a generation of peace have substantially reduced the threat of war. However, we must not interpret this as justification for slackening our vigilance or reducing our military strength. Other nations are continuing to expand their military capabilities, and we do not intend to allow ours to falter. As always, military strength remains a necessary ingredient of continued successful negotiations.

The technological threat we face has not lessened. Our need for new and better defense systems is greater now than ever before. In the sixties, the Soviets caught up with us in nuclear-war technology and surpassed us in numbers of long-range missiles. At sea, they have already overtaken us in the size of their attack submarine forces; their surface ships use modern turbine engines and advanced missiles; they are building their first aircraft carrier; and they have good long-range ocean surveillance. The Soviets' land and air forces are steadily improving, and they are providing large quantities of new equipment to their allies.

The weapon systems we develop to counter these capabilities cost more today than ever before. The systems are far more complex than those of even a few years ago. At least half of the increase in the cost of defense systems stems directly from demands for improved performance.

Aircraft fly faster and higher; missiles are more accurate and more reliable; weapons fire more rounds per minute; and ships literally fly on top of the ocean. Along with these gains in performance and the rapid growth in the complexity of our equipment, the cost of manpower and maintenance is steadily rising.

The total DoD budget request for FY 1974 is $85 billion, as compared to $80.9 billion appropriated in FY 1973 and $77.7 billion for FY 1972. Table 1 depicts the current status of funds reflected in the President's Budget for FY 1972–1974. Some interesting financial data which are not evident in the chart itself are as follows:

TABLE 1
FY 1974 Defense Budget ($ Millions)

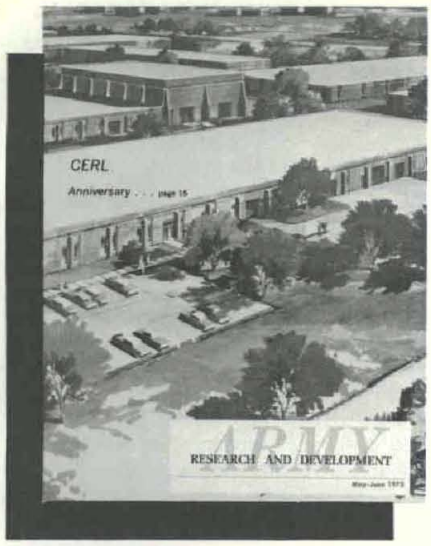
Appropriation	*FY 1972*	*FY 1973*	*FY 1974*
Military personnel	23,147	23,249	22,649
Retired military personnel	3,889	4,438	4,706
Operations and maintenance	21,242	22,179	22,405
Procurement	18,758	18,622	18,806
RDT&E	7,584	8,020	8,555
Military construction	1,227	1,559	1,892
Pay increases/Retirement reform	–	780	3,275
Other	1,884	2,100	2,737
TOTAL DoD	77,731	80,947	85,025

- Total obligational authority (TOA) requested for FY 1974 is $85.0 billion, an increase of $4.1 billion over FY 1973. Of this increase, $3.2 billion (or 78 percent) represents the increased cost of military, civilian and retired pay. The balance is largely accounted for by the inflationary cost of materials and services.
- Reflected in this chart are other program increases of approximately $1.3 billion in investment areas for baseline forces—procurement, research, development, test and evaluation (RDT&E), construction and family housing. This is consistent with our need to modernize these baseline forces and to maintain the high level of our technology base essential to retain technological superiority.
- The FY 1974 outlay of $79 billion for Defense represents 28.4 percent of the total federal outlay—a reduction from 29.0 percent in FY 1973. Even more startling is the fact that this is a reduction of 14.1 percentage points from the FY 1968 peak of 42.5 percent. *It is the lowest percentage since FY 1950.*
- Operating funds will increase by only $2.6 billion in FY 1974 despite pay cost increases of $3.2 billion.
- In terms of the dollar's constant buying power over the years, the Defense TOA for FY 1974 is $2.7 billion less than the prewar FY 1964 level.
- Again speaking of the dollar's actual buying power rather than cold numbers, the Defense outlay of $79 billion for FY 1974 will be $8.7 billion below the prewar level. As equipment to modernize our forces is received, as research programs advance and more and more construction projects are completed, the lag between TOA and outlay will narrow. In these investments, there is a relatively long lead time between approval of the TOA and expenditure of funds to complete each program.

This is how today's trends compare with the situation in 1964, the last truly prewar year.

- The total outlay for defense has increased by $26 billion, of which $21 billion goes for salaries. Salaries have risen to such an extent that, even with the added $21 billion, we are paying 326,000 fewer people than in 1964!

(Continued on page 20)



ABOUT THE COVER . . .

Dedicated July 25, 1969, in a research park adjacent to the University of Illinois, with which it is affiliated under a lease and operation agreement, the U.S. Army Construction Engineer Research Laboratory (CERL) is preparing for its fourth anniversary. Impact of CERL in advancing construction technology and developing new materials to produce better buildings at minimal cost is reported to be "a rapidly growing force." Although basically military-oriented, CERL's results find widespread civil applications.

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

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ARMY RESEARCH AND DEVELOPMENT

Vol. 14, No. 3 **May-June 1973**

FEATURES

DEPARTMENTS

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Selective Scanner. . .

Fluidic Sensor Gauges Atmospheric Content

Successful demonstration of a model fluidic concentration sensor, capable of gauging vehicle exhaust emissions, alcohol on the breath, potentially deadly gas from a leaking furnace, and other atmospheric contaminants, is reported by the U.S. Army Materiel Command Harry Diamond Laboratories.

Titled the "Analogue Flueric Gas Concentration Sensor" in a patent issued to Dr. Fernando Villarroel, the invention reportedly can be reduced from its present size of about one cubic inch. Engineers of two firms that have evidenced an interest estimate that it can be mass produced for about $1.00.

Use of a reference gas such as oxygen, nitrogen, etc., is essential to operation of the self-calibrating device. It determines the proportions of a reference gas contained in the sample gas, without moving parts or active computation. Results can appear as either an electronic or pneumatic readout.

HDL researchers will continue efforts to improve the sensitivity of the device and to explore its potential.

Dr. Villarroel, who recently accepted a position with the U.S. National Institutes of Health, Department of Health, Education and Welfare, served about five years as a research chemist with HDL. During that period he was issued six patents, and authored or coauthored some 25 professional journal articles.

WSMR Facility Assisting NASA Skylab Project

NASA's Skylab project, an unprecedented attempt to orbit manned space workshops for periods from 28 to 56 days, is receiving calibration assistance for meteorological systems from a new facility at White Sands (NM) Missile Range.

WSMR is one of the few places where a complete satellite calibration job can be accomplished because of infrequent cloud cover, intricate instrumentation capabilities and terrain variety.

The WSMR meterological system is sponsored by the Atmospheric Sciences Laboratory (ASL), an element of the U.S. Army Electronics Command, and will be utilized in numerous government programs ranging from Project Skylab to environmental studies as well as defense R&D activities.

Construction of the new facility began last July with preparation of sites at five locations on or near the range. Each site is located on a different sort of terrain. Optical and meteorological instrumentation relays to the base station such data as emissivity, albedo, surface temperature and moisture.

The system will be used in comparing atmospheric and surface data from ground sensors with that collected by the satellites.

LWL Announces Low-Cost Waste Disposal Unit

Prompted by needs experienced during the Vietnam conflict, the U.S. Army Land Warfare Laboratory, Aberdeen Proving Ground, MD, has developed a low-cost small waste disposal unit.

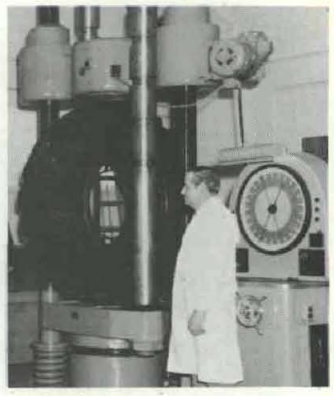
Incorporating basic septic tank principles, the unit digests solid waste anaerobically by bacteria. Weighing about 125 pounds, it may be utilized by up to 200 men per day and requires no maintenance or chemicals.

Assembly of the system requires no special tools or skills. It consists of a fiberglass tank and lid, two fiberglass inlet tubes and sections of plastic pipe for the outlet. The tank and outlet are emplaced in the ground and covered by a latrine box which is constructed by the user. Inlet tubes are then inserted through the box and into the tank which is half filled with water.

Additional water is required only for periodic cleaning and rinsing of the bowl. Non-potable type water has been designated satisfactory for the system, which can be used anywhere except in extreme cold climates.

Although primarily designed for temporary encampments, training areas and fire support bases, some of the prototypes have been in use more than one year. Prototype testing was conducted in Vietnam; Korea; Fort Dix, NJ; and Fort McClellan, AL.

APG Improves Tire Tests With New Machine



A universal testing machine, capable of exerting loads of tension and compression up to 600,000 pounds, is saving time, manpower and improving evaluation of military tires at Aberdeen Proving Ground (APG), MD.

Prior to adoption of the machine by the Automotive and Armor Division, Materiel Testing Directorate, the process of obtaining interrelationship information on tire pressures, weights and loads being transported was a complicated and time-consuming procedure.

Collection of data formerly involved loading and unloading of various materials of different weights on and off the vehicles, changing of tire pressures under varied loads, and the use of additional men and equipment.

Through use of the universal testing machine, which simulates interrelationships of loads, weights and tire pressures, actual tire prints are made on bristol board. The prints show graphically the effects of traction, the area of contact, and yield other information about the tires being evaluated.

HumRRO Developing Computerized Test Plans

The Human Resources Research Organization (HumRRO) was recently awarded a 21-month contract for development of acceptance test plans to enhance capabilities of the Army's Computerized Training System (CTS).

Issued by the U.S. Army Electronics Command, Fort Monmouth, NJ, the $41,000 contract is drawn to provide the Army with adequate procedures in verifying that hardware and software proposed by any vendor for the CTS actually meets specific performance characteristics as represented.

Three separate test plans will be developed by HumRRO describing items to be tested, test methods, procedures, and test results. The plans will permit the Army to include them in Requests for Proposals for CTS hardware and software.

Technical personnel from HumRRO will assist the CTS Product Manager's Office in evaluating acceptance test designs, examination of deliverable items, and insuring the test plan is followed.

APG Tests Tactical Cargo Loader for Air Force

Tactical air cargo loader is the name of this prototype vehicle being subjected to about 6,000 miles of road testing at the U.S. Army's Aberdeen (MD) Proving Ground for the U.S. Air Force.

Control is exercised from a cab extending some six feet from the left front of the vehicle. The TACL has a 25,000-pound cargo capacity over rough terrain and 36,000 pounds on paved surfaces. Equipped with front and rear deck extensions, it can be expanded from 24 to 37 ft., and is over 12 ft. wide.

Using either a 4- or 8-wheel drive and equipped with hydraulic steering on the front wheels, the TACL is powered by a 210-hp V8 diesel engine. With a built-in winch, it can transfer cargo to and from ground level.

Army Tests First Production of XM1140 Fuzes

Successful first article sampling of the XM1140 fuze, termed a significant upgrading of the state-of-the-art in military electronics, has been announced by the U.S. Army's Harry Diamond Laboratories (HDL).

The project for development of the XM1140 airburst fuze for short-range as well as extended-range systems of the Lance missile was initiated in the late 1960s. HDL engineers had designed and field tested by the end of 1971 what proved to be a highly reliable fuzing system.

Early in 1972 HDL procurement officials contracted with Babcock Electronics Corp. and Melpar Division of LTV Electro Systems to produce the XM1140 fuze to meet Army requirements.

The contract committed HDL to deliver two Lance Final Acceptance Testers to each of the fuze producers. Complex electronic assemblies composed of many standard and modified commercial instruments and custom-fabricated elements used.

Brooke Hospital Adds Hemodialysis Facility

Improved treatment for kidney disease victims is the function of a new 7-bed hemodialysis facility recently activated at the U.S. Army Brooke General Hospital, Fort Sam Houston, TX.

In the absence of healthy kidneys, hemodialysis provides filtering actions enabling the body to excrete various toxic agents which accumulate in the blood as the result of normal processes. Kidney disease claims about 90,000 lives annually in the U.S.

In the 4 to 6-hour process, blood is filtered through a cellophane membrane in the kidney machine along with a chemical solution, allowing waste to diffuse into the solution.

Chronic kidney failure patients undergo this treatment two to three times a week. Once mastered the treatment may be used in the home, thus permitting patients to resume a normal life.

Intensified Troop Tests Begin on M60A2 Tank

Intensified Confirmatory Troop Testing (ICTT) of the U.S. Army's newest tank, the M60A2, was started late in April under direction of HQ Modern Army Selected System Test, Evaluation and Review (MASSTER) at Fort Hood, TX.

By June a full battalion of 54 tanks and 5 maintenance "floats" will be turned over to the 2d Armored Division's 1st Battalion, 67th Armor, which will become the only M60A2 unit in the U.S. The ICTT will determine how to train other users of the new tanks and what support will be required for user units.

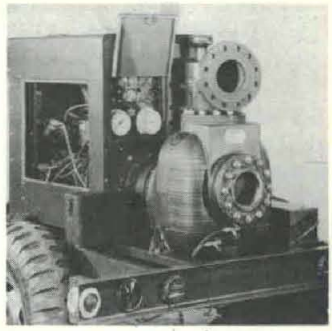
Scheduled to conclude Dec. 21, testing of the M60A2 will be the longest running MASSTER test ever conducted. The automotive and hull components of the M60A2 are essentially the same as its predecessor, the M60A1.

Evaluation, therefore, will be concerned with the tank's new capabilities, including the firepower of a Shillelagh guided missile, full stabilization of a tank commander's station, and a laser rangefinder that provides instant target-range information.

New also are a full-solution computer that corrects for range, cant, ammunition type, drift, wind, parallax and target lead, and first-generation passive night-vision periscopes.

ARMY's NEWEST TANK, the M60A2

Army Type Classifies Centrifugal Pump



Type classified recently for standard Army use is a 1,500 gallon per minute centrifugal pump developed by the U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, VA.

Mounted on a standard military vehicle, the 2,500-pound unit is a component of a 225-ton per hour gravel or rock crushing, screening and washing plant, which requires an hourly wash water output of 90,000 gallons.

Other applications include general pumping in construction work where removal of large quantities of water from dikes and cofferdams is required. A self-priming capability provides for use of the pump in marine salvage operations.

U.S. Army Health Services Command Activated

Noted military and civilian dignitaries attended recent ceremonies activating the U.S. Army Health Service Command (USAHSC) at Fort Sam Houston, TX.

Established in line with the over-all Army reorganization announced in January, the USAHSC directs the operation and management of all Army hospitals and medical activities in the United States. When it becomes fully operational in July, the command will assume responsibility for 50,000 military and civilian personnel.

Army Surgeon General (LTG) Hal B. Jennings presented the USAHSC colors to MG Spurgeon Neel, commander. Prior to assuming command, MG Neel served as Army Deputy Surgeon General.

Former Army Surgeons General (LTG, Ret.) Leonard D. Heaton and (MG, Ret.) George E. Armstrong were among distinguished guests present at the ceremonies.

BG Jack P. Pollock is deputy commander of the Health Service Command and BG Marshall E. McCabe is chief of staff. BG Pollock formerly served as special assistant for Dental Affairs, Office of the Assistant Secretary of Defense for Health and Environment. BG McCabe was deputy special assistant to the Surgeon General for Medical Corps Affairs and Deputy Director of Professional Services.

Army Raises Improved Hawk Missile Production

Production of the Improved Hawk air defense system by the award of an increment of $120.7 million to a contract effected last November, raising the total to $217 million, was announced recently by HQ U.S. Army Missile Command, Redstone (AL) Arsenal.

The 17-foot Improved Hawk is a fast-response low-altitude missile designed to stop high-performance aircraft and air-breathing missiles. Launched from mobile carriers, it is guided by "homing" on reflected radar illumination.

Featuring advanced electronic technology, it is a more reliable and accurate air-defense system than its predecessor, with a new guidance package, larger warhead, and an improved motor propellant. No unit or direct support level maintenance is required because missiles go directly from production lines to launchers as certified rounds.

Ground support equipment in the system has also been updated, with portions automated. A new electronic data processor, for example, will assist in the target-engagement function.

The Improved Hawk, like its predecessor, will be deployed worldwide. The basic Hawk is produced by Raytheon Co. in the U.S., in Europe by five NATO nations, and in Japan.

Fluidics Technology . . .

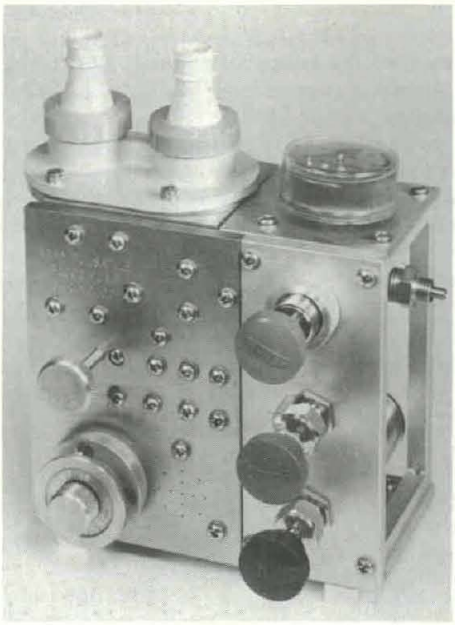
Applications Probed for Weapon Systems Requirements

Weapon systems requirements for lightweight, ruggedly reliable components that minimize maintenance problems are causing the U.S. Army to turn more attention to the potential for application of fluidic controls.

Announced to the public at a press conference convened at the U.S. Army's Harry Diamond Laboratories more than 12 years ago, the relatively new science of fluidics is making increasingly important contributions to weapon systems components. More than two years ago, the U.S. Army Materiel Command assigned to the HDL lead-laboratory responsibility for fluidics.

In a recent listing of some current accomplishments in fluidics, the HDL also invited Army research and development activities to present problems that fluidics technology may help to resolve through joint effort.

A recent study of potential military applications convinced HDL leaders that numerous U.S. Army systems, current or under development, might make more advantageous use of fluidic control components. The study also indicated that many additional potential applications would require relatively minor fluidics technology advances.



Prototype of Army Fluidic Heart Pump

During the 12 years since HDL leaders showed to the press representatives an experimental model of an artificial heart pump that featured controls without moving parts, fluidics technology has advanced amazingly in industrial uses throughout the world. Industrial leaders have predicted that fluidics systems will expand into a future boom development.

Fluidic applications are being developed by the Army Materiel Command for the modern Volunteer Army. Military applications differ from industrially oriented applications because of over-all system requirements of size, weight, environmental operating conditions, and reliability and maintenance requirements.

One of the most advanced military application of fluidics is the hydraulic stability augmentation system (SAS) for helicopters, being developed by the Eustis Directorate of the U.S. Army Air Mobility Research and Development Laboratory, Fort Eustis, VA. The design objective is a cigarette-package-sized system that provides vehicle damping, and yields a maneuver rate response proportional to control input.

The SAS has been demonstrated in the UH-1 helicopter and life tests were conducted on 15 sets of components. In the laboratory, the system was subjected to typical helicopter environments of contamination, temperature and vibration. No failures were encountered and, based on component performance degradation, a system mean time between failure (MTBF) of 83,000 hours was predicted.

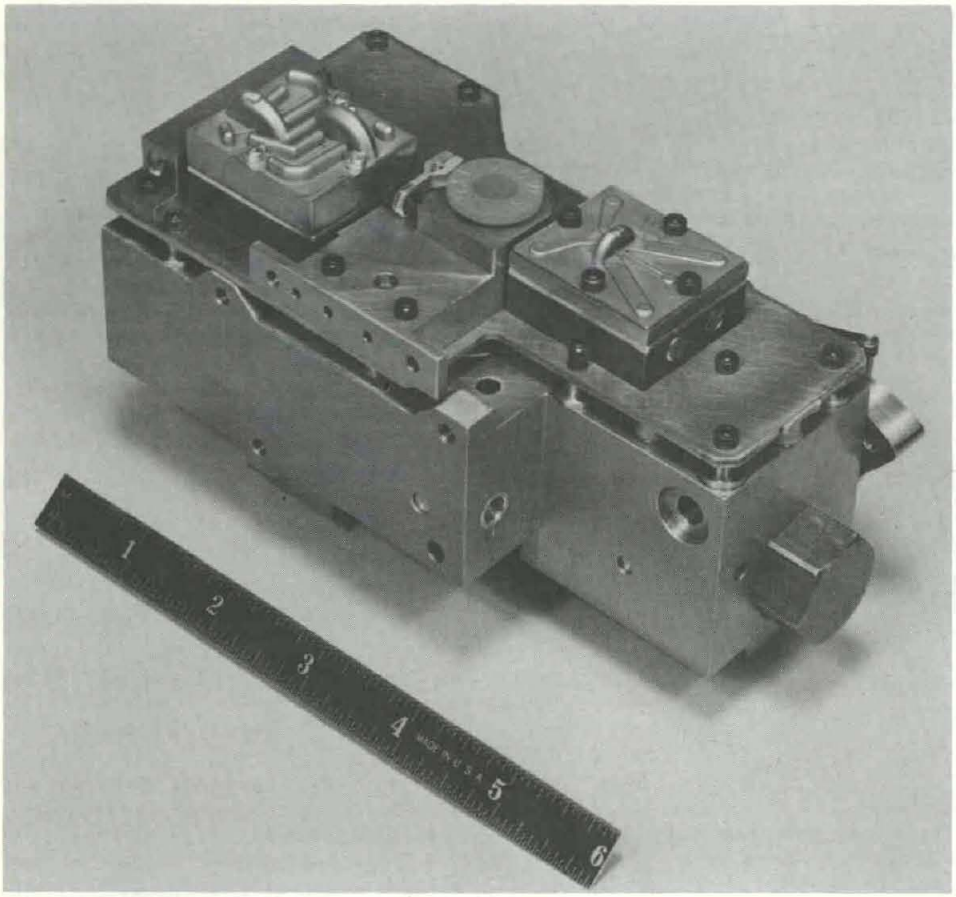
The U.S. Army Missile Command (MICOM) is using a 2-axis pneumatic pickoff attitude gyro for correcting the flight of ballistic missiles. MICOM has incorporated the gyro with a fluidic pulse-duration control system inside the Honest John rocket motor. This deflects exhaust gases during the system operation and steers the rocket. Reportedly, the inexpensive guidance system functions for less than four seconds and eliminates errors due to wind and other factors.

The U.S. Army Weapons Command (WECOM) is developing fluidic systems for use in stabilizing weapons on aircraft, tanks and armored personnel carriers.

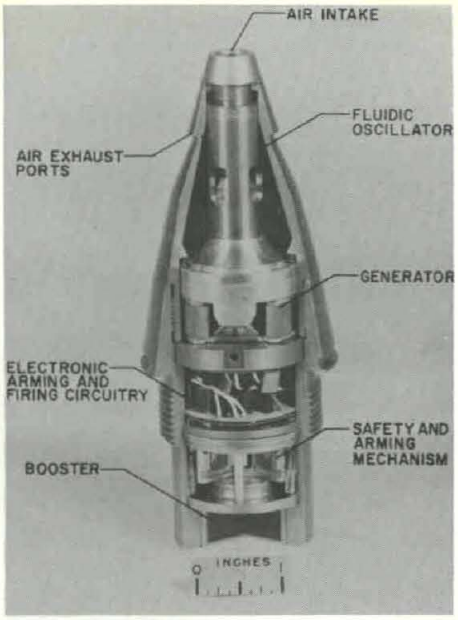
WECOM's Benet Weapons Laboratory is developing a fluidic system to reposition mortars after firing. Recoil forces from a fired mortar cause the weapon to shift, usually backward and to one side. The greatest shift occurs when the weapon is set up in a new location and initially fired.

Normal procedures require a "seating" of the weapon by firing several rounds that are wasted. The fluidic system senses displacements in azimuth and elevation, and automatically repositions the weapon to its original position.

The power supply for the sensing and control system can be either a small



FLUIDIC Stability Augmentation System for Helicopters



FLUIDIC GENERATOR provides both an environmental safety check and power to electronic circuitry of the high-performance, point-detonating fuze for artillery.

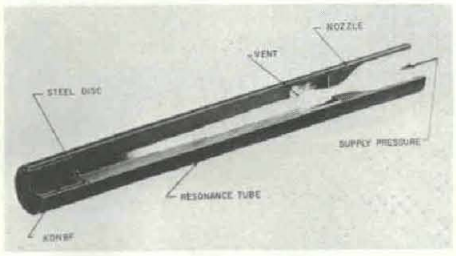
bottle of compressed gas or the exhaust gases of the fired projectile. Successful field tests have been conducted using both types of power supply.

Automatic repositioning is performed in one or two seconds, depending on the shot-to-shot displacement error. The Benet Laboratory is integrating the system to eliminate the tubing of the breadboard system.

The U.S. Army Tank-Automotive Command (TACOM) is interested in hydraulic and gas-operated fluidic systems for control of military vehicles. TACOM is sponsoring work on the fluidic temperature sensor for primary control of an automotive gas turbine engine. Concept feasibility of the sensor has been shown, and an engine demonstration is planned in 1973.

The U.S. Army Munitions Command (MUCOM) is developing fluidic systems for several applications.

Picatinny Arsenal has been involved with development of a fluidic initiator called the "pneumatic match." The low-cost initiator uses a resonance tube to generate intense heat and can



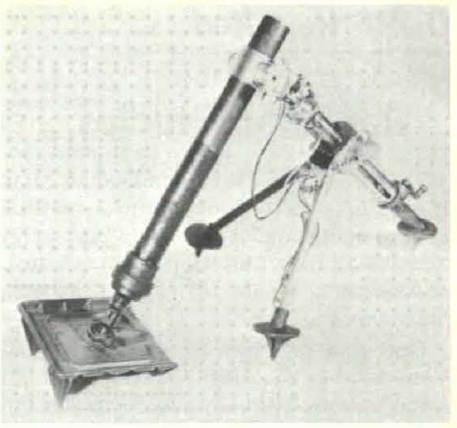
FLUIDIC INITIATOR, called a "pneumatic match," is a closed-end tube that admits ram air pressure in at one end and generates high-intensity heat at the other.

be used to replace electrical initiation schemes. Laboratory and field tests have been conducted to demonstrate its high reliability.

MUCOM has sponsored investigation of two concepts for fluidic arming of point-detonating fuzes for high-performance artillery and mortar munitions. One concept utilizes a fluidic arming and delay circuit that integrates the velocity and provides a constant arming distance of several hundred feet. The other concept, called the fluidic generator, converts ram air into electrical power and is now under development for the Army's Advanced Beehive ammunition fuze.

HDL researchers are cooperating with the Naval Air Systems Command in developing flight-worthy fluidic hardware for a variety of military applications. An expample is a digital fluidic circuit capable of computing altitude. The system has demonstrated accurate operation from sea level to over 40,000 feet altitude.

HDL also is giving advisory assistance to the Naval Air Development Center (NADC), Johnsville, PA, in developing



FLUIDIC SYSTEM senses displacements in azimuth and elevation and automatically repositions the mortar after firing.

fluidics for aircraft avionic systems. One application is to provide a proportional resistance in power-assisted controls to aid pilots in maneuvering. The integrated fluidic system measures angular acceleration and produces the proper stick resistance to the pilot, thus preventing overstressing of the airplane.

Belvoir Employe Earns Award for Artillery System

An invention cited for contributing greatly to an artillery positioning system, and expected to have broader applications, has won Letters of Patent and a $100 award for Allan Kiisk, U.S. Army Engineer Power Group, Fort Belvoir, VA.

Titled a "Range Change Method of Determining Positions," the invention was developed primarily for artillery use with the Long-Range Position-Determining System currently under development. The award was presented by COL John E. Wagner, commander, U.S. Army Engineer Topographic Laboratories.

Allan Kiisk

Army Chief of Engineers LTG F. J. Clarke, in a letter to Kiisk regarding the patent, commented:

"Recently completed tests of the first hardware procured for this ground station-to-aircraft computerized electronic surveying system has confirmed its operability, and even exceeded position accuracies. In addition, this invention holds promise as a significant new tool for meeting important needs in broader and more basic conventional applications, such as the rapid performance of third-order surveys, the tracking of aircraft in flight, and the determining of aircraft positions in connection with aerial photography."

Kiisk has a BS degree in electrical engineering from Oregon State University, a master's degree from Stanford University, is a member of the Institute of Electrical and Electronics Engineers, and a registered professional engineer in Oregon.

STRATCOM FY 73 Savings Exceed DA Assigned Goal

More than two months before the FY 1973 close, the worldwide Army Strategic Communications Command, headquartered at Fort Huachuca, AZ, announced its Department of Army assigned cost-reduction goal of $5.5 million had been exceeded by $11,500.

Among the STRATCOM subcommands reporting reductions were STRATCOM-CONUS (Continental U.S.), STRATCOM-Pacific, STRATCOM-Europe, STRATCOM-South (Panama), STRATCOM Signal Group-AD (Air Defense), STRATCOM Communications Agency-MTMTS (Military Traffic Management and Terminal Service), Army Inter-Communications Agency, Army Communications Electronics Engineering Installation Agency and the Army Communications Systems Agency.

Categories producing the greatest savings were improved telecommunications management, with $2.6 million; value engineering, with $999,000; and supply management, with $683,000.

The $2.6 million saved in the area of improved telecommunications management was the result of transferring communications assets from Vietnam to the Pacific and European theaters, and the reduction or elimination of leased circuits and services.

Radiation Studies, Facility Modifications Highlight 1972 Achievements

The U.S. Army's Diamond Ordnance Radiation Facility (DORF), now in its 12th year of operation, continues to play a significant role in radiation-effect studies, as evidenced by its 1972 list of accomplishments.

Operated for the U.S. Army Materiel Command by the Army's Harry Diamond Laboratories (HDL), DORF occupies an unpretentious building on the grounds of the Forest Glen Annex of the Walter Reed Army Medical Center (WRAMC) near Silver Spring, MD.

During a 215-day period in 1972, the facility was utilized for irradiation experiments with a total reactor thermal power output of 19,438 kilowatt hours and 305 pulses. Experimental programs included radiation-effects studies on electronic components, subsystems and systems; reactor parameter measurements; and dosimetry research.

One "major" project accomplished in the DORF exposure room involved neutron-irradiation tests of the complete Flight Control Set (FCS) of the Spartan missile for the Safeguard ABM Defense System. FCS electronics provide power conversion, and stabilization and control while the Spartan is in flight.

A primary purpose of the Spartan Radiation Effects Evaluation Program was to develop a methodology for determining and predicting the system's response to nuclear radiation environments through simulation.

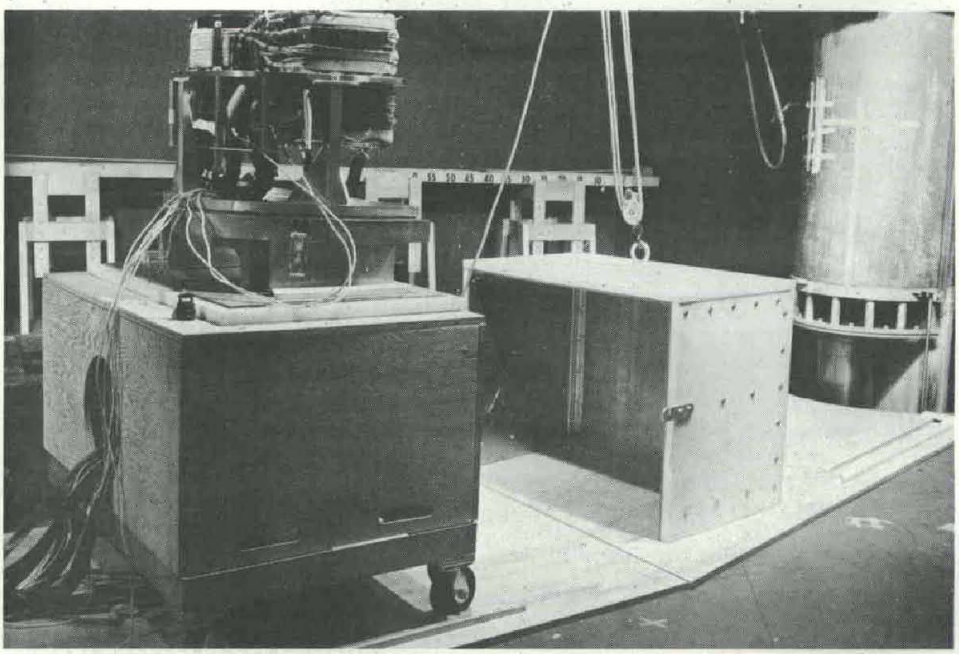
Fast-neutron fluence measurements were made and correlated with transistor gain-degradation measurements throughout the interior of the FCS, on its periphery, and in the free field of the fast-burst reactor.

Gamma dosimetry procedures were developed to make radiation absorbed dose energy measurements in silicon and tantalum. Measurements were made inside transitor cans throughout the FCS interior.

DORF also conducted 1972 biological studies and produced isotopes for the Walter Reed Army Institute of Research and the WRAMC.

Several modifications to the reactor were accomplished during 1972 and the first months of 1973. These included installation of a new reactor control and safety instrumentation system.

Existing instrumentation had been in operation since 1961. The new system incorporates current solid-state components for monitoring and transmitting signals, more efficient interrelationship of circuits, controls, and data display and ease of operation for training purposes.



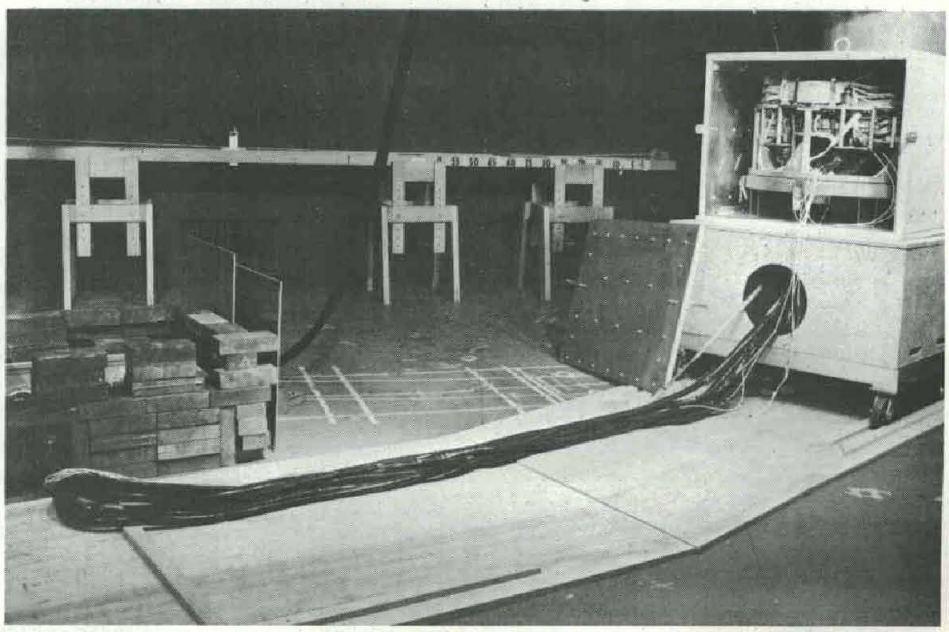
FLIGHT CONTROL SET shown in DORF exposure room atop a wooden positioning cart prior to placement of thermal-neutron shield (attached to cable) for pulse test.

Additionally, the circuit design conforms to U.S. Atomic Energy Commission Reactor Development Technology Standards, which previously used instrumentation did not satisfy.

Another development in 1972 was initiation of a piece parts Nuclear Vulnerability Data Bank under the sponsorship of the Defense Nuclear Agency.

The HDL was designated as primary contact point for the data bank to collect, evaluate, store and disseminate information on radiation effects in semiconductor devices. Raw data accumulated at DORF, as well as other test facilities both inside and outside the DOD, are contained in the data bank.

Data are statistically analyzed, evaluated and summarized in an attempt to eliminate redundant test efforts. Free distribution of data may be accomplished through standard computer listings, magnetic tapes or microfiche cards.



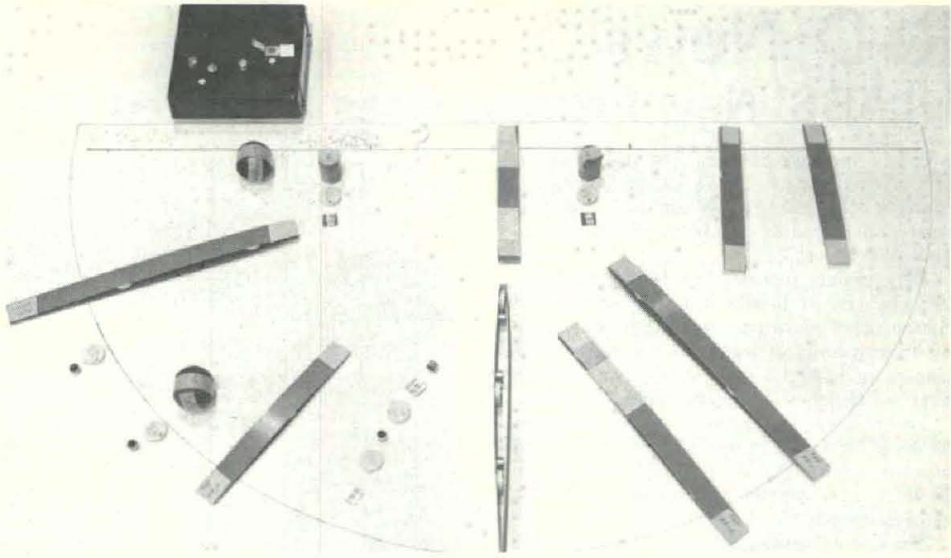
THERMAL-NEUTRON SHIELD around Flight Control Set ready for radiation pulse.

Currently, the data bank contains information on 300 assorted devices, comprising over 2,000 parts. Inclusion of additional devices, particularly integrated circuits, is a continuing procedure.

During 1973, the DORF will continue to concentrate on radiation-effects studies on electronic ordnance components, subsystems and systems. Scheduled programs include irradiation tests on systems used in the Army's Surface-to-Air-Missile-Development program, Naval Ship Ordnance Avionic Systems, and biological studies.

VALUE ANALYSIS on acceptance test criteria for the 60mm M83A3 Illuminating Round indicated that the ballistic tests criteria for the M65A1 Chemical Time Fuze could be transferred to the complete round specification with no degradation in safety or reliability.

Analysis by Herbert Weinraub, John McAnulty, and Leonard Klaus, employed at Picatinny Arsenal, Dover, NJ, resulted in validated savings in testing and material costs totaling $968,900 for FY 1973.



NEUTRON AND GAMMA DOSIMETERS used in and around the Flight Control Set.

Medical R&D Progress Reviewed at ASAP Meet

Medical research and development progress, programs and plans were reviewed in briefings and discussions during a 2-day recent meeting of the U.S. Army Scientific Advisory Panel (ASAP) at the Walter Reed Army Institute of Research (WRAIR), Washington, DC.

Panel members and guests heard detailed discussions of Army research being conducted in the areas of alcohol and drug abuse, burns, environmental hazards, skin and infectious diseases, aviation, and dental research. ASAP Chairman Lawrence O'Neill delivered opening remarks.

Army Surgeon General (LTG) Hal B. Jennings Jr. welcomed the participants, including numerous high-level Army R&D leaders. He noted that it was the first time the ASAP has met at WRAIR since the early 1960s.

Commenting on Army requirements, he said: "We need . . . better wound management, better blood replacements, better ways of having soldiers adapt to their environment, better ways of preventing sickness and nonbattle injury, and better ways to speed the recovery of those whose battle skills are in demand."

Dr. Chris Zarafonetis, professor of internal medicine at the University of Michigan, discussed the expanding role of the Army Medical Department and the need for medical research support for soldiers abroad. He listed objectives of Army medical R&D as support and maintenance of forces in the field, improved use of manpower in military systems, and precombat protection.

Army Deputy Surgeon General (MG) Richard R. Taylor discussed the "Future of Military Medicine" in terms of the manpower needs and the effect of the end of the draft.

"During the past 33 years," he said, "the draft, or the threat of the draft has been a powerful inducement for doctors to come on active duty." He foresaw no future shortage of doctors since those who had deferments to go to medical school would be coming on active duty.

"Afterwards, such plans as stipends for medical students, medical school at full pay, allowances for active-duty personnel, and the new Armed Forces Medical School should take care of peacetime needs."

LTG Jennings termed programs for warrant officer physician's assistants to serve with maneuver battalions and the training of nurse clinicians as "physician expanders."

Other major presentations included "Contributions of Military Medicine," COL Robert J. T. Joy, deputy director, WRAIR; "Army Medical R&D Program Overview," COL Richard F. Barquist, DCO, U.S. Army Medical Research and Development Command (AMRDC); "Burn Research," COL Basil A. Pruitt Jr., CO, U.S. Army Institute of Surgical Research; and

"Skin Disease Research," LTC Alfred Allen, Division of Preventive Medicine, WRAIR; "Drug and Alcohol Research Program," COL Harry Holloway, director, Division of Neuropsychiatry, WRAIR; "Drug Abuse Identification Research," COL Charles R. Angel, director, Division of Biochemistry, WRAIR; "USARV-WRAIR Heroin Research Program," LTC Norman W. Ream, WRAIR; and

"Environmental Hazards Research," COL Leslie B. Altstatt, director of Environmental Quality Research, AMRDC; "Dental Research," LTC Robert Johnson, Surgical Research Directorate, AMRDC; "Aviation Medicine," LTC N. Bruce Chase, Environmental Quality Research Directorate, AMRDC; and "Infectious Disease Research," COL Garrison Rapmund, chief, Life Sciences Office, Office of the Chief of R&D, DA; "Medical Defense Against Biological Agents," COL Dan Crozier, CO, U.S. Army Medical Research Institute of Infectious Diseases; and "Malaria Research," COL Francis C. Cadigan Jr., director of Medical Research, AMRDC.

In addition to panel members and consultants, dignitaries in attendance included GEN Alexander Haig, Army Vice Chief of Staff; LTG William C. Gribble Jr., Army Chief of R&D; Acting Assistant Secretary of the Army (R&D) Charles L. Poor; Assistant Secretary of the Air Force (R&D) Grant L. Hansen; Deputy Under Secretary of the Army (Operations Research) Dr. Daniel Willard; BG Charles D. Daniel Jr., Director of Army Research; BG Robert Bernstein, Assistant Surgeon General for Research and Development; Dr. Marvin E. Lasser, Army Chief Scientist; Dr. Alexander Slafkosky, scientific adviser to the Deputy Chief of Staff for R&D, HQ U.S. Marine Corps; and Dr. Richard A. Montgomery, ASAP vice chairman.

Established in 1954, the ASAP is the senior scientific advisory group of the Department of the Army. Its mission is to advise the Secretary of the Army, Chief of Staff, the Assistant Secretary of the Army (R&D), and the Chief of R&D on scientific and technical matters relating to the Army RDT&E program.

FUTURE OF ARMY MEDICAL DEPARTMENT is discussed by (from left) Dr. Chris Zarafonetis, professor of internal medicine, University of Michigan; LTG Hal B. Jennings Jr., Army Surgeon General; LTG William C. Gribble Jr., Chief of R&D; MG Richard R. Taylor, Deputy Surgeon General; and BG Robert Bernstein, ASG (R&D).

R&D News . . .

NLABS' New Process Uses Fiberized Paper to Clear Oil Spills

In the nation's fight against pollution, the U.S. Army Natick (MA) Laboratories have found a potential new use for wastepaper and wastepaper products, namely, oil spill cleanup and oil recovery.

Experiments reported by developers of the process, Dr. J. Fred Oesterling and Leo A. Spano, have shown promise that removal of oil from a body of water can be achieved by dispersing over the oil layer a quantity of fiberized paper within a specific size range.

The fiberized paper sorbs[1] or collects about 28 times its weight in oil. It is capable of holding the oil on the water surface as an oil-fibrous paper matrix or agglomerate for extensive periods for skimming recovery.

The coinventors explained to the *Army R&D Newsmagazine* that the oil may be expressed (removed) from the paper mass, which then can be refiberized and reused repeatedly to sorb or collect additional oil.

Paper materials which may be used include newspaper, cardboard, waterproof paper fiber container, fiberboard, wastepaper, etc. Using a commercial-type hammer mill, the paper is fiberized to a fragment size ranging from 0.01 to 0.1mm in diameter and 0.75 to 10.0mm long.

One of the most critical elements of the process is fragment size. Laboratory experiments used three separate samples of paper material from the same source but of significantly different fragment size and geometry.

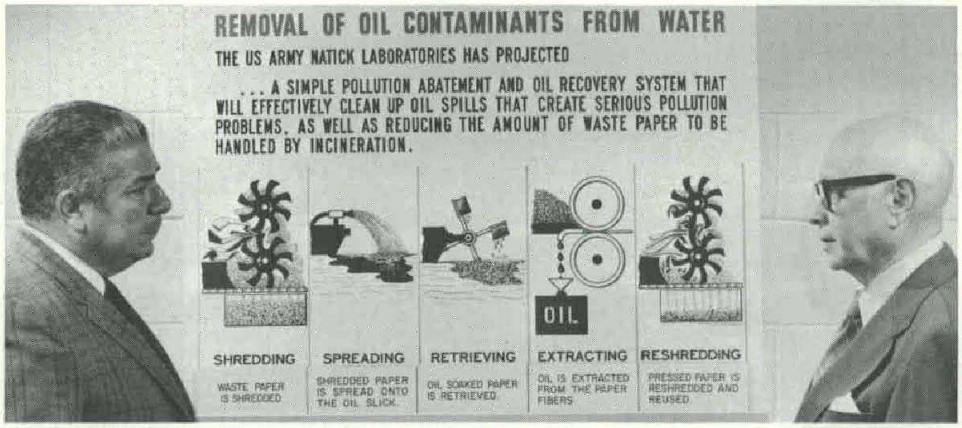
When shredded to approximately 1mm diameter, and ranging from 8 to 23cm in length, the paper collected twice its weight in oil. Ball-milled paper having a maximum dimension of not more than 0.05mm sorbed approximately its equivalent weight in oil. Fiberized paper from 0.01 to 0.05mm in diameter and 0.75mm to 2.0mm in length sorbed approximately 28 times its weight in oil.

The patent literature[2] describes a number of sorbent materials which have been used to sink oil or to immobilize it on the water surface. Straw, sawdust and clay have been tried, but these sorb only relatively small quantities of oil. Some of these materials will sorb water as or more readily than oil.

Fiberized paper is much more oleophilic than hydrophilic. After the first use, the expressed paper will be hydrophobic as well as oleophilic. At this point it could be refiberized and used for collecting oil which has washed up on the beaches or it could be spread on the beaches before the oil slick reached the shore.

The oil recovery system using fiberized paper has been tested on a man-made oil spill in a test lagoon in the Boston (MA) Harbor, where it was found very effective in sorbing the oil (15 gallons of residual fuel oil, specific gravity 0.92 and viscosity 250cs).

Following the discharge of the oil over the water, 4.5 pounds of fiberized paper was broadcast over the oil slick. To simulate the turbulence of open ocean water, a high-pressure air line was submerged in the test lagoon. Discharge air caused a heavy turbulence on the water surface of the test area.



NATICK LABORATORIES COINVENTORS of a process to use finely milled waste paper of many kinds to remove polluting oil slicks from large bodies of water, Leo A. Spano and Dr. J. Fred Oesterling, are shown with a schematic display. Spano, left, is manager of the NLABS Pollution Abatement Program and is credited with numerous major achievements as a "charter member of NLABS." With Vincent Iacono, a physicist, he shared a 1972 U.S. Army R&D Achievement Award for developing the explosive ordnance disposal suit. He was chief of the Advanced Projects Division for more than four years when special protective clothing for combat troops was developed, and also participated in development of the space suits worn by astronauts on Apollo and Gemini flights. An adjunct professor of chemical engineering at the U. of Rhode Island, where he received an MS degree (BS from Pennsylvania State U.), he formerly served with the U.S. Bureau of Mines in research on combustion, gassification of solid fuels, and pollution abatement. Dr. Oesterling, who received his PhD from Penn State U., is also a charter member of NLABS and will retire June 30 with more than 30 years federal service. Currently deputy for research under NLABS Scientific Director Dr. Dale H. Sieling, he has long been one of the most active proponents of the U.S. Army sponsorship of junior science fairs to interest gifted young people in Army science careers. For many years he headed the Army panel of judges that selected about 20 outstanding entries in the International Science and Engineering Fair to accept summer employment or take expense-paid visits to Army in-house laboratories.

Experimenters reported that the sorbed oil-paper agglomerate continued to float regardless of the turbulence. Recovery of the oil-paper matrix was accomplished with a dip skimmer[3] designed by the J. B. F. Scientific Co. A large version of this skimmer was recently delivered to the U.S. Navy for use on the West Coast.

Following recovery of sorbed oil-paper agglomerate by the skimmer, it was transferred to a collecting barrel by pumping with a simple commercial diaphragm pump of the type generally used to pump oil products.

The fiberized paper removed all the oil that had been spilled in the lagoon. Close observation of the water surface following the skimming revealed none of the oil sheen normally left when other sorbents are used.

A concept design of a complete oil spill recovery system that includes the paper fiberizing equipment, sorbent dispenser, the dip skimmer recovery unit and the oil-sorbent processing equipment for recovery is being engineered.

The coinventors said this total system will be completely transportable so that it can be dispatched to problem areas quickly. They anticipate that such a system will prove extremely effective in handling the majority of minor spills occurring in harbor areas, inland waterways and on fresh water lakes. Larger scale tests of this system are being planned.

In the judgment of its developers, this simple pollution abatement and oil recovery system could help alleviate two ecological problems, i.e. (1) effectively clean up oil slicks on water, and (2) make effective use of unwanted wastepaper products. When the pressed paper cake is no longer needed for recycling for oil pick-up, its has potential for use as a source of fuel.

Dr. Oesterling, who was shown eating pancakes covered with syrup made from converting waste paper to glucose to sugar in the July-August 1971 edition (page 10) of the *Army Research and Development Newsmagazine*, termed the oil-slick recovery system "kind of a spin-off" from that process.

Proper milling of the waste paper products is a critical factor in the process of converting waste papers of all kinds into glucose products —even a clean-burning, nonpolluting fuel (ethanol).

The possibility of large-scale production of such a fuel for use in the nation's antipollution program was discussed in an *Army R&D Newsmagazine* feature article by Dr. Carl Lamanna in the September 1972 edition, page 10.

Dr. Oesterling, NLABS deputy for research under Scientific Director Dr. Dale H. Sieling, was the "project pusher" for the team of NLABS researchers credited with developing the glucose products from waste paper process. He told a Newsmagazine staff member that he first tested the possibility of using the finely milled paper "by spreading oil on a small container of water and sorbing it with the paper in my basement one winter evening."

[1] The expression "sorb" or "sorbent" is used to refer to the quality of property of taking up and holding a substance, whether by adsorption, absorption, or physical entrapment in a fiber matrix.
[2] U.S. Pat. Nos. 3,681,237, 3,676,357, and 3,674,683.
[3] New England Marine Resources Information, October 1972, page 2. Published by University of Rhode Island, Narragansett, RI.

Engineer R&D Agencies Consolidating in Huge Complex

Relocation of U.S. Army Corps of Engineer R&D and review facilities in the Greater Metropolitan Area of Washington, DC, began in mid-May. Three agencies will move into the Kingman Building on a 565-acre site at Fort Belvoir, VA.

Involved in the initial relocation are the U.S. Army Coastal Engineering Research Center (CERC), the Board of Engineers for Rivers and Harbors, and the Institute for Water Resources (IWR).

CERC alone is allocated 187 acres for its numerous research facilities, including basic laboratories that have been under construction since last summer and are expected to be completed for occupancy this fall.

The Kingman Building is a 4-story reinforced concrete structure with 76,000 square feet of office space. Construction began in June 1971 following award of a $3,626,000 contract by the Baltimore District engineer to Sharpe and Hamaker Construction Co., Arlington, VA.

Assistant Director of CERC LTC Richard Stevens has doubled since May 1972 as project officer for planning and coordinating the move into the Kingman Building. He said the initial relocation will involve 155 CERC employes, 90 personnel assigned to the Board of Engineers for Rivers and Harbors, and 20 staff members of the Institute for Water Resources.

Exterior finish of the building is of precast concrete and architectural brick, with bronze-colored, heat-absorbing glass window walls. The design is low profile, with wide walkways of exposed aggregate, and complementing landscape to achieve a "campus-like appearance."

Offices will have individual temperature and air conditioning controls. Facilities will include a large lobby, modern ADP complex, closed-circuit TV in a "formal Hearing Room," consolidated library, employes' snack bar, and conference and training rooms.

CERC laboratory facilities initially will include a large wave tank, shore processes test basin, and shop, maintenance and storage buildings. The 635-foot-long, 15-foot-wide, 20-foot-deep wave tank is described as "unique in the world," with a capability of generating and testing waves ranging to six feet high.

Named the J. V. Hall Laboratory, in honor of a former distinguished CERC engineer, the shore processes test basin building will contain a 300×150 foot basin. Other facilities will include three 150-foot-long wave flumes, and instrumentation, petrology, sand slurry, and photo laboratories, along with a scuba diving equipment room. The basin has a 204-foot clear span roof with a 25-foot-high ceiling.

The high ceiling design enables cranes and other support equipment to operate in test activities. LTC Stevens said the covered test basin will be a "great improvement in that it will allow year-around operation without interference from the elements."

Future plans for expansion of the laboratory facilities include a wind-wave flume, tsunami test basin, and a second large wave tank, along with testing capabilities still in the concept stage. The first building contract for $5,250,000 was awarded to the Ranger Construction Co., Atlanta, GA.

Adjacent to the Kingman Building and the CERC laboratory complex is the site of the future home of the U.S. Army Engineer Topographic Laboratories. A building with 100,000 square feet of space has been under construction since the summer of 1972 and is expected to be completed about mid-year in 1974. The Topographic Laboratories are now located on the main post at Fort Belvoir.

With the move into the Kingman Building, a concept that had its origin in July 1965 will begin to materialize into an integrated operational complex. The "dream coming true" was that of LTG William Cassidy, former Chief of Engineers, and his then deputy who succeeded him and is still serving, LTG Frederick J. Clarke.

Recognizing the need to consolidate Corps of Engineers Civil Works, as well as military construction headquarters capabilities, with room for expansion of laboratory capabilities to complement other Corps R&D activities widely dispersed throughout the U.S., LTG Cassidy started the planning for the complex in 1965.

The initial requirements were for a suitable administrative building, and for laboratory facilities for the CERC, the Board of Engineers for Rivers and Harbors, and the Institute for Water Resources.

Under the direction of LTC Don S. McCoy, the CERC is the Corps R&D agency for all coastal engineering R&D activities. The BERH reviews surveys, and prepares reports and makes recommendations concerning proposed work for development of U.S. water resources, including shores of coastal and lake waters. MG Andrew P. Rollins Jr. is the BERH chairman and COL William G. Kratz is currently the resident member.

The Institute of Water Resources mission is to develop methodology for centralizing and planning development and management of U.S. water resources. BG James W. Kelly is the director and COL Charles O. Eshelman is his deputy.

Under the guidance of William Murden, appointed by LTG Cassidy to serve in addition to his normal duty as chief of the Plant Supply Branch, Directorate of Civil Works, work started on site selection, master planning, facilities design, and programing construction. Credited with major assistance are CERC Technical Director Thorndike Saville Jr., George Watts as chief, Engineering Division, Richard Guthrie of BERH, and B. H. Dodge of the IWR.

Siting and master planning required more than 2½ years. It involved the approval of the commanders of Fort Belvoir, Second Army, Continental Army Command, the Secretary of the Army, the Secretary of Defense, the Fine Arts Commission, and the National Capital Planning Commission.

Kingman Building (artist's concept)

Army Computing Council Names Watervliet Employe Chairman

James J. Pascale, chief of the Computer Science Office, Benet Weapons Laboratory, Watervliet Arsenal, NY, was recently named chairman of the U.S. Army Scientific and Engineering Computing Council.

Representing computer sciences chiefs of some 70 Army Materiel Command (AMC) agencies, the council's primary purpose is to direct the course of computer usage within the Army, particularly AMC, and to share information on advances in the computer sciences.

Recent council efforts have included investigation of the feasibility of forming a comprehensive computer network of all medium- to large-scale computers in AMC, to provide for Army-wide sharing of these resources.

Pascale joined the arsenal staff as a mathematician in 1956, serving as a computer programer and supervisor of the computer laboratory prior to assuming his present duties in 1970. He is responsible for developing and directing Watervliet Arsenal R&D computing services.

Graduated from the State University of New York at Albany with a BS in mathematics and physics, he has done graduate work there and at Rensselaer Polytechnic Institute.

Pascale has authored numerous professional papers. He is a member of the Association of Computing Machinery and the AMC working group which is evaluating computer-aided engineering design proposals.

R & D NEWS

Slide Rule Streamlines Computation Procedures

Computations required to allocate the resources of a satellite communications system among a number of users can be accomplished in seconds with a slide rule designed by a SATCOM engineer, as compared to 4 to 10 minutes using current manual methods.

Currently designed in large scale for operation while hanging on a wall, the special slide rule will be reduced approximately 50 percent for desk top operation in future models, the U.S. Army Satellite Communications Agency at Fort Monmouth, NJ, reports.

Until a new computer analytical system becomes fully operational, about June or July, the slide rule will serve as a valuable tool in the manual analytical procedures now used. Thereafter it will continue as part of the manual back-up system in the event of computer system breakdown.

William Todd, who devised the novel slide rule, explains that previous methods of manually allocating time in the control system required complex mathematical calculations or the use of mathematical tables—both termed "laborious, time-consuming processes."

With the new method, readings obtained from a monitoring earth terminal are entered on the slide rule and converted to knowledge of the effective power being transmitted by the satellite. With this information, the controller determines the total use of the satellite —whether adjustments are needed to restore or maintain system balance, and by further use of the slide rule, computes the power of earth terminal transmitters to attain desired performance.

Todd began his civil service career with the Army in 1942 in the former Signal Research and Development Laboratories at Fort Monmouth, after attending Newark (NJ) College of Engineering. In 1960 he was one of 13 civilian technical managers assigned to the Army Advent Management Agency, the forerunner to the SATCOM Agency. He has been awarded 10 patents for electronic inventions and has authored numerous technical articles on electronic systems.

ENGINEER-INVENTOR William Todd discusses use of the satellite communications controller's slide rule with COL Leland D. Wamsted, Army Satellite Communications Agency commander and Army project manager for satellite communications.

BRL Scientific Advisory Committee Revived

SENIOR GUIDANCE. Members of the recently reestablished U.S. Army Ballistic Research Laboratories Scientific Advisory Committee include (three not shown), from left, MG Leslie E. Simon (USA, Ret.), Prof. Morris Rubinoff, Prof. Martin Summerfield, Dr. R. J. Eichelberger (BRL technical director, not a member), LTG Austin W. Betts (USA, Ret.), Herbert K. Weiss and Prof. Homer J. Stewart.

Former Army Chief of Research and Development (LTG, Ret.) Austin W. Betts presided as chairman pro tem when the re-established Scientific Advisory Committee of the U.S. Army Ballistic Research Laboratories convened recently at Aberdeen (MD) Proving Ground.

The first BRL Scientific Advisory Committee, appointed by the Secretary of War in 1940, included such illustrious scientists as Dr. Hugh L. Dryden, Dr. A. W. Hull, Prof. I. I. Rabi, Prof. Harold C. Urey, Prof. J. von Neumann, Prof. Henry N. Russell, Dr. Bernard Lewis and Prof. T. von Karman.

Disbanded in 1969, the original BRL committee was re-established recently by Dr. R. J. Eichelberger, director. In addition to LTG Betts, now with the Southwest Research Institute, the committee includes Prof. Keith A. Brueckner and Prof. Joseph T. Mayer, University of California; Dean and Prof. Daniel C. Drucker, U. of Illinois; Prof. Homer J. Stewart, California Institute of Technology; Prof. Morris Rubinoff, Moore School of Electrical Engineering; MG Leslie E. Simon (USA, Ret.), Electro-tec Corp.; Prof. Martin Summerfield, Princeton U.; and Herbert K. Weiss, manager, Analytical Data Systems, Litton Industries.

Vietnam Spinoff: Dog Training Art Aiding in Disasters

Civilian applications of technology developed in U.S. Army research and development activities are a continuing story, involving since World War II total benefits of billions of dollars to the national economy—but the art of training dogs to detect the enemy in Vietnam is adding to that story.

Aberdeen (MD) Proving Ground reports that the U.S. Army Land Warfare Laboratory, a tenant agency, is collaborating with the Military Dog Detachment of the U.S. Army Infantry School, Fort Benning, GA, in an experimental program to train dogs to locate victims of floods, earthquakes, collapsed buildings and other disasters.

The LWL-AIS program was started in October 1972. Training was conducted at Fort Benning, with the LWL providing technical assistance and funds for the purchase of training equipment and procurement of special aids.

Results have been encouraging. Procedures developed in earlier LWL-sponsored dog training programs have been utilized effectively by the Military Dog Detachment to train the body recovery dogs. Teams are now available for body recovery missions as part of the U.S. Army's capability for providing assistance during times of civilian disasters.

The dogs are trained to locate victims buried in mud, under standing water, collapsed buildings and miscellaneous rubble. Trained at first to discriminate cadaver-like odors in a very restricted setting, the dogs have advanced progressively to more realistic situations.

In a final demonstration concluding the formal training course, four "graduating" body recovery dogs with their handlers searched for simulated bodies through jumbles of wrecked autos, building debris, a muddy swamp and a garbage dump. Each of the dogs found all targets at each location.

Fully trained recovery teams maintain proficiency by performing periodic maintenance of skill exercises. In this way, although in a stand-by-status, the teams are kept in a high state of readiness, literally available on an instant's notice to render assistance whenever their services are requested.

MILITARY DOG performs an off-leash search of a demolished building during an experimental training course designed to teach dogs to assist in locating victims of floods, earthquakes, collapsed buildings.

OSAT Sponsoring Career Assessment Center

Sponsored by the Office of the Special Assistant for Training (OSAT), HQ DA, an assessment center test project for officer candidate, career officer and noncommissioned officer courses has been set up at the U.S. Army Infantry School, Fort Benning, GA.

Major scientific support for development, operation and evaluation of the project is provided by the newly established Fort Benning Field Unit of the Army Research Institute (ARI), Office of the Chief of Research and Development, HQ DA.

Dr. James A. Caviness, acting field unit chief, Dr. Kay H. Smith, senior scientific consultant, and the ARI staff are working closely with Assessment Center Director COL Wallace F. Veaudry and his military staff, in development or adaptation of assessment center exercises tailored for the military situation.

The Human Resources Research Organization (HumRRO) has been awarded a contract to create one assessment exercise for each of three assessment scenarios. The exercises will be a simulation of military operations in a combat or natural disaster emergency context.

ARI is also negotiating a contract for basic research in assessment center methods with Development Dimensions, Inc., with Dr. William C. Byham as principal investigator. Much of the data collection will be carried out at the Fort Benning Assessment Center.

One of the major purposes of this pilot project focuses on the use by individuals of assessment center feedback as a tool in their own career planning and development. Such use of assessment center procedures has received relatively little attention in the past.

One ultimate objective is to integrate assessment centers with career schools in such a way that the effectiveness of both is enhanced.

AMRDL Contracts $328,000 For Research, Test Efforts

Contracts announced recently by the U.S. Army Air Mobility Research and Development Laboratory (AMRDL), Ames Research Center, Moffett Field, include two research efforts on helicopter main and rotor tail blades, a 2-stage centrifugal compressor, and the "Theory of Structural Dynamic Testing Using Impedance Techniques."

AMRDL Director Paul F. Yaggy announced an $85,000 contract with Fiber Science that requires a composite filament-wound, tubular-span main rotor blade for the UH-1 Army helicopter be subjected to extensive static, dynamic, fatigue, structural, impact and ballistic damage testing. Field repairability techniques will be developed and demonstrated. The new fiber is designated PRD-49.

The testing will demonstrate the behavior of the tubular spar concept, with a view to proof of potential for future rotor blades.

Another contract with Fiber Science for $79,000 involves testing a low radar cross section of an OH-6A helicopter tail rotor blade, using the structural properties and capabilities of PRD-49. The approach will include a preliminary design analysis to establish criteria for proper selection of design variables, and to show to what extent radar attenuating materials can be incorporated.

A $65,000 contract with International Harvester Co.'s Solar Division involves research on a 2-stage centrifugal compressor. The objective is to provide technology for ultimate incorporation into advanced helicopter engines, having a higher pressure capability at better efficiency than other compressors of like size having more stages of compression.

Experimental verification of the "Theory of Structural Dynamic Testing using Impedance Techniques" is the goal of a $99,000 contract with Kaman Aerospace Corp. The primary application of this theory is for development of the equations of motion of a complex structure, such as a helicopter fuselage, by using easily obtained dynamic measurements of the fuselage.

DoD Actions Affecting 15 Army Installations

Consolidation of all U.S. Army aviation flight training at Fort Rucker, AL, U.S. Army Signal School activities at Fort Gordon, GA, and most Defense Language Institute training at Fort Monmouth, NJ, is included in a decision affecting 15 Army installations.

Announced by the Department of Defense Apr. 16, in a widespread move to reduce expenditures and manpower, the Army actions are estimated to effect annual savings of about $58 million and 4,600 military/civilian jobs.

Coupled with the Army reorganization plans announced in January, the new rollback program will result in Army savings of $248 million and reduction of 19,000 manpower spaces.

Department of Defense reductions will affect installations and activities in 32 states, the District of Columbia and Puerto Rico. Savings are estimated at $3.5 billion during the next decade. DoD FY 1974 budgetary actions will eliminate some 42,800 positions—26,200 civilian and 16,600 military.

Consolidation of flight training at Fort Rucker places it with the home of the U.S. Army Aeronautical Research Unit, the U.S. Army Aviation Test Board and other Army aviation activities. The change entails relocation of primary helicopter training from Fort Wolters, TX, and attack helicopter (Cobra) training from Hunter Army Air Field, Savannah, GA.

Relocation of U.S. Army Signal Center and School activities from Fort Monmouth to Fort Gordon, GA, will be accomplished in two phases. In the first, tactical communications training will be moved; the remaining Signal School courses will move in phase two.

Most of the fragmented Defense Language Institute activities will be relocated at Fort Monmouth concurrent with the Signal School moves to Fort Gordon. These will include the DLI HQ and East Coast Branch at Washington Navy Yard, District of Columbia, the English Language Branch at Lackland Air Force Base, TX, and the Systems Development Agency, Presidio of Monterey, CA. The DLI West Coast Branch will remain at the Presidio.

Sprint Components Undergo HDL HIFX Tests

Testing of all second-stage components of the Sprint interceptor in the Safeguard Ballistic Missile Defense System was successfully completed recently by using the High Intensity Flash X-ray Facility in the U.S. Army's Harry Diamond Laboratories, Washington, DC.

The Sprint missile investigation was the largest system testing to date in the HIFX, built in 1966 to study effects of various nuclear environments on system component degradation without using underground tests.

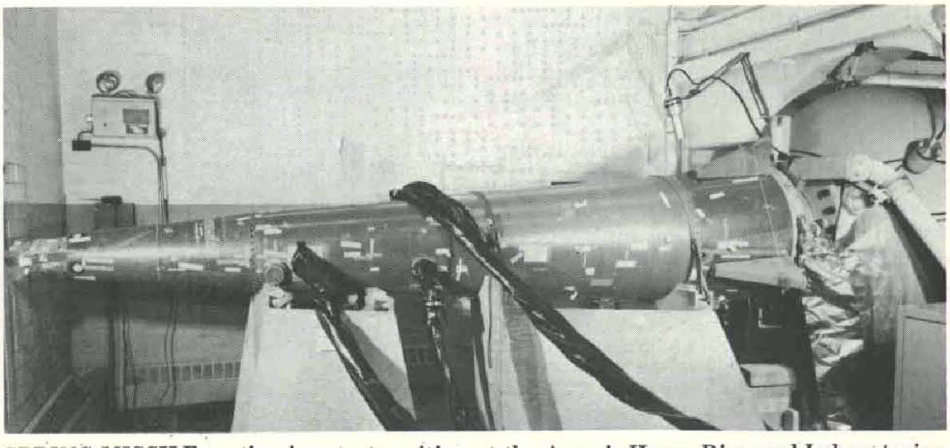
Designated by the parent U.S. Army Materiel Command with lead-laboratory responsibility for nuclear effects research, development, testing and evaluation, the Harry Diamond Laboratories have capabilities that include the most powerful facility of its kind.

The Aurora Facility, located on the U.S. Naval Ordnance Laboratory grounds, where the future home of the Harry Diamond Laboratories is now in the second phase of a 3-phase construction program, is truly unique in the world. For a complete description, see the March-April 1972 edition of the *Army Research and Development Newsmagazine.*

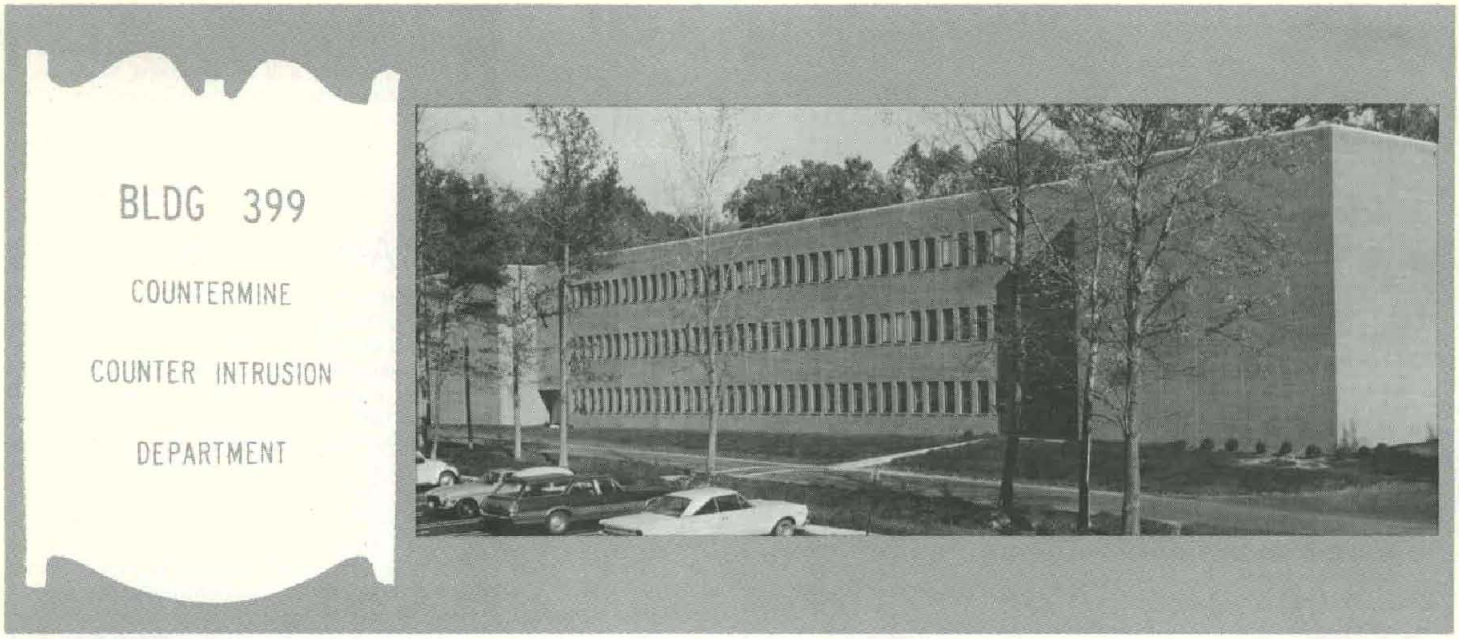
In the recent HDL testing of the Sprint, the second stage, a conical structure about 16 feet long and three feet in diameter, was subjected to various roll and yaw orientations in flight simulation studies.

Real-time data were obtained for each shot in as many as 20 active signal channels, each of whose oscilloscopes was triggered by the HIFX system. Reproduction capabilities of the HIFX permitted large-scale data accumulation by using only 150 radiation pulses.

Participants in the test program included personnel from the U.S. Army Safeguard Systems Command, U.S. Army Munitions Command, Bell Telephone Laboratories, Gulf Oil Corp., Martin Marietta Corp. and McDonnel Douglas Corp.



SPRING MISSILE section in a test position at the Army's Harry Diamond Laboratories.



Research and development of detectors and sensors will be conducted at a new $1.3 million facility recently opened at the U.S. Army Mobility Equipment Research and Development Center (MERDC), Fort Belvoir, VA.

The first 3-story building built expressly for the MERDC, the facility will serve as headquarters for the Countermine/ Counter Intrusion (CM/CI) Department, one of five major, mission-oriented, technical departments at the center.

Speaking at dedication ceremonies, Dr. Robert B. Dillaway, deputy for laboratories, U.S. Army Materiel Command (AMC), said the building provided the R&D Center with greatly improved and expanded facilities for carrying out its mission.

He said he had been amazed at the important developments achieved by the department in view of its previously scattered facilities, which included trailer workshops, and that he is looking forward to even greater successes in the fields of detectors and sensors.

In addition to R&D activities in mine detection and neutralization, tactical remote sensors, interior and exterior physical security, and special-purpose sensors, the CM/CI Department has related activities in systems analysis, evaluation and application, and product engineering.

The new building provides over 44,000 square feet of office and laboratory space. Facilities include a magnetic room, an optics and infrared room, an anechoic chamber, radiation, chemistry, mechanical, soils, and cryogenics laboratories, and five separate electronic laboratories.

The magnetic, optics and infrared rooms provide the capability for studying physical characteristics of a wide variety of sensing techniques, ranging from infrasonics to ultrasonics. All are applicable to the development of new technology for important intrusion detection equipment.

The anechoic chamber will permit characterization of many types of remote frequency systems, as well as target responses over a broad frequency range.

Primarily, the chamber will be used for the METRRA (Metal Re-Radiation) program, which has application to reconnaissance, surveillance, and mine detection operations in the field. The design concept for METRRA was pioneered by the CM/CI Department, and is now a major area of effort.

The chemical laboratory provides an independent in-house capability in sample preparation and standardization, gas chromatography, mass spectrometry, and plasma chromatography. Laboratory models of trace gas detectors involve effluvia collection and characterization from refined and actual explosive formulations.

Hardware used in the countermine and counterintrusion programs involves modern and sophisticated electronic technology, circuitry, and packaging. The five electronic laboratories design, fabricate, measure and evaluate a wide range

DISPLAY ROOM in the new building of the Countermine/Counter Intrusion (CM/CI) Department features many of the detectors and sensors developed at the USAMERDC.

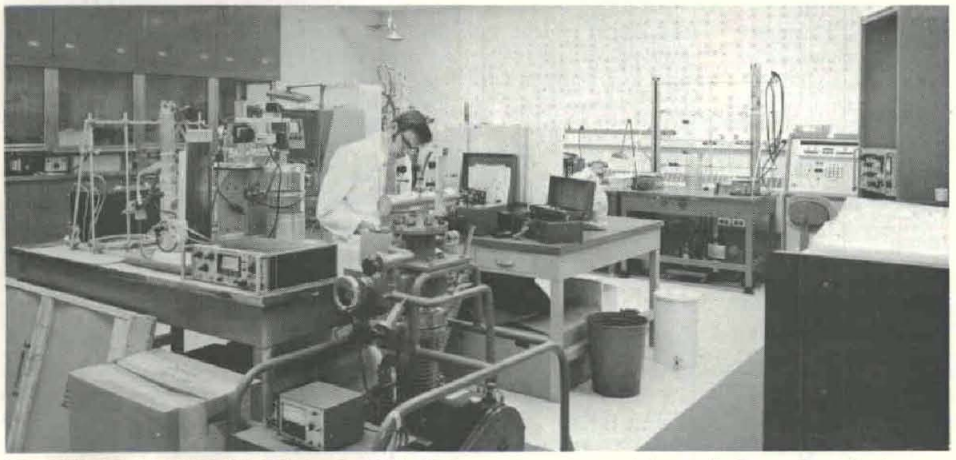
AMC Deputy for Laboratories Dr. Robert B. Dillaway (right) spoke at dedication ceremonies for the new building. With him are Terence G. Kirkland, chief of the CM/CI Department, and COL Bennett L. Lewis, former commander of the Mobility Equipment R&D Center.

of electronic gear.

Headed by Terence G. Kirkland, the CM/CI Department is organized into seven divisions with a multidisciplinary staff of 170 engineers, scientists, technicians and administrative personnel.

William B. Taylor, technical director, presided at the dedication ceremonies for COL Tenho R. Hukkala, MERDC commander, who was unable to attend.

COL Bennett L. Lewis, former commander of the center, under whose tenure construction of the building was started in 1971, was an honored guest.



CHEMICAL LABORATORY in the CM/CI Department provides an independent in-house capability in sample preparation and standardization, gas chromatography, mass spectrometry, and plasma chromatography. Pictured is Dr. Glenn E. Spangler, a physicist.

HumRRO Examines Attitudes Of Selected MVA Participants

Reactions of assignees to experimental programs at selected stations in the Modern Volunteer Army (MVA) program are discussed in a recent Human Resources Research Organization report, *Attitudinal Studies of the VOLAR Experiment: A Longitudinal Study, 1971-72.*

Six questionnaires were prepared for distribution at five U.S. installations—Forts Ord, Jackson, Benning, Carson and Knox—and at Gelnhausen and Kitzingen, Germany, U.S. Army Europe (USAREUR). The report states that the only sampling large enough to warrant definitive analysis involved Fort Ord, CA, and Fort Jackson, SC.

The purpose was to determine whether attitudes and reactions of men to VOLAR innovations at their current duty stations were affected by the status, VOLAR or Non-VOLAR, of their previous stations. Comparisons were made of samples taken when the experiment was initiated in 1971 and samples taken in 1972 when the program was continued on an expanded scale.

Two of the questionnaires were given to permanent party personnel, one for officers and the other for enlisted men. Four questionnaires probed the attitudes and reactions of men in training—VOLAR I before basic combat training (BCT), VOLAR II after BCT, VOLAR III after advanced individual training, and VOLAR IIS for men who missed taking VOLAR I.

In general, the questionnaires probed background characteristics, various attitudes, plans for the future in or out of the Army, and, through check lists, evaluations of items that were possible objects of VOLAR innovations.

Large differences were noted in demographic and background characteristics in the four major test groups. Findings of the study suggest that these were extensive enough "to cast doubt on any hypothesis that the differences in their responses might be a result of differences (VOLAR vs non-VOLAR) in training."

ALMC, ASM Cosponsoring RDT&E Certificate Program

Cosponsorship of a Certificate Program in Research, Development, Test and Evaluation has been announced by the U.S. Army Logistics Management Center (ALMC), Fort Lee, VA, and Association for Systems Management (ASM).

The ALMC is a U.S. Army Materiel Command major training center for senior military and civilian executives of the Department of Defense. More than 18,000 students were enrolled in its 1972 on-campus and off-campus education programs. Headquartered in Cleveland, OH, the ASM is an international organization.

The RDT&E Certificate Program requires that enrollees successfully complete a core of four required and six elective courses. Certificate recipients are encouraged to remain current in their professional skills through participation in the ALMC Reading Program. Books from which participants may select are jointly approved by the ALMC and the ASM.

Additional information may be obtained by writing to: The Registrar, U.S. Army Logistics Management Center, Fort Lee, VA 23801.

Effective Management:

The Cornerstone of Successful RDT&E Programing

In addressing the Spring meeting of the Review Board of the Office of the Chief of Research and Development, in his capacity as chairman, Army Deputy Chief of R&D MG George Sammet Jr. emphasized the objective of applying effective management principles to Army RDT&E programing.

MG George Sammet Jr.

The OCRD Review Board, which convenes twice annually, is comprised of the Deputy Chief of R&D and the functional directors of OCRD. Nonvoting advisers include the Army Chief Scientist, representatives of the Office of the Chief of Staff, Office of the Assistant Secretary of the Army (R&D), and the Office of the Assistant Chief of Staff for Force Development, the Director of Weapons Systems Analysis, and RDT&E budget specialists.

MG Sammet said the primary objective of the Review Board is to recommend to the Chief of Research and Development a program that supports operational requirements and Department of the Army plans.

The goal is to provide a program that emphasizes, and realistically funds, those projects that promise the greatest reward. In order to make properly knowledgeable judgments, the Review Board hears detailed presentations of current and projected RDT&E efforts by all developing agencies.

MG Sammet opened his remarks by stating, "We must be positive that our programs are solidly justifiable. We must be ready to defend why our programs are essential, not simply base our case on what we propose to do."

In addition to the stated objective of the Review Board, as outlined in OCRD regulation 15-1, MG Sammet directed special consideration of the following RDT&E budget guidance.

"The importance of good management cannot be overemphasized. Our managerial responsibilities in developing an apportionment recommendation for FY 1974 and in properly defining, justifying, and funding the RDT&E program in the target year and outyears is a grave responsibility.

"Emphasis is no longer on expediency to solve the problems of winning a war; emphasis now is on management—responsible management that fosters the development of reliable hardware and equipment that can be used with confidence by the soldier.

"Good management also involves the ability to establish credible and meaningful internal project priorities. For example, almost without exception, in the development of a weapons system, the first and foremost priority must be reliability.

"Other qualifications and specifications for the weapons system should then be carefully prioritized in descending order following reliability, e.g., maintainability, extended range, mobility, maneuverability, air transportability, etc.

"Another management area that should be stressed," MG Sammet said, "is the establishment of a credible Initial Operational Capability (IOC). The IOC must be realistic and logical and should not be locked into a firm fixed format that comes only after full production.

"Some flexibility must be built into an IOC," he explained, "to allow for unforeseen developmental problems, or the application of new innovations resulting from technological advances. In many cases, an IOC date can properly be established after low-rate initial production, for this is usually when the first deployable unit is equipped.

"In the area of new starts, the Review Board must take a good hard look at each one. FY 1972 was a big year for new starts; we actually started eight large new programs. A problem occurs due to the fact that multiple new starts and existing big systems do not mix when it comes to a limited budget.

"Based on previous experience in defending the RDT&E program before Congress, it must be assumed that this year a large number of new starts will not be very well received or funded.

"A new start must be strongly justifiable in terms of the whole R&D effort. It must be remembered that when a new program is initiated, a multiyear commitment is made—both in RDT&E and PEMA (Procurement of Equipment and Missiles, Army) funds. Budget authorities expect the program to be completed in the proposed time and within the funds initially requested.

"The existing climate also does not favor laboratory growth. Although this is the time to build for the future, it is likewise the time to look inwardly and to determine what portion of the Army's laboratory structure is geared to the future and what portion is only reminiscent of past needs.

"Another management area that must be continually monitored is the obligation of appropriated funds. The RDT&E community must ensure that the scheduling of programs is in consonance with funding requests, and that obligation of appropriated funds is accomplished in an efficient manner.

"A primary goal for every program or project manager should be the elimination of year-end unobligated balances. Those that are not reduced to acceptable levels will be reprogramed where they will be used. The Review Board offers a vehicle for accomplishing this if necessary.

"In this same area of smart financial management, the words 'incremental funding' have been heard over and over. Adherence to the incremental funding policies, as outlined by the Office of the Secretary of Defense and the Congress, is the name of the game.

"Violations of these principles will most assuredly be picked up by the Congress and, as happened during the previous Congressional session, money will be lost. Incremental programing requires keen attention during program and budget formulation. It also requires special attention in the program execution phase.

"Some people still believe that the RDT&E program has a 'slush' fund. Nothing could be further from the truth. Unfunded or underfunded requirements are just what their name implies. By failing to fund a requirement, the developing agency is asking this Board to take money out of its 'hide' to finance the requirement.

"Developing agencies must stay within assigned budget limits. If an item cannot be funded by the developer, it is either not important enough, and therefore should be dropped, or the developer will have to identify some lesser priority work to accommodate it. A $2 billion RDT&E budget should permit funding of those projects that really need to be accomplished."

With respect to budget decrements, MG Sammet stated:

"There are those in the field who believe that decrements provide OCRD with extra funds. This belief is absolutely incorrect! Decrements are necessary during the budget formulation process in order to respond quickly to changes in budget guidance.

"It is not possible to reconvene a Review Board each time the budget guidance is changed, nor is it possible or even desirable to go to the field to resolve such exercises.

"This Board has asked the developing agencies to provide decrement type information in the form of identifying the lowest priority projects as a contingency in the event Congress levels an across-the-board cut in appropriations. Once the authorization and appropriation acts are passed, there are no decrements. Any dollars remaining in the decrement account will be immediately released.

"Without a doubt, during the management and execution phase of the FY 74 budget, there will be requirements for additional funds for high-priority unprogramed activities. These funds will be made available by identifying other projects that have not progressed as planned, or, if necessary, by deobligation from the lowest priority programs. The latter, of course, is the least desirable action. There is no OCRD 'kitty'—the developing agencies have all the money.

"It is particularly important that the 'Big Five' programs be fully funded. This means funding to the level required to perform all work on schedule so that critical milestones may be met. These programs are the most important Army RDT&E efforts. They have the backing of the Army's top management, and they cannot be allowed to slip or falter for lack of sufficient funds to do the job.

"Producibility Engineering and Planning, better known as 'PEP,' is now a part of the R&D program. OCRD received $27.1 million from DCSLOG (Deputy Chief of Staff for Logistics) APE (advanced production engineering) funds for FY 74. We are in the process of negotiating for the transfer of FY 75–79 APE resources to fund PEP. Once this FY 75–79 transfer is made, there should be no future unfunded PEP requirements.

"Developing agencies must remember that, in the future, the performance of PEP is an R&D responsibility and, as such, the funds for

its performance, if not properly programed, will have to be provided at the expense of other efforts. Once again, it is a matter of proper management."

MG Sammet expressed a word of caution on the decrementing of programs for the purpose of assisting other underfunded or unfunded areas. Decrements often result in slippages and cause cost overruns. This results in a compounding of the problem of attempting to provide sufficient monies to adequately fund all programs.

Current OCRD guidance is that no program should be decremented to the extent that cost overruns may be caused unless the program requiring the funds can be classified as critically important, and no other source of funds exists. Once a program is initiated, the developer has committed himself to a multiyear obligation.

Criticism is often leveled at the length of development time expended from initiation of a program to the IOC date. This can, in part, be attributed to the labeling of an *effort* as a *system* too early.

Once a group of items is labeled a system, it is thought to be one. This will likely create misunderstanding, as component development should remain separate and not be termed a system until the latter part of the validation phase in (funding category) 6.3. MG Sammet said it would be preferable for no development to be termed a system until it is ready to enter engineering development 6.4 funding. Unfortunately, the system acquisition cycle does not always allow for this, but it will allow for delay of the system designation until late in advanced development—the later the better.

Ideally, he explained, there should be no reason for change between approval of the President's budget and apportionment. The program should be carried out in the image in which it was planned. It is recognized that the ideal situation may never exist. Nevertheless, the Army should look askance at variations in the RDT&E apportionment request.

There will always be a few minor changes, he said, and with good justification. However, the Army must avoid what could be called 'whimsical changes.' This means that much better thought and planning will have to go into the formulation of the President's budget submitted to the Office of the Secretary of Defense late in the year.

MG Sammet provided guidance on any contemplated revisions of $2.0 million or more to the President's FY 1974 budget with unusual emphasis. Revisions of $2.0 million or more require a reprograming action that must be submitted to the Congress, and these actions have rarely been approved in a timely manner.

In addition, these reprograming actions reflect unfavorably on the Army's ability to develop and present a firm program. As a result, revisions of $2.0 million or more will not be favorably considered unless it can be conclusively demonstrated that critical programs will be seriously affected if the proposed increase is deferred until FY 1975.

MG Sammet's final point to the developing commands was that the field must realize that priority of developmental projects is a function of the Assistant Chief of Staff for Force Development—not OCRD. Thus, it is incumbent upon the developing commands to discuss this aspect of their program with ACSFOR.

In summary, he outlined the reasons OCRD requires all recipients of funds to present programs to the OCRD Review Board, as follows:

- The CRD, as the RDT&E appropriation director, has as his responsibility the defense of this appropriation before Congress. He must know what makes up the appropriation, and must be personally assured that he is able to back its content.
- Next, there are the management problems of unobligated balances and incremental funding. Management of these areas and their impacts on the program are Review Board areas of interest that affect all future programing actions.
- Finally, the total RDT&E appropriation is the result of Congressional deliberations. When such deliberations result in a lesser amount than that requested, it is up to the Review Board to recommend appropriate reductions to the CRD. It is his responsibility to make the reductions that provide the Army with the best R&D program possible.

MG Sammet concluded by summing up the reasons for everyone's presence at the Review Board in one word—**management!**

Flexible Package Wins NLABS' Employe Isker Award

Ten years of pioneering effort in managing development of the flexible package for thermoprocessed foods has earned U.S. Army scientist Frank J. Rubinate the COL Rohland A. Isker Award of the Research and Development Associates for Military Food and Packaging Systems, Inc.

Announcement of the award cited the chief of the Packaging Division, U.S. Army Natick (MA) Laboratories for "imaginative leadership . . . and unusual foresight in recognizing the military potential of a flexible package to replace the tin-plated steel can for military rations."

Rubinate's work within a decade has been compared to the invention and evolution of the metal can in the food industry over a 110-year span. He is credited with "sustained enthusiasm and belief in the project" and with persuading industry of the commercial prospects of the system.

Industrial suppliers, the NLABS reported, were encouraged by Rubinate to produce the required packaging materials at "no cost to the Army."

Frank J. Rubinate

Born in New York City, Rubinate attended the College of the City of New York and Polytechnic Institute of Brooklyn. In 1943 he became vice president and laboratory manager of Container Testing Laboratories, Inc., until he entered the Army in 1945. Since 1946, first at Chicago and later at Natick, he has headed various aspects of the Army's work on containers and packaging systems.

Author of numerous technical publications and a patent holder, he has represented the Army as a member of such organizations as the American Society for Testing and Materials, The Packaging Institute, Inc., National Security Industrial Association, R&D Associates, Inc., and Armed Forces Product Evaluation Committee.

Army Issuing Call for Papers for 1974 ASC

Many hundreds of U.S. Army scientists assigned to in-house laboratories can now begin thinking about how they can compete successfully for the coveted distinction of presenting a technical paper at the Ninth U.S. Army Science Conference in 1974. The dates are June 18–21 and the host is the U.S. Military Academy, West Point, NY.

Dr. I. R. Hershner, scientific director of the Directorate of Army Research, Office of the Chief of Research and Development, HQ DA, has announced that a call for narrative summaries of proposed papers will be issued in June. Based on interest evidenced in the 1970 and 1972 conferences, some 600 contenders are expected to submit summaries and about 100 will be successful.

As chairman of the 1974 Army Science Conference Advisory Committee, Dr. Hershner said the objective is: To provide a forum for presentation, critique and recognition of significant accomplishments by Army scientists and engineers.

The Chief of Research and Development LTG William C. Gribble Jr., who will sponsor the conference through the Army Research Office, Durham, NC, has indicated he desires that papers presented "be properly reflective of the scope, depth and quality of the Army's widely diffused research activities."

Narrative summaries will be submitted to headquarters of commands where the proponents are employed, and "must represent original work performed in an Army R&D installation."

Normally, authors of 10 to 15 honors papers share some $3,500 to $4,000 in cash honorariums presented through the U.S. Army Incentives Awards Program. The most coveted honor will be the Dr. Paul S. Siple Silver Medallion, initiated in 1970 to memorialize the famous U.S. Army polar explorer.

Serving with Dr. Hershner on the ASC Advisory Committee are James E. Norman, director of the Research Technology Division, Army Research Office, alternate chairman; Dr. Craig M. Crenshaw, chief scientist, U.S. Army Materiel Command, whose alternate is Dr. Gordon Bushey, physical scientist; Dr. Gilford Quarles, chief scientific adviser, Army Corps of Engineers, whose alternate is Robert F. Jackson, chief of the COE R&D Office; COL Dale E. Wykoff, chief of Research Planning, Army Medical R&D Command, with COL Francis C. Cardigan, director, Medical Research, AMRDC, as alternate. Mrs. Anne Taylor, a veteran of nearly 10 years on the ASC arrangements staff, is project officer.

ANNIVERSARY OF CERL . . .

Military, Civil Impact of Corps of Engineers' Facility Increasing

Impact of the U.S. Army Construction Engineering Research Laboratory, in its mission of applying total system planning and methodology to military and civilian construction requirements, is termed "a rapidly growing force" as CERL prepares for its fourth anniversary July 25.

CERL was dedicated on that date in the beginning of its present impressive complex of new buildings in the Interstate Research Park adjacent to the University of Illinois at Champaign. Army Chief of Engineers LTG Frederick J. Clarke was the speaker, and he stressed CERL's function to strengthen the Corps' over-all construction program, including military and civil works projects.

"The total systems approach," he explained, "allows diverse groups, working together, to understand . . . construction problems and needs.

"Through better communications and understanding, we can detect and usually eliminate the blind spots which often blur the vision of those parties concerned with construction problems—the owner, architect-engineer and the builder. If handled properly, systems approach can solve many problems before they are set in concrete and steel."

CERL did not become fully operational until more than two years later—following an intensive nationwide recruitment search to pull together the exceptionally skilled and carefully blended professional staff it now boasts, and continual expansion through a phased, extensive construction program.

"Projects and services of CERL today," Director/Commander COL Robert W. Reisacher and Deputy Dr. L. R. Shaffer joined in stating recently, "are limited only by the imagination and needs of the military establishment it serves."

CERL's short-term goal is explained: "To provide solutions to the immediate problems in military construction, with emphasis on vertical rather than horizontal design, through the use of new materials, improved habitability characteristics, industrialized building, new construction techniques, and improved operating and maintenance procedures."

Not too originally, since the slogan was used by many before Washington Redskins football coach George Allen blared it nationwide day after day during the 1972 season, it is stated that "For CERL, *The future is NOW.*"

Actually, that can be translated to mean that CERL's period of preparation for its dually important military and civilian role has climaxed, and that its carefully developed capabilities are fully ready to serve the nation.

CERL's long-range goal is defined as: the development of (1) lighter, stronger materials of greater durability for both theater of operations (overseas) and continental U.S. construction; (2) vertical systems built of elements to maximize the aesthetic and functional utility in the U.S. over its life-cycle of military construction, while minimizing construction, operation and maintenance costs; and (3) vertical systems in the theater of operations which minimize engineer troop effort, quality, and construction time costs — more construction for the dollar.

With construction costs continuing to rise at a rate of about 10 percent annually, CERL has active programs which, when completed, are expected to reduce the cost of vertical construction to the military in the continental U.S. by an estimated $75 million a year.

Further, in theater of operations programs and projects, a possibility exists that vertical construction will be able to be placed with 25 percent of the force and time now required—"if CERL's work in inflatable construction techniques is successful."

CERL's work program

currently is comprised of 14 projects to maximize life-cycle benefits while minimizing life-cycle costs of military facilities. The objective is to integrate technological development of the program into the construction process of the military.

CERL program activities have grown at a remarkable rate: in FY 70 they were financed by a budget of $700,000. The FY 73 budget is $6.7 million with an additional $1.2 million in reimbursable orders being received from other governmental agencies.

These projects encompass the major steps required in the procurement of vertical construction in the U.S. and in the theater of operations (T/O)—i.e., planning, architecture, engineering, construction management, and maintenance.

Research planning includes projects in Environmental Quality Management, Pavement Systems Management, and in the Army Functional Component System.

CERL is the designated lead laboratory in the Army for environmental quality in fixed facilities. Thus it undertakes environmental research that includes a system for the automated preparation of environmental impact assessments as well as devising methods to appraise the environmental impact of facility construction and maintenance.

Pavement research revolves around an automated model to identify the minimum life-cycle design schemes in building new or refurbishing existing airfield pavements. The Army Functional Component System aims at developing construction methods and materials requiring less time and fewer troops with less training in T/O construction.

Architectural research focuses on developing criteria for improving the aesthetic and functional habitability of military facilities. Industrialized Construction involves the how, why, when, and where of incorporating selective building systems into the construction program.

In engineering, the emphasis is on ballistic missile defense construction, fabrication technology, materials synthesis, environmental quality in construction and manufacturing, field army systems, and energy programs.

BMD construction research aims to develop ways to minimize erection time and costs of ballistic missile defense facilities.

Fabrication technology deals with developing techniques for quality control of construction, and research in materials synthesis strives to identify and scale constituents for composite materials systems which minimize construction and maintenance costs.

To manage environmental quality during construction and manufacturing, CERL research is seeking to reduce pollution from Army installations through innovative abatement concepts.

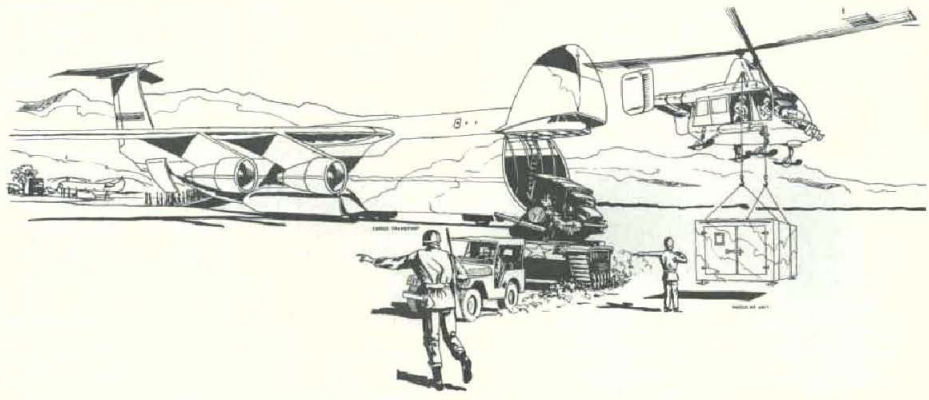
Field Army Systems research deals with improving the efficiency, economy and functionality of base camp construction. Energy research focuses on solutions to unique Department of the Army operations related to the growing national energy resources problems.

A dual-pronged probe into Construction Management—i.e., Optimization of Construction Management and Military Engineering Management—is under way. The purpose is to identify and evaluate procedures to maximize the productivity of the Corps' resources in the procurement of facilities; also, to develop aids for use by military engineers in T/O for optimizing the allocation of resources among construction projects.

Finally, in the area of CERL Maintenance Research, a Military Construction Automated Information and Retrieval System is operational. This is a computer-based procedure to assist Army personnel in planning, design, and construction and maintenance management of military facilities while developing minimal organic operational data bases to support these procedures.

Program Implementation

To conduct its many-faceted program, CERL has been organized into six divisions responsible for work in each of the 14 program segments. The divisions are Construction Systems, Data Systems, Electromechanical and Environmental Systems, Management Systems,



Shipment of Modular Construction Units

Pollution Control

Materials, and Special Projects. They are designated in terms appropriate for the "interdisciplinary approach" required to implement the program in vertical construction.

Manning these divisions is a professional staff of slightly more than 100, about 40 with PhD degrees. Professionals represent disciplines ranging from health scientists and engineering physiologists to civil engineers, sanitary engineers and physicists.

The diversity of these specialists is termed a solid basis for forming interdisciplinary teams (the systems approach) to attack the wide range of problems inherent in the procurement of vertical construction. The 170 employes presently at CERL represent an increase of 110 over the 1969 complement.

CERL has a construction systems lab, materials lab, and utilities building. An additional facility—the biaxial shock test machine building—is scheduled for completion this summer.

Currently, executive and administrative personnel occupy lab space, for lack of other offices, but planned expansion on the 30-acre site will alleviate this space shortage. The buildings and land are leased from the University of Illinois Foundation.

To fulfill the mounting demands being made upon CERL, some expansion already has been contemplated. An increase in lab space is being sought by constructing administrative buildings and in locating an accommodation for the environmental laboratory.

The biaxial shock machine is designed and built to proof test Safeguard ABM System equipment by subjecting 12 tons of load to an acceleration of 40 g's in both the horizontal and vertical directions.

Other major equipment items required to implement the CERL program include a modern Closed Loop Material Analysis System; an X-Ray Unit 400, IV; Dynamic Tension Analysis System; Scanning Electron Microscope; and a Structural Test Load Floor.

Dissemination of Research

All CERL research is conducted for use of the government agency requesting it. Results are disseminated through reports, symposia, computer programs, short courses, and technical manuals—all of which are made available to the private sector and to other governmental agencies on request.

Reports are made available through the Defense Documentation Center, Cameron Station, VA 22304. In addition, CERL publishes a quarterly organ which highlights the status of current work, lists recently published reports, and gives professional news of the staff. CERL REPORTS is available by contacting the Office of the Director.

CERL researchers have received various commendations for significant results and two have received Department of the Army Research and Development Achievement Awards. In February 1972, Bobby Gray received this award for his work in the development of fibrous concrete—concrete reinforced with steel fibers to provide a material of twice the strength, particularly suitable for airport runways, landing strips and roads.

In June 1971, Dr. E. Lyle Murphree received the same award for initiating the systems approach to solving airfield pavement problems, an approach which reportedly is finding rapidly increasing applications.

Accomplishments. Results of CERL research have been cited as significant in several areas. Steel-reinforced fibrous concrete has showed a 16 percent saving in initial costs on a half-million dollar project and maintenance savings on the order of 50 percent. CERL is spearheading the adoption of this material in U.S. construction in both the military and civilian communities.

CERL research shows that the industrialized building industry in the U.S. can provide facilities for the Army at about the same cost as conventional construction, but in only one-third to one-sixth the time without any special alterations to existing products. The current industrialized building project at Fort Knox, KY, is a spin-off of CERL's research.

CERL is pioneering habitability research and has developed criteria to make the interior designs of Army facilities compatible with the desires of the troops. Studies have shown that as much as a 35 percent reenlistment may be realized by attractive barracks designs, and that productivity can be improved 40 percent with a more pleasing environment in offices.

Reportedly, this research is getting wide acclaim and may lead to a change in the normal Army Engineering services. CERL researchers estimate that time and costs in construction of ballistic missile defense facilities by use of CERL advances can lead to a savings of 15 percent in construction costs.

Development of an on-line environmental impact assessment system containing 2,000 potential elements of impact is another CERL milestone. The system provides assurance to the Army personnel on any level that an environmental impact assessment on "his" work is complete and sufficient.

In the area of airfield pavement research, CERL has developed a computer-aided life-cycle system (LIFE I). This identifies the pavement system which will yield *least* life-cycle costs—initial cost and operation and maintenance.

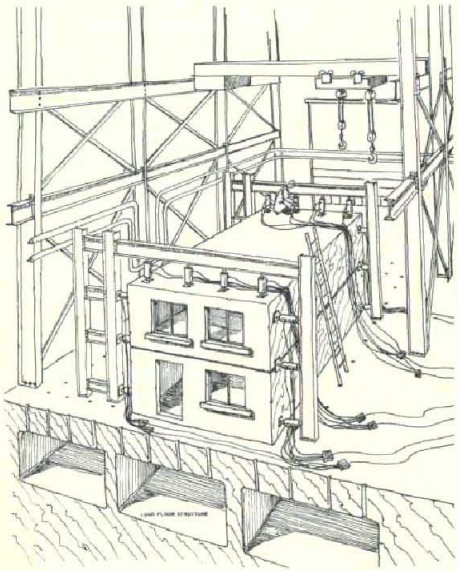
The Future. While CERL leaders consider accomplishments of the lab to date are impressive, they believe the future holds greater promise. Of the 14 program segments now in operations, all are expected to continue to be important and to be augmented to address other issues in vertical construction facing the military.

The ability of CERL to react quickly to define long-term R&D with short-term output of immediate usefulness is termed a "characteristic of the lab's research." This watchword has been the basis for CERL's present record and will continue to be true in the future. For example, CERL cites that it is currently leading the Corps of Engineers team for R&D in Army facilities for the energy crisis. The team includes the U.S.A. Cold Regions Research and Engineering Laboratory (CRREL), and the Engineering and Nuclear Power Group.

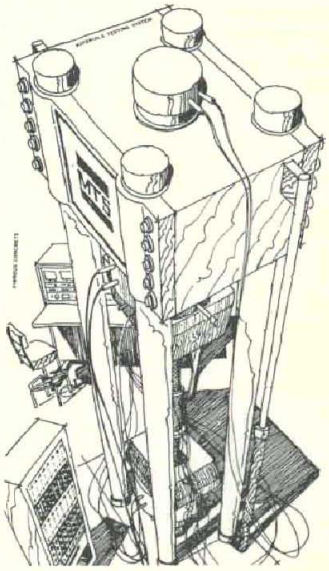
Another aspect of CERL stressed by leaders is its "reach out" philosophy. CERL R&D is monitored by decision-makers in an active construction organization, with results aimed at providing technical options.

Dealing with the problems of "tomorrow"—

(Continued on page 18)



Load Floor Structure



Closed Loop Loading System

Military, Civil Impact of Corps of Engineers' Facility Increasing

(Continued from page 17)

e.g., the energy crisis, environmental assessments, and habitability research–is CERL's job today, but the future is ever in sight. Because it takes from 7 to 15 years to integrate research into practical business applications, the work CERL does today is intended to provide solutions to tomorrow's problems.

Flight Conference Considers Helicopter Instrument Concepts

Concepts concerning the increasing need to provide instrument flight capabilities aboard all military helicopters were exchanged during a recent Instrument Flight Conference at Edwards Air Force Base, CA.

Sponsored by the U.S. Army Aviation Systems Command (AVSCOM), the 2-day meeting was hosted by the U.S. Army Aviation Systems Test Activity (USAASTA). About 150 engineers, researchers and test pilots from military agencies and private industry discussed current and projected instrumentation flight needs and rules.

AVSCOM Director of Research, Development and Engineering COL John C. Geary opened the conference with a challenge to develop specific guidelines for helicopter handling qualities and instrument flight mission requirements.

The lack of instrument flight rules (IFR) to cover the varying inventory of military helicopters, and the wide range of missions they perform, he said, currently hinders development of fully instrumented aircraft.

Director of Army Aviation BG William Maddox also stressed the need for development of specifications and standards for the successful evaluation of helicopter IFR operations. The foundations have been built, he said, for the day when helicopters will complete their missions regardless of weather conditions. Then Medevac, resupply, fire support and other more routine missions of the helicopter pilot, he said, will be accomplished in a manner that will greatly improve capabilities of ground combat forces.

Other problems considered included the stability and control of helicopters, such as: How much stability must the aircraft possess before it becomes suitable for IFR flight? Do all helicopters require the same degree of stability to complete all missions?

These questions combined with discussion on the development of flight director systems, the number of pilots necessary for IFR flight, the need for specified airways and approaches for helicopters, and how to handle icing conditions in flight, stimulated awareness of the magnitude of problems to be resolved.

COL ELWOOD J. HEIN, Picatinny Arsenal Ammunition, Development and Engineering Directorate, recently accepted, on behalf of PA Commander COL Jonathan L. Holman Jr., the 1973 National Society of Professional Engineers' Government Professional Development Award. Society president James Shivler Jr. presented the award with a citation recognizing Picatinny's "superior engineering employment practices." Presented annually, the award is a means of encouraging and rewarding superior engineering employment practices among federal, state and local government agencies.

Col. Robert W. Reisacher

Director and Commander COL Robert W. Reisacher has headed the U.S. Army Construction Engineering Research Laboratory since July 1972, served earlier as a military assistant to the Under Secretary of the Army, and was formerly in R&D with the U.S. Army Aviation Test Board.

Other assignments have included contract construction with the Corps of Engineers Mediterranean Divisions, the Alaska District, and as Saudi Arabia district engineer; staff and faculty, U.S. Military Academy; commander of the 7th Aviation Battalion in Korea; and deputy commander, Support Command, 1st Cavalry Division (Airmobile), Vietnam.

Graduated from Carnegie Institute of Technology, he has master's degrees from Princeton University (MFA) and George Washington University (MS). He completed a year's study at Edinburgh University, Scotland, as a Fulbright Fellow in 1952. He is a graduate of the U.S. Army Command and General Staff College, Armed Forces Staff College, and Army War College. Registered as an architect in the State of New Mexico, he is a member of the American Institute of Architects.

Dr. L. R. Shaffer

When he accepted an appointment as deputy director of the U.S. Army Construction Engineering Research Laboratory in July 1969, Dr. L. R. Shaffer placed himself on familiar ground. He earned a 1957 MS degree and 1961 PhD at the University of Illinois, where CERL is located on adjacent land. He received his BS degree in civil engineering from Carnegie-Mellon University.

Shortly after receiving his doctorate, he was selected to head the Construction Engineering Group in the Department of Civil Engineering at the university, and in 1963 became cochairman of the Civil Engineering Systems Laboratory. His career includes two years with the Sharon works of the National Castings Co. and two years as assistant to the director of engineering, Sharon Steel Corp., Sharon, PA.

During 15 years with the University of Illinois, his professional interest was focused on development and application of modern scientific management techniques to the needs of professionals in the construction industry. He continues this interest in his present job.

ALMC Announces Revision of Field Manual 38–7

Revision of Army Field Manual 38–7, "Materiel Acquisition Management," now retitled "Research, Development, Test and Evaluation Management," and renumbered AFM 38–70, is announced by the Army Logistics Management Center.

The ALMC announcement said the completely revised and concisely written document provides Army managers and technicians with a "viable and up-to-date compendium of RDT&E doctrine." It will be used in Army service schools and Reserve and National Guard Units as a text and instructor's reference guide. Incorporated in the new version is the most current Department of Defense and Department of the Army policies, procedures and organizational responsibilities for conducting and managing the complex process of developing materiel and weapon systems.

New topics not discussed in the previous edition include: the application of management science techniques to quantify the risk associated with materiel development; financial; procurement; engineering and logistical control techniques used during RDT&E; unique characteristics and philosophies of managing scientists and engineers; and the use of management information systems to assimilate, control and disseminate data on past, on-going and planned research programs.

The manual is expected to be available for issue to the field by August 1973. As controlled by local installation/command regulations, requests for the documents should be made either through appropriate local publications offices, or directly from the Commander, U.S. Army AG Publications Center, 3800 Eastern Blvd., Baltimore, MD 21200.

Report Stresses 'Sharp' Eyesight As Key Aid in Aircraft Detection

Capabilities of an unaided pair of "sharp" eyes for helping ground observers detect low-flying aircraft are difficult to improve–so concludes a recent Human Resources Research Organization (HumRRO) study.

Technical Report 73-3, *Attempts to Improve Visual Detection Through Use of Search Patterns and Optical Aids,* suggests that neither visual search training nor optical aids are of any great help in detection capabilities.

Experiments compared detection abilities of observers equipped with low- and moderate-powered optical systems and using different search techniques. Results suggest that persons with high visual acuity tend to use effective scanning procedures; those with average or poor acuity tend to benefit from visual-search training.

Fundamental vision characteristics (such as visual acuity and field-of-view) are believed to be the major sources of variance in determining the time required to acquire visual targets.

AMMRC Applies Moire Methods To Composites Stress Studies

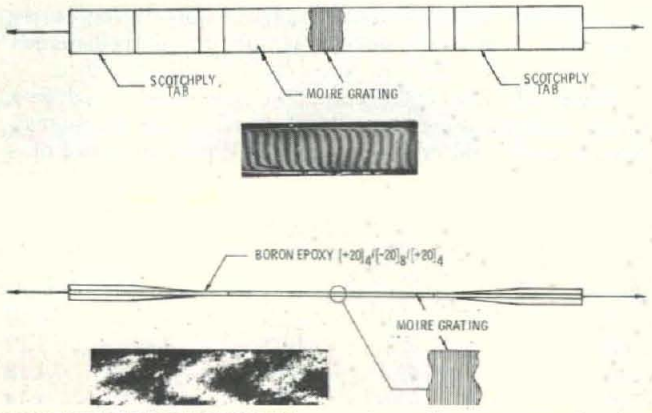
By Donald W. Oplinger and Burton S. Parker

Improved understanding of the way fiber-reinforced composite materials respond under mechanical deformation has emerged from recent theoretical and experimental studies at the Mechanics Research Laboratory, Army Materials and Mechanics Research Center (AMMRC), Watertown, MA.

Particular attention has been given to the development of refined moire methods. This technique, visualizing the fine details of the deformation of solid materials under complex stresses, appears to be particularly suitable for studying important aspects of composite response.

Fiber-reinforced materials generally incorporate fibers oriented in different directions to accommodate a variety of loading requirements. For example, in surface layers of composite materials incorporated in aircraft wings, requirements exist for both torsional stiffness to minimize flutter problems and for bending stiffness to give structural support to the aircraft.

Accordingly, several different fiber orientations must be present in the composite outer layers. Interaction of layers of differing orientation generates stresses that must be given special attention at free edges, holes, and other discontinuities.



MOIRE FRINGE PATTERNS on surface of boron epoxy laminate containing filaments oriented at 20° to long axis of specimen. *(Distortion in the fringes represented by deviation from parallel straight lines indicates the occurrence of shear strains near the specimen edge. Lower view (obtained on narrow edge of specimen) shows that layers of differing orientation deform by sliding parallel to each other in opposite directions).*

Earlier theoretical studies suggested that the load-carrying ability of the composite laminate would be degraded by the interaction of the various fiber layers. Findings also pointed out techniques for distributing the layers in such a way as to minimize the degrading effect.

Experimental verification of theoretical results, especially by a method such as moire patterns, was considered essential to validate theoretical predictions, and thereby to provide a firm basis on which practical engineering approaches could be based.

The accompanying photograph demonstrates the confirming evidence provided by moire measurements in a fiber-reinforced material. In both views, it is to be noted that if no interactions between fiber layers were present, the moire patterns would consist of uniform parallel straight lines, aligned perpendicular to the direction of applied tension in the laminate.

The pattern seen at the narrow edge of the specimen is particularly significant in demonstrating that the fiber layers of differing orientation tend to slide parallel to each other in opposite directions.

Current AMMRC work is aimed at exploring the consequences of these effects in adhesive and mechanically fastened joints. Thorough understanding of the performance of structural joints is considered a key factor in achieving maximum performance from fiber reinforced materials.

DONALD W. OPLINGER received a bachelor's degree in physics from Lehigh University in 1953, and his master's degree in physics in 1955 from the University of Rochester.

He has authored eight publications on the mechanics of synthetic fibers under processing conditions, and on the mechanical behavior of fiber-reinforced composites. He recently became a coinventor with the award of U.S. Patent 3,675,863, relating to improved methods for high-speed spooling of textile yarns.

BURTON S. PARKER received a BS degree in mechanical engineering from Northeastern University in 1943 and has completed graduate work in mechanics at M.I.T., the University of New Hampshire and Northeastern University.

Employed since 1954 at the AMMRC and its predecessor organizations, Parker is a registered professional engineer in Massachusetts. He has had a number of government reports and society papers published and/or presented and is a lecturer in mechanical engineering technology at Lincoln College, Northeastern University.

Watervliet Improves Gun-Boring Technique

Acclaimed as a "major advance" in cannon manufacturing technology is the development of a new bore guidance system at the Benet Weapons Laboratory, Watervliet (NY) Arsenal.

"The most significant process I've seen in my 32 years of gunmaking," stated Fred J. Clas, arsenal chief of operations.

Designed and developed by William Wondisford, Advanced Engineering Division, the method produces a bore straight to within five-thousandths of an inch along the 36-foot length of a 175mm barrel. Boring time is reportedly reduced by 31 hours, or 80 percent.

DISCUSSING SCHEMATIC of bore guidance system which they developed are Joseph Tenzyk (left) and William Wondisford.

Production of accurate deep holes—sometimes 40 times hole-size in length—has always been a major problem in the metalworking industry. This is especially true at the arsenal where the bore in a cannon must be ultra-precise to insure terminal accuracy of a projectile through a predictable trajectory.

The new system has proved vastly superior to the conventional method in which a series of reamers are passed through the gun tube several times to carry out the boring operations.

The system consists of cutting tools and a boring head with an accelerometer that detects and, through a servomechanism, instantly corrects any eccentric movement of the head—to preclude any deviation from a straight course in much the same manner as an automatic pilot keeps an aircraft on true course.

Only one pass through the tube is required instead of the several needed when the conventional method is used, thereby reducing the amount of surplus material on the outer diameter of the forging.

Watervliet Arsenal is presently employing two of the guidance systems—both on 175mm tubes. Because of the success of their performance, plans are under way to adapt the system for use in boring tubes for the 105mm gun and 155mm and 8-inch howitzers.

Use of the guidance system has determined that its application is feasible in the manufacture of hydraulic cylinders, turbine shafts, periscope tubes and other items that require the boring of long straight holes to precise tolerances.

SPEAKING ON . . .

(Continued from inside front cover)

• Our investment spending—that is, for construction, procurement, research and development—has increased only 1 percent in the last 9 years. That's a $300-million rise, but we are looking at a Defense investment of $22.9 billion this year.

To talk of an increase in our Defense investment spending since 1964 would be an inaccurate portrayal of the facts. The economy has experienced a sharp inflation since then. What we could buy with $22.6 billion in 1964 would cost $30.2 billion today. In reality, therefore, instead of a 1-percent increase over the last 9 years, there has been a 30-percent decrease in actual spending to modernize our nation's defenses.

Furthermore, we are not buying the same kinds of items in 1973 that we did in 1964. Today's weapons are much more advanced and therefore much more expensive than those we bought in 1964. These added costs are not reflected in the price indices used in this 9-year comparison.

Another point I wish to discuss is the ratio of our RDT&E and procurement funds to the total DoD budget. You read somewhere every day that costs of weapon systems for the Defense Department are increasing at such a rate that we are rapidly pricing ourselves out of the market, and that we will not be able to afford the kind of defense required for the future.

I want to point out that the two key accounts for developing and purchasing weapons are RDT&E and procurement. Since 1964 the calculated increase in these two accounts amounts to 25 percent, whereas in the same period the Defense budget went up 55 percent and the federal budget, 118 percent. *To be specific, the money spent to develop and purchase weapon systems over the last 10 years has increased less than any other part of the Defense budget—and this isn't even taking into account the general 39-percent price increase during this period.*

We actually operate within a constrained total budget. In other words, the total just doesn't go up—we have to swallow the added cost of inflation, technological advances and program changes. According to current DoD projections, RDT&E and procurement programs will not increase significantly in the next 5 years.

The problem is not only serious but intricate. The dollars spent for national defense this fiscal year will have the lowest buying power since 1951; manpower in the national defense will be at its lowest level since 1950; history shows that our defense systems are increasing in cost by a factor of 10 every 20 years. In a nutshell, the problem involves decreasing dollars and manpower, increasing costs, and an increasing potential threat.

There are, of course, several alternative ways out of this dilemma. One is to reduce force levels. This alternative has been used in the past, particularly as we developed and deployed more modern, cost-effective equipment. Part of our rationale has been that fewer, more effective, equipments must replace many, less effective, old ones.

We believe this total reliance on cost-effectiveness is no longer appropriate and that force levels are now approaching the minimum essential to enforce our national policy. The alternative of continuing to reduce force levels is a most unattractive solution.

Another alternative is to expand and formalize the concept of mixed force levels, which we have termed a high-low force mix. Under this concept, we would combine a smaller high-performance force with a larger standard force, the mixed force designed for lower total cost. We would seek technological superiority and a high degree of readiness and mobility for the high-performance force. This force would be designed against the worst threat it would be likely to encounter.

The standard force would be designed against the numerically largest threat, on the assumption that the high-performance force would be available to combat superior threats. This is not a new idea. The Army has traditionally had a few high-cost armored divisions and a larger number of low-cost infantry divisions. The Navy and Air Force have also been cost conscious in force planning.

There are two other equally important possibilities: One, we could place more emphasis on continuing to improve existing systems instead of embarking on new programs. The other, we could make an all-out effort to arrest the cost growth from constantly expanding requirements.

The total Defense RDT&E budget request for FY 1974 is $8,616.6 million, as compared to $8.019.5 million appropriated in FY 1973. Our proposed RDT&E program has been balanced as a result of an intensive review of both internal and external factors.

External influences on the RDT&E program are exerted by considerations of reduced manpower levels, increasing operations and maintenance costs, and competing demands to procure equipment for immediate force deficiencies.

Within the RDT&E account, we have tried to strike a proper balance among the fiscal needs of the technology base, ongoing and previously approved programs and pro-

TABLE 2
Comparison of RDT&E Budget with DoD Budget and GNP ($ Billions)

Fiscal Year	*RDT&E*	*Total DoD*	*% of DoD*	*GNP*	*% of GNP*
1960	5.6	42.0	13.3	495.2	1.13
1962	6.4	49.4	13.0	542.1	1.18
1964	7.0	50.9	13.8	612.2	1.14
1966	6.7	63.5	10.6	721.2	.92
1968	7.3	76.7	9.5	826.0	.88
1970	7.4	75.4	9.8	955.0	.77
1972	7.5	77.7	9.7	1,093.1	.68
1974	8.6	85.0	10.1	1,313.0	.65

TABLE 3
Defense Related RDT&E Budget in 1958 Dollars
($ Billions)

Fiscal Year	*RDT&E Budget*
1958	5.7
1962	6.1
1968	7.0
1972	5.5
1974	5.6

TABLE 4
Summary of RDT&E Programs by Budget Activity
($ Millions)

	FY 1972	*FY 1973*	*FY 1974*
Military sciences	532.4	488.3	517.9
Aircraft & related equipment	1,969.3	1,836.4	1,780.3
Missiles & related equipment	1,801.5	2,095.3	2,254.0
Astronautics & related equipment	388.9	407.9	602.5
Ships, small craft, & equipment	493.6	583.1	620.1
Ordnance, combat vehicles & related equipment	362.6	349.6	414.1
Other equipment	1,465.4	1,629.6	1,730.0
Program management, support	570.8	629.4	636.3
TOTAL	7,584.5	8,019.6	8,555.2

grams in the new-start category. We have recognized the out-year impact of our budget decisions, and have balanced our program in the out years.

You will note in Department of Defense Table 2 that over the last 9 years the RDT&E budget, as a percentage of the total DoD budget, has remained relatively constant (approximately 10 percent), while the RDT&E budget, as a percentage of the Gross National Product, has been decreasing steadily since 1962.

The reason these two percentages follow different trends is that in Fiscal Years 1967 through 1972, while the Defense RDT&E budget remained fairly level (between $7 and $7.5 billion), the GNP was increasing almost 10 percent each year.

Although our RDT&E budget remained fairly level during those years in constant 1958 dollars, the FY 1974 level is below that of 1958, as shown in Table 3.

Now let's look at the RDT&E budget activities as they are presented to the Congress, in Table 4. Some generalities on these budget activities are as follows:

Military sciences. This activity supports research of potential military application in the physical, mathematical, environmental, engineering, biomedical and behavioral sciences. The objective of this research is to provide the basic understanding we need to efficiently develop new systems and improve military operations.

Aircraft and related equipment. This activity funds RDT&E related to airframes, engines, avionics and other installed aircraft equipment, as well as applied research in supporting aeronautical technology. It also supports the development of major aircraft systems. Some programs receiving increases in FY 1974 are: A-X close-support aircraft; the EF-111A electronic support aircraft; the SCAD bomber penetration decoy; the STOL transport; the UTTAS helicopter; the heavy-lift helicopter and a new advanced attack helicopter.

Missiles and related equipment. This activity provides for RDT&E on missile systems of all types. Among the strategic programs, the TRIDENT system—the submarine and its ballistic missiles—shows a major increase in FY 1974. In addition, development will commence on a submarine-launched strategic cruise missile.

Military astronautics and related equipment. Funded under this activity are programs directed toward improving space technology for military purposes and developing space vehicles for particular military missions. Significant increases in FY 1974 apply to a prototype satellite to demonstrate precise navigation capabilities, increased emphasis on advanced surveillance technology, and missile attack assessment.

Ships, small craft and related equipment. This activity provides for RDT&E of ship structures and equipment, including propulsion, communications, navigation, and surveillance systems directly affecting ship operations. A significant increase in FY 1974 is programed for the development of surface-effect ships.

Ordnance, combat vehicles and related equipment. This activity supports the RDT&E of improved artillery, guns, rocket launchers, mortars, small arms, mines, grenades, torpedoes, nuclear and chemical munitions, and conventional air-launched weapons, as well as the exploration and evaluation of new fuzes, propellants, explosives, detonators, dispensers and armor. Programs receiving additional support in FY 1974 include improved guns for the A-X and F-15 aircraft, the prototype of the new Army main battle tank, a rapid-fire cannon for Army vehicles, and tri-Service programs exploring the feasibility of military applications of lasers.

Other equipment. This activity provides for RDT&E on equipment not separately funded under the other activities. Increases in FY 1974 for this activity will go for electronic warfare devices, tri-Service tactical communications, antisubmarine-warfare and undersea surveillance, and reconnaissance drones.

Program-wide management and support. This last activity supports the administrative and housekeeping efforts of the Military Departments as well as those of international military headquarters and agencies. The increase here for FY 1974 is due primarily to pay raises.

You might have noted that the total reflected on this table for FY 1974 does not agree with the total RDT&E budget request that I mentioned earlier. The reason for this difference is that the FY 1974 total shown here does not include the pay raises.

After examining these budgetary trends and our proposed solutions, there is one obvious conclusion: The R&D community will continue to operate within a fixed budget. If we are to support a proper mix of forces at an affordable cost, we must firmly establish cost as a dominant factor in the design of new systems—the cost to produce them, the cost to operate them, and cost to maintain them.

If production and O&M (operation and maintenance) costs are to be reduced, much more effort must go into improved design. Within our fixed RDT&E dollars, we must not only improve design and development effort; we must provide for more prototype programs, for more advances in technology, and for more test and evaluation.

I consider the FY 1974 RDT&E budget program to be transitional between the past emphasis on items to support our forces in Southeast Asia and future budgets which will place even more emphasis on maintaining and accelerating our technology.

As you know, our independent research and development program with industry, our in-house and contract research programs, and our exploratory development programs are designed to expand our technical knowledge to the limits. We are on the periphery of many new and exciting areas that hold great promise of improving our national defense position.

Looking ahead through the 1970s, I see the major thrusts in RDT&E directed toward extending our technology in the following areas: High-energy lasers; all-weather capability; night capability; strategic mobility; tactical mobility, particularly of ground forces; lethality of conventional weapons; weapons range; accurate location of enemy targets under night and all weather conditions; high-speed surface ships; unified command and control through better communications; electronic warfare; submarine detection and localization.

We will have to improve management procedures to: Speed up weapons development; reduce technical risk in development programs; increase coordination of requirements and technology; involve U.S. industry even more in meeting Defense Department requirements; increase international research, development, test and evaluation in collaboration with our Allies.

At the same time, we must continue application of our technology to improve the capabilities of our Armed Forces through: Better selection of personnel; better training methods and techniques; improved professionalism of our volunteer force by means of a better man-machine interface.

To accomplish the changes we anticipate, we will need the help, understanding and support of the American people, particularly from our partner on the great Defense-industry team. We must continue, for the foreseeable future, to maintain a defense posture second to none.

Dual-Cycle Rifle . . .

U.S. Army Small Arms Systems Agency Developing New Concept

By Lester W. Roane

The average rifleman, when in combat, doesn't hit his target very often. That is no indictment of the rifleman or his training or his weapon. It is simply a fact, a widely recognized fact, responsible for much of the commander's traditional concern for fire discipline.

Although "everybody" has known this fact for generations, perhaps for centuries, it was not until about World War II that it received the serious scientific attention it deserved. Both the U.S. and German armies then took a hard look at the issue and concluded that small arms ammunition expenditures in combat were extremely high relative to the number of casualties inflicted on the enemy.

Although figures vary widely, depending on the source and the combat conditions, it is safe to say that the number of rounds fired per enemy casualty runs well into the thousands for almost any realistic combat scenario.

In the years following World War II, the Office of the Chief of Ordnance (OCO) directed a great deal of attention to understanding the exact nature of the problem. By 1951, OCO had directed the Operations Research Office (ORO) to conduct a series of tests and mathematical analyses that would identify the specific elements of the problem and provide insights into their solution through weapons system design.

ORO projects and follow-on efforts included the SALVO program, which ultimately led to the Special Purpose Individual Weapon (SPIW), and the Small Arms Weapons Study (SAWS). Several extensive field tests were conducted at a variety of locations to back up the mathematical analyses.

The studies and tests resulted in several important conclusions that have strongly influenced the directions of small arms research, development and design. Certainly one of the most significant findings was that aiming errors in combat are very large because of the fleeting and obscure nature of infantry targets.

Following from that finding were weapons concepts intended to compensate partially for the aim error by firing several projectiles with each trigger pull. Dispersion of the projectiles increases target coverage and the probability of a target hit.

The concepts developed can be properly grouped into two classes:

- First is the "shotgun" approach of launching two or more projectiles from the same cartridge. Duplex or triplex bullets, segmented bullets, buck shot and multiple flechette rounds are typical of this approach. The design effort is focused on ammunition, since almost any semiautomatic rifle could be adapted to the role.

(A major advantage of the shotgun approach is simplicity of the weapon. Unfortunately, this advantage does not carry over to the ammunition, which is usually quite complex. In order to achieve adequate effective range, it is necessary to control carefully the dispersion of the projectiles so that the pattern on target will not be too "thin." This has been a persistent problem.)

- Second is the "machinegun" approach of firing controlled bursts of two or three separate rounds in rapid sequence each time the trigger is pulled. A major problem in this instance is to limit movement of the weapon during the burst so that projectile dispersion is held to acceptable limits.

(Solutions to this problem have been: 1) incorporation of muzzle compensators which deflect escaping propellant gases to cancel out partially the recoil-induced turning moments; 2) use of low-impulse ammunition; 3) high-firing rates intended to get the full burst out of the barrel before gun movement becomes excessive.)

Various weapon and ammunition designs incorporating one or more of the characteristics mentioned have been tested in recent years. Development of one burst-firing weapon, the flechette-firing XM19/XM70, has reached a fairly advanced state. In close coordination with the development work, some very revealing component and function tests have been conducted within the past few years. One of these tests showed clearly the desirability of very high cyclic rates in burst-firing weapons.

The cyclic rates of "conventional" machineguns, assault rifles and carbines generally lie in the 500 to 1,000 shot per minute (SPM) range. Multibarreled, externally powered "Gatling Gun" designs operate quite nicely at much higher rates (6,000 SPM and higher), but they are unsuitable for use by individual riflemen because of their weight and bulk.

As conventional rifle mechanisms are pushed to the higher cyclic rates, reliability and durability tend to fall off rapidly. A careful look at the conventional firing cycle reveals why this is to be expected.

When the round is fired, the moving elements must extract the empty case from the chamber, eject it and cock the hammer (if there is one) on the rearward stroke. The moving elements must also transfer energy to a storage device (usually a drive spring or buffer) and be brought to rest. On the forward stroke, a new round must be stripped from the magazine and chambered for firing.

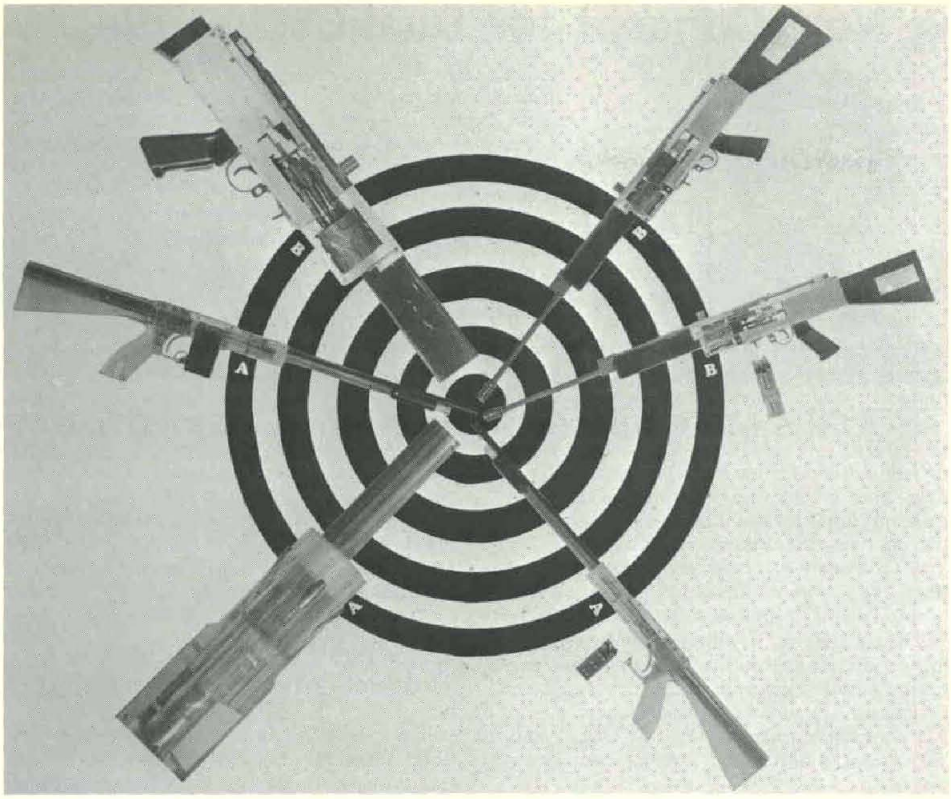
For military rifle cartridges, this sequence requires that the moving parts have average velocities of 10 to 15 feet per second (fps), in order to provide cyclic rates of 1,500–2,000 SPM. Peak velocities run several times higher than the average value, reaching 40–60 fps in most designs.

In this region, spring surging is a very serious concern. Additionally, impact loads at these high velocities are very high, producing stresses that may drastically shorten parts life.

Thus, the twin horns of the rifle designer's dilemma are: 1) a desire to raise cyclic rates dramatically so as to keep projectile dispersion at an acceptable level; and 2) a need to keep the velocities of the moving parts as low as possible so as to enhance reliability and durability.

Conventional gun design has not offered a satisfactory solution to these

USASASA Commander COL Raymond S. Isenson, Technical Director Leonard R. Ambrosini (left) and Robert F. Magardo, project engineer, examine a mockup of a Dual-Cycle Rifle. The new weapon concept promises increased effectiveness for individual soldiers, with burst-fire of several thousand shots a minute, according to developers.



MOCKUP MODELS of the Dual-Cycle Rifle under development by the U.S. Army Small Arms Systems Agency, Aberdeen Proving Ground, MD. Models (A and B) show complete assembly, the magazine removed, and closeup with cartridge ejection.

conflicting objectives. There simply has been very little that is genuinely new in rifle design since the first gas-operated self-loading rifles were introduced in the 19th century. For the most part, Messrs. Maxim and Browning would be quite comfortable with even the most advanced rifles in the world today.

About two years ago, engineers of the U.S. Army Small Arms Systems Agency (USASASA), under the direction of COL R. S. Isenson, commander, and Technical Director L. R. Ambrosini, took a fresh look at the problem. The result was a concept for a Dual Cycle Rifle (DCR) that fires bursts at a very high rate but performs other functions at a conventional low rate.

The concept was presented to industry as a Request for Proposals in 1971. Industrial interest was high, with 15 companies responding. Four were chosen for concurrent design and analysis of "paper guns," and fabrication of nonfiring mockups of the critical mechanical elements.

The four paper guns have been carefully analyzed and two were recently selected for continuation. Two firing prototypes of each design will be evaluated in a "shoot-off" to be conducted in 1973. A single design will then be carried into engineering development.

At the core of the DCR concept is recognition of the fact that the "fire" and the "clear/reload" functions need not occur at the same rate. High linear velocities of the moving parts are associated only with the clear/reload functions. The fire functions involve only small part movements and, therefore, do not require excessive velocities, even at firing rates of several thousand SPM.

A vastly simplified but generally valid analog is a conventional single-action revolver. As all devotees of cowboy movies know, a "six shooter" can be fired in pretty rapid bursts during a shoot-out (and with a single trigger pull, when the hero is "fanning" his gun). However, the empty cases are extracted and ejected and the cylinder is reloaded with live rounds at quite a casual rate.

The revolver analogy leaves a great deal of the total operation to the manual dexterity and personal preferences of the shooter. He decides how many rounds (1–6) should be in a burst. He cocks the hammer and largely controls the firing rate within the burst. Later, he sets his own pace for clearing and reloading. In a burst-firing rifle, we will want to have the weapon mechanism do all these things.

The basic operating concept, then, is to fire one and only one burst at the desired high firing rate (Cycle One), and then activate a clear/reload mechanism operating at a much lower rate. Component velocities during Cycle Two can be held to acceptably low levels. The weapon is then ready to fire another burst at the high rate with the next trigger pull. Thus the name: Dual Cycle Rifle (DCR).

Two specific designs now being pursued have several features in common:

- They use only one barrel. Multiple-barrel designs were discarded early in the evaluation due to unfavorable strength-to-weight figures.
- They are being designed around strictly conventional ammunition. This avoids mixing ammunition development with weapon concept evaluation at this early stage.
- They fire 3-round bursts only. Follow-on efforts may include provision for single shot/semiautomatic fire if user requirements call for it.
- They feed from similar magazines, having conventional spring-operated followers and conventional feed lips. The magazines are unconventional only in that they employ three parallel stacks of ammunition so that feeding of the three rounds is simultaneous.
- They are being designed for an initial burst rate of about 4,500 SPM while holding peak mechanism velocities around 30 fps.
- They employ very short strokes of lightweight parts during the fire cycle. Component velocities are reduced during the clear/reload cycle by picking up more massive components which must travel greater distances.
- Design weight of the loaded rifles is 7–9 pounds for either design.

The two designs differ significantly as follows:

Design A: The operating rod moves continuously to the rear during the fire and clear functions. Gas energy is provided to the rod after each round is fired. A 3-chamber asymmetrical rotating cylinder is used. The magazine is on the bottom. Starting from a loaded and cocked weapon, a simplified firing sequence is as follows:

- Fire Round 1 (using stored spring energy).
- Launch operating rod to the rear (using propellant gas energy).
- Index Round 2 into firing position and cock the striker (using energy of the moving operating rod).
- Fire Round 2 (operating rod is still moving rearward but in a cam-path dwell).
- Index Round 3 and cock striker.
- Fire Round 3.
- Open chambers for extracting and feeding (operating rod picks up additional moving parts, increasing mass; velocity begins to decrease).
- Extract empty cases.
- Stop operating rod on buffer.
- Launch operating rod forward (using stored spring energy).
- Strip 3 live rounds from the magazine.
- Eject empty cases (forward ejection).
- Index Round 1 into firing position, lock and rest for next burst.

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USASA Developing New Concept for Dual-Cycle Rifle

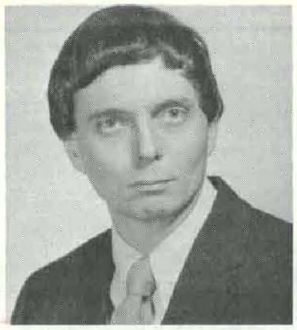
(Continued from page 23)

Design B: The operating rod shuttles back and forth over a short distance during the fire function, and over a much longer distance for the clear/reload functions. A 9-chamber symmetrical rotating cylinder is used. There are 3 extract/eject stations, none of which is coaxial with the barrel. At least 5 of the chambers are empty at all times. The magazine is on the left side. Starting from a freshly loaded and cocked condition (i.e., 3 chambers loaded with live rounds; chamber number 1 in the firing position; chambers 4–9 empty) a simplified firing sequence is as follows:

- Fire Round 1 (using stored spring energy).
- Launch operating rod to the rear (using propellant gas energy).
- Partially index Round 2 and fix the firing pin to the operating rod. The hammer is not used to fire rounds 2 and 3.
- Return operating rod to the forward position and complete indexing of Round 2 (using stored spring energy and residual momentum from the chamber drum). Fire Round 2 and launch operating rod to the rear.
- Index Round 3 and return operating rod. Fire Round 3 and launch operating rod to the rear for its "long" stroke cycle.
- Extract/eject empty cartridges from chambers 1 and 2. Compress drive spring. Stop operating rod on buffer. Launch operating rod forward. Feed Rounds 4, 5, and 6, index Round 4 into firing position, and rest for next trigger pull.
- Repeat the above cycle with only one change. Indexing of Round 4 puts the empty Round 3 case into an extractor position. Then when the next clear/reload cycle is initiated, three empty cases (3, 4, and 5) will be extracted and ejected.

Although the two specific designs described are being developed by commercial contractors, the basic patent applications have been filed by COL Isenson, L. R. Ambrosini and Robert F. Magardo of USASASA. Those derivative patents, which may eventually be obtained by contractors, based on federally funded research and development, will result in royalty-free use of the inventions by the U.S. Government.

In summary, the DCR represents a fundamental departure from conventional rifle design, the purpose of which is to improve significantly the combat effectiveness of individual soldiers. It is a genuinely new and very promising approach to a basic problem several generations old. Although additional study and engineering will be required to optimize ammunition, weapon components and reliability, the DCR looks like a most promising candidate for the next generation infantry rifle.



LESTER W. ROANE is chief of the Industrial and Quality Assurance Division, U.S. Army Small Arms Systems Agency, Aberdeen Proving Ground, MD.

Prior to assuming his present duties in 1970, Roane served various RDT&E assignments with the U.S. Army Test and Evaluation Command (TECOM); White Sands (NM) Missile Range; National Advisory Committee for Aeronautics—NASA's predecessor; and private industry.

Among his academic credentials are a BS degree in aeronautical engineering from Virginia Polytechnic Institute and a master's degree in public administration from Harvard University.

TECOM's Materiel Test Course Has Trained 1,619

Graduation of Class No. 50 in the U.S. Army Test and Evaluation Command's intensive training course for test officers recently boosted the number of its alumni to 1,619.

What began on an experimental basis in April 1967 as an "Orientation Course on Materiel Testing," and was promptly dubbed "TECOM College," is now a permanent fixture in the command's military and civilian personnel training program.

Courses are under the staff supervision of J. P. Jordan, director of the TECOM Personnel, Training and Force Development Directorate.

Thirty instructors are all key personnel working in the various staff sections of the HQ TECOM, Aberdeen (MD) Proving Ground, with long years of RDT&E experience. They represent the tier of management immediately concerned with planning, conducting and reporting of RDT&E conducted by TECOM field elements.

The basic 2-week course reflects one phase of a major continuing effort by TECOM to improve its performance as the Army's principal materiel testing organization. "TECOM College" stems from the unique nature of the command's military materiel mission. The course orients newly assigned military and civilian personnel in the planning, terminology, analysis and conduct of materiel testing.

As one of the nine major subordinate elements of the Army Materiel Command, TECOM provides the Army with an independent appraisal of weaponry. From its test reports, TECOM's only product, the Army can determine if an item conforms to specifications, if it is capable of doing the things it was built to do, and whether it will serve the needs of the American soldier in the field.

Logistics Engineers Schedule Product Integrity Convention

The Society of Logistics Engineers (SOLE) will address the theme of "Logistics and Product Integrity" during its 1973 international convention at Hunt Valley, MD, Aug. 21–22.

SOLE's primary purpose is "to engage in educational, scientific, and literary endeavors to advance the art of logistics technology and management."

The convention is one of SOLE's actions aimed at the practical application of defense contract-developed technology to consumer problems. Other objectives include serving the interests of people outside the logistics fields and an expansion of the horizontal view of SOLE to include the full scope of logistics.

Expected to attract leaders of the military, industry and U.S. Government, the convention will feature numerous technical papers. For information on how to submit papers of appropriate format write: Ray Harvey, Society of Logistics Engineers 1973 International Convention, P.O. Box 164, Hunt Valley, MD 21030.

Analyst Earns Presidential Award for $5.42 Million Saving

Secretary of Defense Elliot L. Richardson presented the Presidential Management Improvement Award to George V. Johnson, chief of the U.S. Army Troop Support Command's Cost Analysis Division, for saving the government $5.42 million.

Stemming from the President's emphasis on improving management effectiveness in the government, the award is the highest granted under the government-wide program directed to this goal.

Johnson was the only Army recipient among five recent Department of Defense employes honored with the award. The accompanying citation credits him with devoting more than 600 hours of off-duty time, at his own initiative, to develop two management techniques based on the log-linear S-curve model.

One of the techniques measures the cost of making design changes to a product that is in production. The second predicts the production costs for a product that is in R&D.

Johnson entered federal service in November 1962, following graduation in 1961 from the University of Alabama. In 1967 he departed from the Aeronautical Chart and Information Center, where he was associated with NASA's lunar orbiter program, to accept employment with the U.S. Army Mobility Equipment Command, since redesignated as TROSCOM.

'The Restless Earth'

National JSH Symposium Focuses on Geological Forces of Change

Characteristics of today's youth in response to social, economic and political worldwide forces of change appeared consonant with "The Restless Earth" theme of the U.S. Army's 11th National Junior Science and Humanities Symposium at the U.S. Military Academy, May 9–12.

Representative of the brightest scientific talent among some 6,500 participants in 32 regional JSH symposia throughout the nation during the past year, six students from each region were accompanied by about 100 selected teachers and regional officials as guests of the Military Academy. The U.S. Army Research Office, Durham, NC, sponsored the symposium for the Army.

Principal speakers included Prof. William R. Muehlberger, head of a team of about 20 geologists responsible for planning and analyzing the geological studies portion of the Apollo moon flight program; Dr. Diskin Clay, assistant professor of classics, Haverford (PA) College; Dr. Walter Pitman, Lamont-Doherty, Geological Observatory, Columbia University, New York City; and Dr. Tanya Atwater, Scripps Institution of Oceanography, La Jolla, CA.

Based on presentations of technical papers judged by student audiences (with built-in safeguards to assure that technical merit rather than popularity influenced the voting), five students were selected to attend the International Youth Science Fortnight.

Winners of the trip to England July 25 to Aug. 8 are: Daniel Faircloth, 18, a senior at West Columbus H.S., Cero Gordo, Chadbourn, NC; Roland Dolle III, 17, a junior at Dugway H.S., Dugway Proving Ground, Utah; William D. Steers, 17, a senior at St. Johns H.S., Toledo, OH; Miss Leslie McCament, 17, a senior at Highland H.S., Albuquerque, NM; and David Anick, 16, a senior at Ranney School, New Shrewdbury, NJ.

LONDON YOUTH SCIENCE FORTNIGHT award winners in the 11th NJSHS will go to England July 25–Aug. 8 for the international assembly of science students. LTC Robert C. LaFrenz (far left) will succeed MAJ Edward F. Bruner as U.S. Military Academy project officer for the 1975 NJSHS. LTC Edgar C. Hickson Jr. (center) ended four years of JSHS Program very active support as Army Research Office executive. Donald C. Rollins (far right) is director, JSHS Office at Duke University. The students are (l. to r.) Daniel Faircloth, William Steers, Leslie McCament, David Anick and Roland Dolle.

Dr. Donald D. Bode, University of Utah professor and director of the JSHS Program in the Intermountain Region, has been selected to escort the winners on the trip to London and during the extensive program of activities scheduled for their participation in the London International Youth Science Fortnight.

In opening the symposium as presiding chairman, COL Lothrop Mittenthal, commander of

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Schlesinger

Nominated to Become New Defense Secretary

President Nixon's May 10 nomination of Dr. James R. Schlesinger as Secretary of Defense to succeed Elliot L. Richardson, sworn in May 25 as Attorney General, was awaiting Senate confirmation as the *Army Research and Development Newsmagazine* went to press.

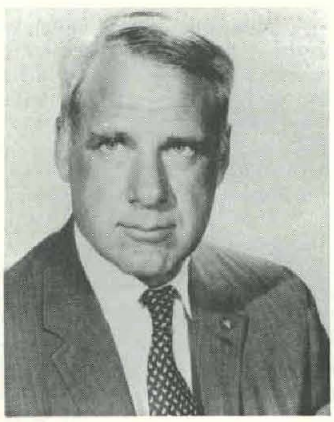
Dr. Schlesinger took office Aug. 17, 1971, in a 6-year appointment as chairman of the U.S. Atomic Energy Commission and was succeeded Feb. 6, 1973, by Dr. (Miss) Dixy Lee Ray, four days after he was sworn in as director of the U.S. Central Intelligence Agency (CIA).

When he became head of the CIA he had served since 1969 as assistant director, Bureau of the Budget. He was instrumental in framing the administration's energy policy, particularly in relation to air and water pollution, and served as the bureau's representative on the forerunner to the present Council on Environmental Quality. He later was acting director BoB, until it became Office of M&B.

From 1963 to 1969 he was director of Strategic Studies at the Rand Corp., specializing in strategic analysis with emphasis on nuclear weaponry. He also served as project leader for a government nuclear proliferation study.

Dr. Schlesinger was an associate professor of economics at the University of Virginia for eight years. He authored *The Political Economy of National Security* in 1960 and has written extensively on systems analysis related to political decision-making.

While teaching at the University of Virginia, he was a consultant to the Federal Reserve Board of Governors, and academic consultant to the U.S. Naval War College. He has a BS, MS and PhD from Harvard.



Dr. James R. Schlesinger

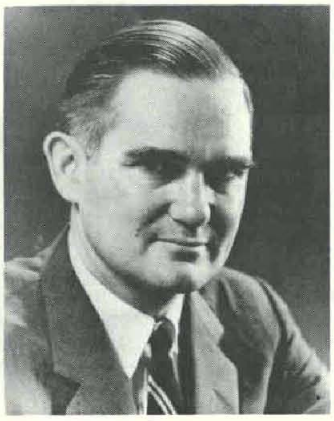
Callaway

Succeeds Froehlke as Secretary of the Army

Howard H. Callaway, a 1949 graduate from the United States Military Academy, was sworn in May 15 to succeed Robert H. Froehlke as Secretary of the Army. Froehlke had served since July 1971, and announced his resignation several weeks earlier to return to industry.

Until he accepted President Nixon's appointment, Callaway was president of Interfinancial, Inc., and chairman of the Finance Committee of Gardens Services, Inc., both in Georgia. During 1965–67 he was representative of Georgia's Third Congressional District and in 1966 was a candidate for governor.

After graduating from the Military Academy with a BS degree and a commission as a second lieutenant, he served in the infantry until 1952. In the Korean War, he participated in three campaigns as a platoon leader with the Far East Command, earning the Republic of Korea Presidential Unit Citation and Combat Infantry Badge. Later he served two years as an instructor at the Army Infantry School, Fort Benning, GA.



Howard H. Callaway

An active member in numerous business, political, educational and civic enterprises, Callaway was named by former Secretary of the Army Stanley R. Resor as a civilian aide for the Third Army Area in 1970.

He has also served as president of the Young Presidents Organization, chairman of the Council of Trustees of Freedoms Foundation, Valley Forge, PA, and is a member of the Association of the U.S. Army. He is a former member of the Advisory Commission on Intergovernmental Relations and the Board of Regents of the University System of Georgia.

National JSH Symposium Focuses on Geological Forces of Change

(Continued from page 25)

the U.S. Army Research Office, posed the question: "Why would the Army sponsor such an activity?" Then he explained:

"First of all, the Army is very much involved in science, basic research—we use the fruits of basic science in our applied technology. We also participate in science and our laboratories are staffed with skilled scientists; we support research in the universities; we have a long tradition of being interested in and using science.

"Obviously, then, we have an interest in letting other people know about our interest and in stimulating young people such as yourselves to embark on a career in science. We are also very much interested in the humanities as they relate to the broad background of a scientist and contribute to an awareness of the impact of science on civilization."

U.S. Military Academy Superintendent LTG William A. Knowlton welcomed the attendees by commenting that the National JSHS has been held at the USMA on a biennial basis since 1963, alternating with the Army Science Conference.

"Your theme this year, 'The Restless Earth, is timely and should be of lasting value. Many of our academic courses at West Point relate to the environmental issues. . . . We share the widespread concern about the ecological problems and the realization that accurate knowledge of complex earth processes is essential to any satisfactory solution.

"With my academic background in the social sciences, I am particularly pleased at the interdisciplinary approach which your symposium will take. We recognize that scholars from all disciplines must join in helping to solve the nation's current problems.

"The objectives of your symposium—to promote study and experimentation in the sciences, to emphasize the role of science and the humanities in the national culture—are parallel to academic aims at the military academy. . . ."

In preparation for basic understanding of the theme of the symposium, attendees viewed a television documentary film, "The Restless Earth," soon after arrival. The film depicted continental changes traced scientifically to Earth's formation and through evolutionary cycles to its current status.

Judged by the enthusiastic response of the students, certainly one of the symposium highlights was a presentation by the USMA Department of Earth Space and Graphic Science. A "multimedia," hard-hitting review, it was titled "The Good Earth." Essentially, it was a composite of newspaper, magazine and film clips that carried a hard-hitting message about current environmental pollution throughout the U.S. Musical parodies added rollicking humor. Department head COL Gilbert W. Kirby Jr. chaired this session.

High-level support of the JSHS Program throughout the U.S.—involving 38 states and scheduled to increase with the addition of four new regions next year, making a total of 36 regions—was attested by the distinguished leaders of 11 concurrent discussion panels.

The four new regional directors who attended the National JSHS for the first time are: *Indiana,* Prof. Kenneth W. Uhlhorn, director, Science Teaching Center, Indiana State University; *Louisiana,* Dr. Harry Bennett, Louisiana State University; *Missouri,* Dr. Charles R. Granger, Department of Biology, University of Missouri at St. Louis; *Texas,* Dr. Dale Bettis, Department of Aerospace Engineering, University of Texas.

EMPATHY IN THE EXTREME was achieved by Dr. Tanya Atwater, Scripps Institute of Oceanography, by her completely informal NJSHS presentation. When she finished her address, students crowded the stage to continue questions regarding her study.

KEYNOTE SPEAKER Prof. W. R. Muehlberger, head of NASA's team of geologists for the Apollo program of moon surface studies, chats with COL Lothrop Mittenthal, commander, U.S. Army Research Office and chairman of the NJSHS, and LTG William A. Knowlton, superintendent of the United States Military Academy.

Discussion panel chairmen and topics were:

Group 1, Dean Ralph Fadum, "The Conservation and Development Dilemma." Group 2, Dr. John Vance, "Science in Society." Group 3, Dr. Edward M. Eyring, "The Quest for an X-Ray Laser." Group 4, COL George F. Leist, "The Science of Mind Control and How It May Contribute to the Benefit of Mankind."

Group 5, Dr. Harry L. Levy, "Computer Assisted Instruction in the Humanities." Group 6, Robert A. Rice, "Is Greater Education Important to YOU?" Group 7, Robert Rines, "The Need and Role of the Scientist in Law and Government Administration." Group 8, Dr. A. Paul Wishart, "The Energy Crisis."

Group 9, Dr. Sylvan Mikelson, "The Drug Scene: Some Issues in the Sciences and the Humanities." Group 10, Dr. Maynard Miller, "Entropy and the Dynamic Self-Regulation of Geologic Systems." Group 11, LTC Robert A. Hewitt, U.S. Military Academy, "The Government's Role in Environmental Problems."

STUDENT PAPERS were presented by selected representatives of each of the 32 regional JSH Symposia during the past year.

Award winners for the visit to the London Science Fortnight and the titles of their presentations are: *Daniel Faircloth,* Phosphatidyl Choline: a Carbon Dioxide Diffusion Accellerator; *Miss Leslie McCament,* Antibiotic Properties of Lichens; *Roland Dolle III,* The Investigation of Potential Uses for the Essential Oil of Artimisia Tridentata (Utah sagebrush); *William D. Steers,* The Isolation and Elucidation of Structure of an Alkaloid from Rhus typhina; *David Anick,* Analysis of the Game of Dots and Related Games.

Conjecturing about the scientific significance, the potential applications, of basic research performed by the most gifted students is interesting in view of their talents for careers in Army science. Take, for example, the paper presented by Roland Dolle.

Started as a junior science researcher, when his father—a U.S. Army career chemist at Dugway (UT) Proving Ground (now on duty at Camp Zama, Japan)—gave his son two chemistry sets for Christmas when he was in the third grade, Dolle has gradually built up a collection of about $1,000 worth of equipment in his garage laboratory.

More than eight months of intensive spare time effort went into Roland's project that made him a 1972 winner in the Intermountain Regional JSHS. Since Dugway H.S. has a policy of limiting entries in the regional to an outstanding sophomore, it was Roland's first big test since he won first place as a fifth grader in a H.S. science fair in Ohio.

The investigation included the isolation and practical application of sagebrush oil, in an effort to establish its potential as an insecticide. Roland found that the oil is highly effective as an insecticide, larvicide, insect repellant, bactericide and fungacide; also, that it is an effective solvent with possible preventive qualities for inhibiting metal corrosion.

President of his junior class, Roland has devoted most of his spare time for several years to research, including his work as a sophomore on "Application of Wet Qualitative Analysis for the Identification of Elements in Utah Rocks." He plays the piano, skiis whenever he has a chance, and likes to deep sea fish off the California Coast.

Daniel Faircloth's success in going to the National JSHS this year was the climax of three years of investigation—performed largely at the University of California at San Diego under special arrangements while he was attending James Madison H.S. He will enter Yale University this fall, intent on graduating with a degree in medicine and surgery, under a $5,150 scholarship award.

Daniel's research project examined the component micro-structure of a selected silicone polymer membrane. He discovered a process to alter the structure and enhance the diffusion rate of soluted carbon dioxide through the membrane. He hopes to develop a membrane suitable for an artificial lung.

A very tall, broad-shouldered, handsome youth, Daniel has five brothers and four sisters. His father is a Navy chief petty officer.

William D. Steers plans to enroll at Cornell University this fall, on a 4-year scholarship of $2,200 annually, and to major in biochemical engineering. Starting his home laboratory while he was in the fourth grade, he has acquired "about $2,500 worth of equipment."

William credits Father Charles Sweeney and Dr. Joseph Schradie at the University of Toledo for starting him on and assisting him during the 2½ years of research that culminated in success—the trip to the 11th National JSHS and now to the London Science Fortnight.

William speaks familiarly about ultraviolet, infrared and mass spectroscopy, nuclear magnetic resonance, elemental analysis and molecular structures—all associated with his research on the extraction and fractionization of *Rhus typhina* leaves. The abstract of his paper notes "nitrogen functional groups, a carbonyl group, -OH groups, benzene ring structures, and an oxymethyl group. The total structure of this compound is not known at this time. . . ."

Miss Leslie McCament is scheduled to enroll this fall at Texas Christian University as a premedical student. Her career objective is to enter pathological research and biochemical investigations. Her father is assistant head librarian at the university, and she will enroll under a 4-year National Merit Scholarship.

About two years of effort produced her

(Continued on page 28)

Froehlke Presents Pace Awards for 1972 Army Achievements

Secretary of the Army Robert F. Froehlke presented the 1972 Pace Awards at Pentagon ceremonies May 11 to LTC Hugh H. Trumbull Jr., Office of the Chief of Research and Development (OCRD), and Harold M. Cotner, Office, Deputy Chief of Staff (Military Operations).

Named in honor of Frank Pace Jr., Secretary of the Army from 1950 to 1953, the awards are presented annually to one Army civilian employe and one Army officer in recognition of outstanding individual achievement during the previous calendar year.

Primary consideration for the award is based on completion of a significant task or staff assignment which has brought benefit to the Army. This may include improvement in service, substantial financial savings or a significant technological or military development.

LTC Trumbull was recognized for beneficial applications resulting from a 1972 Army study of Utilization of Space Technology. The citation credits him with formulating a "dynamic program of action," based on the study, to focus the attention of the Army staff and appropriate Army agencies on space technology applications for ground systems. He was Army representative for some space-associated studies.

LTC Trumbull was recognized as the only member of the Army staff "assigned specifically to monitor, coordinate, and disseminate information pertaining to the Army's use of satellite data and space technology." As the Army member of the DoD Navigation Satellite Executive Steering Group, he also focused attention on the potential benefit of using satellite signals for Army navigation and positioning needs.

During 1972 he briefed the Defense Science Board, National Aeronautics and Space Council, Air Force Scientific Advisory Board, Army Scientific Advisory Panel and numerous other Army agencies.

LTC Trumbull is a 1958 graduate of the U.S. Military Academy and has a MS degree in aerospace engineering from Princeton University. Prior to joining OCRD he attended the Army Command and General Staff College. He served (1968–70) with the Advanced Ballistic Missile Defense Office, OCRD, Huntsville, AL.

Harold Cotner, a 32-year veteran of federal service, was cited for having distinguished himself during CY 1972 by imaginative and cost-conscious management of a broad range of unconventional warfare, psychological operations and civil affairs logistic and materiel programs. He is employed in the International and Civil Affairs Directorate, Office of the Deputy Chief of Staff for Operations, HQ DA.

Working "largely on his own initiative," the award nomination states, he led in the development of the Ideographic Composing Machine, which combines computer, hologram and laser technologies. This permitted, for the first time, the capability of typing Chinese, Japanese and Korean ideographs on a keyboard-operated machine.

Additionally, he designed and produced a unique foreign language manual on guerrilla warfare for use in field operations.

Cotner graduated from Kansas State College in 1941 with a BS degree in industrial arts education. During 1941–47 he served as an enlisted man and later as an officer in the U.S. Army Corps of Engineers.

Presentation of the 1972 Pace Awards marked 10 years since the initiation of the event. Previous recipients acclaimed for their R&D achievements have included LTC C. J. Le Van, OCRD (1962); MAJ Charles K. Heiden, OCRD (1963); LTC Edwin S. Townsley, OCRD (1965); LTC Patricia T. Murphy, ANC, Office of the Surgeon General, and Carleton H. Gray, Office of the Chief of Engineers (1966); and LTC Stan Sheridan, OCRD (1967).

Former Secretary of the Army Frank Pace Jr. was among the dignitaries in attendance at this year's awards ceremonies. Others included Secretary of the Army Robert F. Froehlke; Under Secretary of the Army Kenneth E. BeLieu; Acting Assistant Secretary of the Army (R&D) Charles L. Poor; Former Army Chiefs of Staff GEN Maxwell D. Taylor, GEN Lyman Lemnitzer, GEN George Decker, GEN Harold K. Johnson and GEN J. Lawton Collins; LTG J. G. Kalergis, Assistant Army Vice Chief of Staff; LTG William C. Gribble Jr., Army Chief of R&D; LTG John Norton, commander, Combat Developments Command; and BG Donald R. Keith, Director of Developments, OCRD.

MILITARY WINNER of 1972 Pace Award, LTC Hugh H. Trumbull Jr., his wife Ann, daughter Donna, and son Pete, pose with Frank Pace Jr., former Secretary of the Army (1950–1953), and former Secretary of the Army Robert F. Froehlke (1971–1973).

CIVILIAN WINNER of 1972 Pace Award, Harold M. Cotner and wife Patricia are shown during award ceremonies with former Secretary of the Army Frank Pace Jr., for whom the award was named, and former Secretary of the Army Robert F. Froehlke.

National JSH Symposium Focuses on Geological Forces of Change

(Continued from page 27)

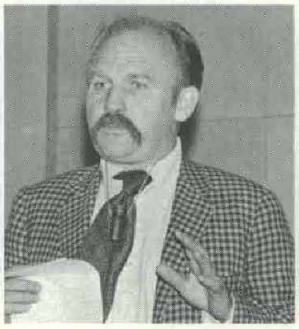
award-winning paper for participation in the 11th National JSHS and the forthcoming London Science Fortnight. Her objective was to validate the efficacy of early antibiotics derived from lichens.

In tests of five varieties of lichens, she established that four of them effected bacterial inhibition. Although she points to the need of additional research, she believes that he findings to date do point to the potential importance of lichens as medicines.

David Anick's ambition is to become a mathematician or an engineer and he will start toward that goal this fall as a student at Massachusetts Institute of Technology under a National Merit Scholarship award. His father is an Army career scientist with the Electronics Command at Fort Monmouth, NJ.

David has developed what he considers an "absolutely fool-proof system"—"at least it has always been successful to date"—of winning at the game of dots. Based on observations of other contestants as well as his own participation, he devoted about six months of mathematical calculation toward developing the rationale of his technique.

Dr. Diskin Clay
Humanities speaker



Dr. Walter Pitman
Plate Tectonics speaker

BG J. R. Jannerone
(Dean of USMA)

KEYNOTE ADDRESS. Prof. William R. Muehlberger's address was a fascinating account of his experiences and observations as leader of a team of NASA geologists who worked with the astronauts in planning for geological studies of the moon's surface during the Apollo missions.

In detail, he described characteristics of the moon, its craters, mountains, various rock formations, soil and other conditions as investigated by the astronauts during their moon walks. One of the largest craters, he said—by way of explaining results of the still continuing impacts of meteorites—is about the distance from the Military Academy to the city of Chicago in diameter, with the rock structure broken to a depth of 20 miles.

The "spectacular successes" in collecting rock specimens and in making visual and instrumental determinations, he said, have "opened a window" to the beginning of how planets were put together. The return of some rocks estimated to be 3.7 billion years old resulted, he said, "in a scramble to restudy the Earth, and since we have found older rocks here on Earth."

More than 2,000 scientists throughout the world are now participating in the study of the specimens from the moon as they may be interpreted in respect to geological history dating back billions of years. Some of the moon's mountains, he said, are "fantastically big . . . more than 7,000 feet in altitude. . . ."

Prof. Muehlberger closed his presentation with a film showing the areas of geological studies on the moon and the equipment and techniques employed. The film ended with some remarkable views of the Earth and Antarctica taken by the astronauts during their flights.

After graduating from California Institute of Technology, where he earned BS, MS and PhD degrees, Prof. Muehlberger achieved national prominence by his structural studies of many geological aspects of the United States. Since 1954 he has been identified as a faculty member at the University of Texas, and from 1966 until he joined NASA's staff in 1971, headed the Geology Department.

HUMANITIES ADDRESS. In discussing "Greek Cosmology and Cosmography" in the "Humanities Address," Prof. Diskin Clay presented a scholarly review of the efforts of ancient Greek leaders to understand the universe.

Early cosmological speculation, he said, generally defined the masses of the natural world as "air, earth, fire and water." Their efforts to conceptualize an original generative source resulted in strongly divergent views, even as is true in many of the current scientific hypotheses.

One contention given substantial support was that the universe was surrounded by a great fiery membrane before it ruptured, resulting in the movement of the Earth, the Sun, the Moon and other planets. This view is expressed by many modern scientists as the "Big Burst" cataclysm of change.

Plato, Aristotle and the Stoics who followed them held that the creator had ordered purposes and ends in mind and that "God and Nature did nothing accidentally or in vain," Dr. Clay said. Speaking of Socrates when he was in jail awaiting execution, he described his inquiry into the forces of nature by quoting him: ". . . When I was young, I had a passion for this; for I thought it was sublime to know the causes of each thing; why it came into being; why it was destroyed; why it exists. . . ."

Dr. Clay explained the viewpoints of the Greek philosophers dating back to Herodotus as the "father of history," Hesiod's epic on the origins of the Greek gods in which he referred to the Earth as the unshakeable seat of the Gods. He commented on the philosophical contributions from Empedocles back to Homer, including Poseidon's views on the Iliad, the thinking of Anaximander, Thales, Anaximenes, Alcmaeon and a long list of the great Greeks.

Dr. Clay is the author of numerous publications relating to Greek history and philosophy. In 1963-64 he and his wife were members of the American School of Classical Studies in Athens, following his experience during three years as a Fulbright and then as a Woodrow

(Continued on page 29)

ESCORT OFFICER for students going to London Youth Science Fortnight, Dr. Donald D. Bode, is shown (l. to r.) with John Reiher, Delaware Region JSHS director; Dr. Sherwood Githens, senior advisor and one of the founders of JSHS Program; BG Robert Bernstein, acting commander, Walter Reed Army Medical Center; COL George F. Leist, JSHS Program "founding father"; Dr. Sidney Magram, Army Research Office in Durham, N.C.

JSHS REGIONAL DIRECTORS (l. to r.) Dr. A. Paul Wishart, University of Tennessee; Dr. Mark Foster, Univ. of Virginia; Dr. John Vance, chairman, JSHS Advisory Committee; Robert A. Rice, Univ. of California; Eugene B. Wittlake, Arkansas State Univ.

Awards . . .

TEN U.S. PATENT AWARDS were issued to the U.S. Army Materiel Command's Harry Diamond Laboratories, Washington, DC, during the first quarter of FY 1973. Announced recently, this feat maintains HDL's record of accounting for 15 percent of all U.S. Army patents in recent years. HDL has less than 0.5 percent of U.S. Army civilian personnel strength. HDL Technical Director Billy M. Horton presided at the patent awards ceremony. In the front row are (l. to r.) Fred Harris, Phil Ingersol and Joe Warwick. Second row: James Meek, Donald Mary, Ira Marcus, Harry Davis and Vondell Carter. John Furlani (not shown), Davis and Ingersol shared a patent for "Electronic Device Applicable to Ordnance Safety and Arming System; Clyde Morrison, Donald Wortman and Rueben Farrar (not shown), "Nuclear Charged Self-sustaining Laser; Mary and Davis, "Remotely Sensing Optical Tachometer." Individual awards were presented to Dr. Maurice Apstein (not shown), HDL associate technical director, for "Fluidic Generator"; Warwick, "Injection Moldable Flammable Composition and Devices Made Therefrom"; Marcus, "Coded Tape and Open Contact Sensing Circuit"; Carter, "Flueric Temperature Sensor; Harris, "Magnetically Controlled Proportional Fluid Amplifier"; Fred Flad (not pictured), "Electric Timer with Nonvolatile Memory"; Meek, "Differential Motion Timer."

THROUGH THE U.S. ARMY INCENTIVE AWARDS program, nine Harry Diamond Laboratories employes were honored recently with group Special Act or Service Awards. Shown in the first row (l. to r.) are Klaus Sann, Harlan Oelke, Kenneth Doster and Robert Gregory. In the rear are HDL Commander COL David W. Einsel Jr., Dennis Cook, William Trueheart, Sam Breskend, David Watson, Joe Archuleta, and HDL Technical Director Billy M. Horton. Design and fabrication of an aircraft instrumentation package, termed a "significant advance" in windowless antenna radar systems, earned a citation for Sann, Cook, Doster, Oelke and Trueheart. Watson, Archuleta, Breskend and Gregory contributed to Lance missile fuze testers development.

'THE RESTLESS EARTH' . . .

(Continued from page 28)

Wilson Fellow. He received his PhD in 1967 with a dissertation on "Lucretius' Translation of Greek Philosophy."

Dr. Walter Pitman's presentation as a veteran member of the staff of Lamont-Doherty Geological Observatory, Columbia University, NY, was directed to the relatively new geologic concept of plate tectonics.

In support of this theory of historic and continuing continental drift, he showed a map of the world as it is believed to have existed some 200 million years ago, when all major continents formed one huge land mass. Some 45 million years ago, this mass began to break apart into the continents as they exist today.

Geologists have established that six major tectonic plates and many microplates, along with many oceanic ridge structures, are involved in the current continental drift, Dr. Pitman said. Although this shift is evident in numerous geologic studies, the last major change is fixed about 700,000 years ago.

Dr. Tanya Atwater, who recently passed her 30th birthday, was acclaimed by her admiring audience of teenagers as "really something" —an enthusiastic appreciation of her complete informality in discussing the topic: "Will California Fall into the Sea? How the New Theories of Continental Drift Help us Understand the San Andreas Fault."

In her work with the Scripps Institute of Oceanography, Dr. Atwater has devoted a large share of effort in recent years to studying the subject she presented. "She really brought it down to earth for our understanding," one student commented. Never at any time did she deviate from her disarmingly unaffected approach—something like, "OK (an expression she used a great deal) fellow students, here's something that really fascinates me. Let's rap about it a bit."

Time and again Dr. Atwater stirred laughter and bursts of applause. When she finished, students swarmed up to the stage seeking an opportunity to speak to her.

Participants in the 11th NJSHS will probably long cherish many memories of their visit to the U.S. Military Academy—talks with many of the cadets in classrooms, a walking tour of historic points that included the messhall where 4,000 cadets can be served home-style meals in 90 seconds, the chapel organ now being expanded into the third largest in the world, and the beautiful religious music played by Dr. John A. Davis Jr.

Add to those memories the earnest young face of the Rev. Nelson W. Kocheski Jr., USMA chaplain, as he gave the invocation: *"Let us pray. Almighty God that placed us in a world of awe and mystery, open our eyes, we beseech Thee, that we may behold the order and wonder of Your creation. Enlighten our minds that we may comprehend all that You have set before our gaze.*

"Enkindle our hearts that, seeing and understanding, we may also love the world and those with whom, through Your divine decree, we share it. Grant, O Father, that men whose eyes, minds and hearts are set toward the truth may some day live together in peace, security and plenty. This we ask, almighty Father, in the name of the word for which this world was created."

EXCEPTIONAL CIVILIAN SERVICE. *Dr. Maurice Apstein,* associate technical director of the U.S. Army Harry Diamond Laboratories, recently received the Exceptional Civilian Service Award (ECSA), the Army's highest award for civilian employes.

Acting Assistant Secretary of the Army (R&D) Charles L. Poor presented the award. Dr. Apstein was cited for exceptional performance of duties and major contributions to defense systems from 1949 to 1972.

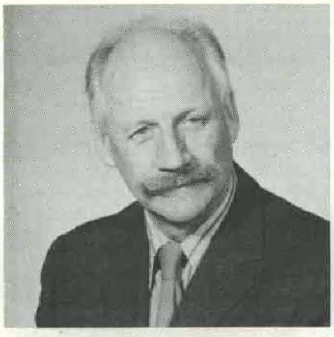
Herman P. Gay, U.S. Army Ballistic Research Laboratories, received the ECSA in recognition of his outstanding performance and scientific accomplishments. Dr. R. J. Eichelberger, BRL director, presided over the recent ceremonies.

Gay was credited with major contributions in research on kinematics and dynamics of automatic weapons and advances in computer simulation, pressure measuring techniques, and in-bore motion of projectiles.

MERITORIOUS CIVILIAN SERVICE. *Dr. Milton A. Laitman,* Office of the Army Surgeon General, was awarded the Meritorious Civilian Service Award at his recent retirement ceremony.

The citation praised his application of ingenuity and encyclopedic knowledge of civilian personnel management to the advancement of quality civilian personnel programs in the Army Medical Department.

LEGION OF MERIT. *COL Edward E. Bennett* was presented the Legion of Merit (LM) at his recent retirement ceremonies for service with the Army Tactical Data Systems (ARTADS) Field Office. BG Albert B. Crawford, project manager of ARTADS made the presentation.



Don C. Lindsten

John A. Zwolinski

Mrs. Agnes Taylor

Benjamin C. Barker

MERDC 16th Annual Achievement Awards Presented For Science, Technology, Leadership, Support

Army Chief of R&D LTG William C. Gribble Jr. gave the principal address and other ranking R&D leaders presented the U.S. Army Mobility Equipment R&D Center 16th Annual Commander's Achievement Awards on May 18.

Presented at outdoor ceremonies at Fort Belvoir, VA, the awards recognized John A. Zwolinski for scientific achievement, Don C. Lindsten for technological achievement, Benjamin C. Barker for leadership, and Mrs. Agnes Taylor for administrative/technical support.

SCIENTIFIC ACHIEVEMENT. Dr. James Renier, chairman of the Scientific Advisory Group, U.S. Army Troop Support Command, presented the scientific award to Zwolinski.

Selected by the MERDC Mechanical Technology Department, Zwolinski was cited for his achievement in conducting in-house research that led, for the first time, to the numerical solution of the turbulent flow diffusion equation. This mathematically models the fundamental principles of reverse osmosis, turbine combustor and diffuser, design and exhaust emission control.

The solution has been substantiated by extensive experimental results, thus providing the scientific community with a significant advancement in the basic theory of heat and mass transfer.

Zwolinski received a BS degree in mechanical engineering from Washington State University in 1968 at which time he joined the MERDC. He has since earned a master's degree from George Washington University and is completing course work toward a doctorate.

Dr. Jay A. Fox and *George W. Ulrich, Dr. Johann A. Joebstl, Dr. John R. Gonano,* and *George C. Esposito* were also nominated for the scientific award.

Fox and Ulrich, physicists in the Barrier Division of the Military Technology Department, represent the first 2-man team to be nominated in the 16-year history of the awards. They were selected for advancing the state-of-the-art in the spallation in materials when caused by short-pulse laser radiation and hypervelocity projectile impact.

As the Electrotechnology Department nominee, Joebstl was cited for his investigation of pure and contaminated platinum surfaces which produced results important in the development of superior catalysts for fuel cells and other devices.

Chosen by the Countermine/Counter Intrusion Department, Gonano was credited with a "significant breakthrough" in concepts of explosives detection by means of pulsed nuclear resonance and unique discrimination techniques.

Nominated by the Coating and Chemical Laboratory, Esposito was cited for his development of a rapid and accurate procedure for measuring total aromatics in enamels, lacquer, and thinners using liquid chromatography.

TECHNOLOGICAL ACHIEVEMENT. BG Joseph E. Fix, Deputy Director for Operations, Directorate of Research, Development and Engineering, U.S. Army Material Command, presented the technology award to Lindsten.

Lindsten was chosen by the Military Technology Department for his concept, development, design, test and type classification of a water treatment decontamination set. When used in conjunction with standard military purification units, it provides capabilities for producing drinking water from sources contaminated by chemical and biological agents.

Lindsten received a BS degree in chemical engineering from the University of Minnesota in 1940 and joined the R&D Center in 1948 after military service.

Other technological achievement nominees were *Mrs. Beverly D. Briggs,* Countermine/Counter Intrusion Department, for development of complex computer programs; *Douglas B. Uthus,* Mechanical Technology Department, for redesigns rendering over $15 million worth of cranes fully suitable for Army use in a broad range of applications; and *Donald D. Faehn,* Electrotechnology Department, for design and development of advanced concept centrifugal compressors for gas turbine engines.

ADMINISTRATIVE / TECHNICAL SUPPORT. COL Tenho R. Hukkala, MERDC commander, presented the Gelini Medal to Agenes Taylor. An honor initiated in 1971, the Gelini Medal is presented in memory of the late COL Walter C. Gelini, who was MERDC commander when he died in May 1970.

Nominated by the Technical Support Office, Mrs. Taylor is the second woman in 16 years to receive one of the MERDC Commander's annual awards. She was selected for her achievement in establishing the administrative framework for the newly organized Countersurveillance and Topographic Division.

Mrs. Taylor joined the R&D Center in 1968 after serving since 1953 in assignments that included the Office of the Chief of Engineers and the U.S. Army Medical Command, Japan.

Other administrative/technical support nominees were *Mrs. Peggy Thomas,* Equipment Management Office; *Omer F. Long,* Countermine/Counter Intrusion Department; *Chester W. Hughes,* Mechanical Technology Department; *James A. McKlevis,* Electrotechnology Department; *Richard H. Davis,* Technical and Research Support Office; and *R. G. Jamison,* Coating & Chemical Lab.

LEADERSHIP. MG Hugh R. Higgins, commander, Army Mobility Equipment Command, presented the leadership award to Benjamin C. Barker. Nominated by the Countermine/Counter Intrusion Department, he was cited for his direction of technical, test and evaluation, engineering and production activities associated with the initial production of the Joint Services Interior Intrusion Detection System.

Barker received a BS degree in electrical engineering from the University of Texas in 1961. He has been employed at the MERDC since 1967.

Other leadership nominees were *Darald C. Frink,* Mechanical Technology Department, for management of an engineering development program involved with new and improved environmental control equipment; *Edward Prada,* Electrotechnology Department, for technical and managerial contributions to the DoD project manager, Mobile Electric Power; and *MAJ Ferdinand Madsimowski,* Military Technology Department, for leadership of a major production system for camouflage screens.

Personnel Actions . . .

Pezdirtz Takes Over as AMC Chief of Staff

MG Joseph W. Pezdirtz

MG Joseph W. Pezdirtz, the new chief of staff, Army Materiel Command, succeeded MG Charles T. Horner Jr. upon his recent retirement.

MG Pezdirtz had served since 1971 as commander, Korea Support Command, Eighth U.S. Army. He was assigned as assistant G-3 for Plans, HQ Seventh U.S. Army, Stuttgart, Germany in 1966 and later served as commander, 4th Armored Division, Erlangen, Germany.

In 1968 he became deputy commander for Area Support, U.S. Army Communications Zone, Europe (redesignated U.S.A. Theater Army Support Command). Following a year as senior adviser, First Republic of Korea Army and commander, Detachment "L", U.S. Army Advisory Group, Korea, he served in 1970–71 as chief, U.S. Army Advisory Group, Korea, and later as special assistant to the commander, U.S. Forces, Korea.

MG Pezdirtz began his military career with an Army Reserve commission upon graduation from the University of Michigan in 1942. He is a graduate of the Command and General Staff College, Armed Forces Staff College, Naval War College, and the Armored School, Advanced Officer's Course.

Among his military decorations and honors are the Silver Star, Legion of Merit with Oak Leaf Cluster, Army Commendation Medal, Combat Infantryman Badge with Star, Distinguished Unit Citation, Republic of Korea Presidential Unit Citation, Army General Staff Identification Badge, and Joint Chief of Staff Identification Badge.

Hardin Directs Electronic Warfare Laboratory

Clyde D. Hardin

Director of the U.S. Army Electronic Warfare Laboratory at Fort Monmouth, NJ, is the new title of Clyde D. Hardin, a 20-year Army career scientist who until December 1970 was Special Assistant for Southeast Asia Matters to the Assistant Secretary of the Army (R&D).

Hardin left that assignment to become director of the Research and Development Counterpart Group in Korea, an Advanced Research Projects Agency (ARPA) unit set up by the Department of Defense to help the Republic of Korea create R&D capabilities.

Formerly with the Johns Hopkins Institute for Cooperative Research, Hardin entered federal service in 1948 as a scientist with the National Bureau of Standards in the Ordnance Division. This division later became the nucleus, in 1953, for the establishment of the Diamond Ordnance Fuze Laboratories, redesignated the Harry Diamond Laboratories in 1962. He headed the Advanced Research Laboratory (1959–65) and then became chief of the R&D Lab until 1969.

While with the Office of the Assistant Secretary of the Army (R&D), Hardin was senior Army representative to various Vietnam committees. These included the Defense Department's Project PROVOST (Priority Research Objectives, Vietnam Operational Support) Council. He also served with the Defense Communications Planning Group, the Army Scientific Advisory Panel, and the President's Scientific Advisory Council. In 1970 he was appointed director of the NATO Long Range Scientific Study on Surveillance.

A radar specialist, he holds a 1956 commendation from the Secretary of the Army for his contributions to radar, and is listed in *American Men of Science, Who's Who in the East,* and *Who's Who in Government.*

He received a Special Act Award from the commanding general of the Army Materiel Command for 1967 service in Vietnam, a Department of Army Research and Development Achievement Award, Meritorious Civilian Service Award, and a Republic of Korea commendation from the Korean Minister of National Defense.

Boyes Directing OCRD Plans and Programs

BG John H. Boyes

BG John H. Boyes, new director of Plans and Programs, Office of the Chief of Research and Development (OCRD), HQ DA, succeeded MG Wilbur H. Vinson Jr., now commander of the U.S. Army Southern European Task Force, Vicenza, Italy.

BG Boyes has commanded the U.S. Army Combat Developments Command Personnel and Logistics Systems Group, Fort Lee, VA, and served as special assistant to the Deputy Chief of Staff for Logistics (DCSLOG) (Programs and Budget), Washington, DC.

Other key assignments have included battalion commander, 188th Maintenance Battalion; Task Force Oregon, 723rd Maintenance Battalion, Americal Division; and chief of staff, U.S. Army Support Command, (Provisional) Da Nang, Vietnam.

Enlisting in the Army in 1940, he received a commission in the Ordnance Corps in 1943. BG Boyes has a 1949 BS degree in education from Pennsylvania State College and a 1962 MBA degree from Babson Institute of Business Administration. He is also a graduate of the Command and General Staff College and the Army War College.

Included among his military honors are the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, Meritorious Service Medal, Air Medal and Army Commendation Medal with OLC.

Dirks Commands Infectious Diseases Institute

COL Kenneth R. Dirks

COL Kenneth R. Dirks is the new commander of the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), Fort Detrick, MD. He succeeds COL Dan Crozier, retired after more than 30 years of active military service.

COL Dirks received his MD degree in 1947 from Washington University School of Medicine, St. Louis, MO, and served residencies in pathology at Veterans Administrations Hospitals in St. Louis and Indianapolis, IN. He is a graduate of the Industrial College of the Armed Forces.

After receiving an Army Reserve commission, COL Dirks entered active duty in 1954. His most recent assignment was deputy commander, USAMRIID.

Other key assignments have included deputy commander and commander, U.S. Army Europe Medical Laboratory, Landstuhl, Germany; director of Research and deputy commander, U.S. Army Medical Research and Development Command, Washington, DC.

Among his military honors are the Legion of Merit with two Oak Leaf Clusters (OLC), Meritorious Service Medal, and Army Commendation Medal with two OLC.

Hukkala Assumes Command as MERDC Commander

COL Tenho R. Hukkala

Activities of the U.S. Army Mobility Equipment R&D Center (MERDC) at Fort Belvoir, VA, are now commanded by COL Tenho R. Hukkala, following duty in the Office of the Secretary of the General Staff, Department of the Army, since July 1971.

Other key assignments have included deputy chief, Engineer Branch, Office of Personnel Operations, HQ DA; commander, 39th Engineer Combat Battalion, Vietnam; branch chief, Systems Division, Defense Communications Planning Group, Washing-

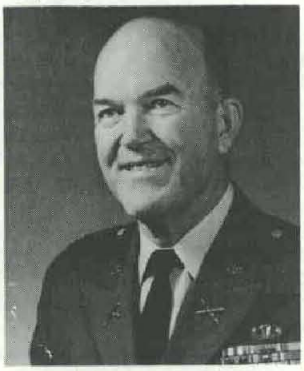
ton, DC; and chief, Troops and Equipment Branch, War Plans Division, Engineer Strategic Studies Group, Office of the Chief of Engineers.

Graduated from Ripon (WI) College in 1952 with an AB degree in mathematics and physics, he earned his master's degree in physics from the U.S. Naval Postgraduate School in 1957. He has completed the Command and General Staff College and the Army War College.

COL Hukkala has been awarded the Silver Star, Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, Air Medal with four OLC, and the Army Commendation Medal with OLC.

Dingeman Named TECOM Deputy Chief of Staff

COL Robert E. Dingeman recently became deputy chief of staff for Support, HQ U.S. Army Test and Evaluation Command (TECOM), Aberdeen (MD) Proving Ground. He served recently on the faculty of the Army War College at Carlisle Barracks, PA.



COL Robert E. Dingeman

Graduated from the U.S. Military Academy in 1945 with a commission in field artillery, he has MS degrees in mechanical engineering from the University of Southern California and in international affairs from George Washington University.

Key assignments have included duty with the Office, Deputy Chief of Staff for Personnel, the Directorate for Inspection Services in the Office of the Secretary of Defense, and HQ U.S. Army, Vietnam.

COL Dingeman is a graduate from the Command and General Staff College and the Air War College. His military honors include the Silver Star, Legion of Merit with two Oak Leaf Clusters (OLC), Soldier's Medal, Bronze Star Medal with "V" device and four OLC, Air Medal with five OLC, Army Commendation Medal with two OLC and the Purple Heart.

Milias Appointed to DoD Environmental Post

George W. Milias was recently named director (Environmental Quality), Office of Assistant Secretary of Defense (Health and Environment), succeeding COL Herbert E. Bell, U.S. Air Force.

Milias is former deputy regional administrator of the Environmental Protection Agency for California, Nevada, Arizona, Hawaii and the Pacific Trust Territories.

In 1970 he was selected as conservationist of the year by the California Wildlife Conservation Board. He also received the highest award of merit from the California Anti-Litter League and the California Conservation Council.

Milias has a BA degree in history and political science from San Jose State College and a master's degree in political history from Stanford University.

Turnmeyer Picked as Lance Project Manager

Newly promoted BG George Turnmeyer was assigned recently as the U.S. Army Lance Missile project manager, Redstone Arsenal, AL.

He has served as deputy commander and later commander, U.S. Army Materiel Command (AMC), Europe; joint staff officer and coordinator, Pacific Branch, Operations Division, Organization of the Joint Chiefs of Staff; in the Office, Special Assistant for Project Management, AMC; and in various overseas assignments.

COL George Turnmeyer

COL Turnmeyer has a BS degree in military science from the University of Maryland and an MBA degree (industrial management) from Babson College. He is also a graduate of the Command and General Staff College, Armed Forces Staff College and the Industrial College of the Armed Forces.

His military decorations include the Legion of Merit, Meritorious Service Medal and Army Commendation Medal with two Oak Leaf Clusters.

WES Director, District Engineers Assigned

U.S. Army Corps of Engineers key personnel changes announced recently include a new director of the U.S. Army Engineer Waterways Experiment Station (WES) and district engineer reassignments.

LTC (COL designate) George H. Hilt has been named to succeed Ernest D. Peixotto as director of the WES, Vicksburg, MS. Currently he is attending the U.S. Naval War College, Newport, RI.

COL John A. Hughes Jr. has been named to succeed COL William D. Falck as Pacific Ocean Division engineer, COL Thorwald Roger Peterson takes over from COL Guy E. Jester as St. Louis District engineer, and COL Frederick G. Rockwell Jr. to replace COL James C. Donovan as Sacramento District engineer.

COL Robert S. McGarry is designated as Detroit District engineer, succeeding COL Myron D. Snoke, and COL Drake Wilson will replace COL Harry A. Griffith as Mobile District engineer. COL Clarence D. Gilkey is assigned as Portland District engineer, replacing COL Paul D. Triem. COL Albert C. Lehman has been named to succeed COL John V. Parish Jr. as Memphis District engineer.

COL Clyde A. Selleck Jr. is assigned as Philadelphia District engineer, replacing COL Carroll D. Strider and COL John V. Foley will be Los Angeles District engineer, succeeding COL Harry M. Roper. COL William G. Kratz is selected as a resident member of the Board of Engineers for Rivers and Harbors. COL Nelson P. Conover takes over from COL Richard M. Connell as Walla Walla District engineer.

Reader's Guide . . .

Metric System Publications/Aids Available

In response to growing national interest in the adoption of the metric system of weights and measures, as reported in the May–June 1972 edition of the *Army Research and Development Newsmagazine,* "Speaking on . . . The Metric System in World Trade," several recent low-cost publications or aids are available.

The Modernized Metric System is a redesigned and updated National Bureau of Standards wall chart, defining and illustrating the seven basic units of the system.

It is available from the U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402, as the National Bureau of Standards Special Publication 304, Rev. Oct. 1972, for 55 cents, prepaid. It's also available from Field Offices of the U.S. Dept. of Commerce as SD Catalog No. C13.10:304.

Brief History of Measurement Systems, 4 pages, 25 cents, includes a one-third size version in color of the chart, *The Modernized Metric System,* as well as a history of measurement systems. Order NBS Special Pub. 304A from the U.S. GPO, Superintendent of Documents, or Dept. of Commerce C13.10:304A.

For Good Measure, 10 cents, is a plastic rule with basic metric information. One side has a brief comparison of metric and nonmetric units and approximate conversion factors for length, volume, and mass; the opposite side has a 6-inch rule on one edge, a 15-centimeter rule on the other. Order from the U.S. GPO, Superintendent of Documents as NBS Special Pub. 376 or, Dept. of Commerce SD Catalog No. C13.10:376.

Metric Conversion Card, 10 cents. This is a wallet card giving factors for converting from customary to metric units of length, area, volume, mass, and temperature on one side. The other side gives the corresponding conversion factors for going from metric to customary. Order as NBS Special Pub. 365 or, Dept. of Commerce SD Catalog No. C13.10:365.

Electrical Engineering Units and Constants, 10 cents, is a wallet card containing a microdictionary of basic quantities and symbols in electricity and electronics. It explains, for example, that the *weber* is a volt-second and the *tesla* a weber per square meter. Available as NBS Special Pub. 368 or, Dept. of Commerce SD Catalog No. C13.10:368.

Report Analyzes Military Reading Requirements

Determination of reading requirements necessary for adequate military job performance is the topic of a recently published report by the Human Resources Research Organization (HumRRO).

Identified as Technical Report 73-5, *Methodologies for Determining Reading Requirements of Military Occupational Specialties,* this document includes a simple, easy-to-administer formula for estimating reading grade levels of difficulty of Army job reading matter.

Produced from HumRRO Work Unit READNEED, the document was coauthored by John S. Caylor, Thomas G. Sticht, Lynn C. Fox, and J. Patrick Ford.

Corrosion-Resistant Material for M16A1 Rifle Components

By James V. Rinnovatore, Karl F. Lukens, John D. Corrie

Although high-strength aluminum alloys are used extensively in Army materiel because of their high strength-to-weight ratio, service experience has shown that problems can arise with the use of such alloys due to corrosion, unless preventive measures are taken.

A recent problem explored by the Materials Engineering Division at Frankford (PA) Arsenal was concerned with the exfoliation corrosion of receiver components used in the M16A1 rifle. The receivers are fabricated from 7075-T6 die-forgings with a minimum yield strength of 65,000 pounds per square inch.

A brief review on the history of the M16A1 rifle shows that after it had been in service for three years in a hot and humid climate, exfoliation corrosion was detected on parts of the lower receiver—the areas in contact with hands of the soldier. Although proper functioning of the rifle was not affected, the problem was considered to be of sufficient significance to warrant a metallurgical study.

The approach considered was divided into two related phases. The first was a detailed metallurgical study of die-forged 7075-alloy receiver components of the M16A1 rifle. Factors included prior mechanical history of the original forging blank material, and quenching rate from solution temperature.

Three lots of 7075-alloy forgings, each representing different thermal-mechanical histories, were evaluated. The second phase was a parallel study of forgings fabricated from premium-grade 7175, X7050, 7049 and PM94 aluminum alloys. All alloys contain zinc, magnesium and copper as major alloying elements, but differ from 7075 with respect to the quantity of these constituents and impurity levels.

With the exception of PM94, which was produced by powder metallurgy techniques, all the alloys were blank-cast, worked by forging, rolling or extruding, and then formed into receivers. The major elements of the alloys are listed in Table 1.

All forgings were evaluated for strength properties and resistance to exfoliation in the as-received T6 tempers and in alternate heat-treated conditions produced within the lab.

Electrical conductivity measurements were performed on the heat-treated forgings as a check on the various tempers. Resistance to exfoliation was measured by a continuous immersion of forgings for 48 hours in a solution containing NaCl, KNO_3, and HNO_3. The test has been accepted as a standard test for exfoliation by the American Society for Testing Materials.

Table 2 lists a portion of the results from the exfoliation, mechanical and conductivity tests performed on the various alloys. Only those alloys and tempers are listed which provide adequate strengths and complete immunity to exfoliation corrosion.

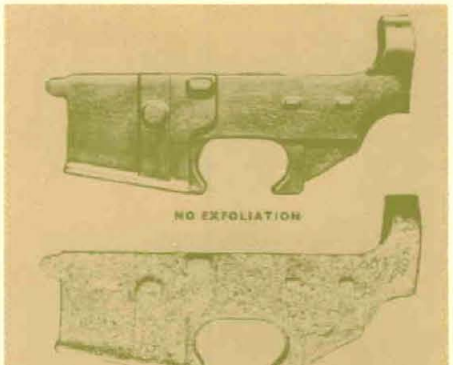
With the exception of PM94, all alloys in the T6 temper exhibited a significant degree of exfoliation corrosion. However, by appropriate heat treatment to a T73 (or T7X) temper, resistance to exfoliation corrosion was achieved with retention of the required 65 ksi yield strength.

TABLE 1 CHEMICAL COMPOSITION OF ALUMINUM ALLOY FORGINGS

ALLOY	Zn	Mg	Cu
7075–A (EXTRUDED STOCK)	5.67	2.40	1.58
7075–B (EXTRUDED STOCK)	5.67	2.47	1.47
7075–C (ROLLED STOCK)	5.67	2.44	1.56
7175	5.61	2.33	1.52
X7050	5.70	2.08	2.67
7049	7.55	2.30	1.65
PM94	7.68	2.55	1.06

TABLE 2 STRENGTH, CONDUCTIVITY, AND EXFOLIATION CHARACTERISTICS OF 7000 SERIES DIE FORGINGS

ALLOY & TEMPER	YIELD STRENGTH, ksi	CONDUCTIVITY, % IACS	EXFOLIATION
7075–A T73	64.8	42.9	IMMUNE
T73	70.3	40.5	IMMUNE
7075–B T73	67.1	40.4	IMMUNE
7075–C T73	66.5	40.2	IMMUNE
T73	66.7	39.2	IMMUNE
7175 T73	71.1	40.4	IMMUNE
T7X	80.1	37.8	IMMUNE
X7050 T73	71.4	42.6	IMMUNE
T7X	84.7	39.4	IMMUNE
7049 T73	67.6	41.3	IMMUNE
PM94 T7X	71.4	40.5	IMMUNE
T6X	88.3	34.0	IMMUNE



M16A1 LOWER RECEIVER FORGING

The results shown in the table can be summarized as follows: (1) the present alloy, 7075, can be thermally treated to produce an exfoliation resistant material with a minimum yield strength of 65 ksi. This can be achieved by a standard T73 temper. (2) 7000-series aluminum alloys, such as X7050, premium grade 7175, and PM94, can be thermally treated to produce exfoliation-resistant forgings which are much higher in strength than alloy 7075.

Other significant results of this work were:

- Temperature and time of aging are very important factors to control in order to insure that the optimum combination of strength and exfoliation corrosion resistance is achieved. It was found that this is best checked by the use of electrical conductivity measurements. For example, a T73 temper is insured if the corresponding electrical conductivity has increased by a minimum of 6.0 percent IACS (International Annealed Copper Standard) as compared to the conductivity of a T6 temper. This method of proof is more sensitive than other methods such as hardness and is easily performed.
- The immersion test used in this study provides a direct means for determining exfoliation characteristics of aluminum alloy forgings.

On the basis of this study, it was recommended that the specification for the M16 receiver forgings be changed from the present requirement of 7075 alloy in the T6 temper to a requirement of 7075 with a minimum yield strength of 65 ksi and a conductivity greater than or equal to 40 percent IACS. Measurements of these properties should be obtained from tests on production line forgings.

In addition, it was suggested that special attention be given to heat-treatment practices to insure strict controls on quenching temperatures and on aging temperature. As an alternative to this recommendation, it was suggested that X7050 and premium-grade 7175 be considered as possible substitute alloys for 7075.

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