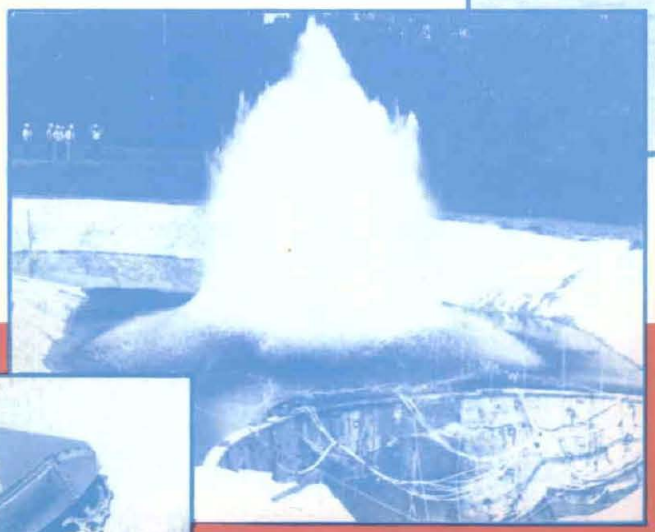
ARMY
RESEARCH AND DEVELOPMENT
January-February 1975



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U.S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

SPEAKING ON . . .

Return on Investment in Research and Development

Norman R. Augustine
Assistant Secretary of Army (R&D)

Assistant Secretary of the Army (R&D) Norman R. Augustine presented his views regarding improved management of research and development programs to produce superior military materiel on an improved cost-effective basis in addressing the 1974 annual meeting of the Association of the United States Army. His address follows.

Just recently I completed my first year of service as Assistant Secretary of the Army for Research and Development. As I assessed progress toward the goals I had set for myself at the beginning of that year, two observations seemed to stand out.

The first of these was the rather awesome realization that, at the time I had been confirmed by the Senate, I had said to myself that any problem which occurred after one year I would consider to have been my own doing!

The second observation was to note what an extraordinary privilege it has been for one individual to have had as much opportunity to make a contribution as this particular job offers. I would hope that I can live up to the trust such a privilege implies . . . although at times I share the concern of Dennis the Menace when he noted, "It's still getting dark early—same as last year. I thought they would have that fixed by now!"

Occasions such as this one today are a special pleasure. All of us in this room have many things in common, not the least of which is our dedication to the common goal of assuring that our Army is the finest the world has ever known.

Each of you entrusts three cents a day of your personal income to me to manage, together with the Army R&D team. This is our share of the one dollar a day that each individual in the United States devotes to National Defense. The efficient management of this money is a responsibility we take very seriously. You are entitled to a substantial return on your investment, or ROI . . . just as the stockholders of your companies are entitled to a reasonable return on their investments.

Unlike your companies, in the case of the Army, "return" is measured in terms of fighting capability in the field. The "bottom line" is not economic survival. The bottom line is survival itself.

I would hasten to take note that there are many other factors which influence that bottom line in the fighting capability equation. Some years ago I read a book about research and development in which the author . . . described some of the combat experiences of a Medal of Honor winner.

The author told how this particular soldier and his unit were assaulting a machinegun position and were pinned down by intense automatic weapon and small arms fire.

As the soldier began to move forward toward the enemy position, he was quickly observed and heavy fire rained down upon him and his unit. He was hit in the arm and knocked off his feet. He got up and began to run forward, still firing his rifle at the enemy position. He was hit again and again and was finally knocked to the ground, this time unable to get up.

Crawling forward, he approached near enough to the enemy position to throw a hand grenade into its midst and silence the weapon. At this point the author concluded his description, noting with a tinge of irony, "It was another great victory for American technology."

With this perspective in mind, I would like to talk about return-on investment from our RDT&E expenditures. I discovered soon after arriving in Washington that the Army's research and development program is responsible to a rather large Board of Directors—a 535-man Board of Directors, to be specific.

In fact, I had been on the job a total of two hours when I first had the privilege of testifying before a portion of this Board. I was to learn that all of the individuals represented on this particular part of the Board, as with virtually all the other members of the Congress, shared a sincere and common dedication to a strong military capability for our country—and a willingness to pay a reasonable price to obtain that capability.

At the same time, I found then, and have repeatedly found since then, a great intolerance with R&D programs which are not producing a reasonable return. Further, I have noted no reluctance upon the part of the Congress to take decisive action when we appear to have failed in carrying out our responsibilities of assuring the adequacy of the return which is derived.

In addition to the taxpayer and his representatives, there is yet one other group of people to which I feel a special obligation. This group comprises the people who wear the uniform of our country and who lay down their lives on the quality of equipment that we provide them.

The question arises as to how we can assure these individuals the maximum chance of surviving and winning on battlefields of the future. The question is not an academic one. Of the last 3,421 years, only 268 have been free of armed conflict somewhere in the world. Fighting men in the United States Army have been in combat during no less than 22 out of the last 33 years.

Where, then, is our winning margin to be? It must presumably either be associated with the people that form our forces or the things that we provide these people—or in some combination of the two. In terms of numbers of soldiers, it is unlikely that we in the United States will outnumber any foreseeable enemy on any foreseeable battlefield. In terms of quality of soldiers, yes; here could be a decisive margin in our favor in terms of training and motivation. This is one of the major goals of the Volunteer Army.

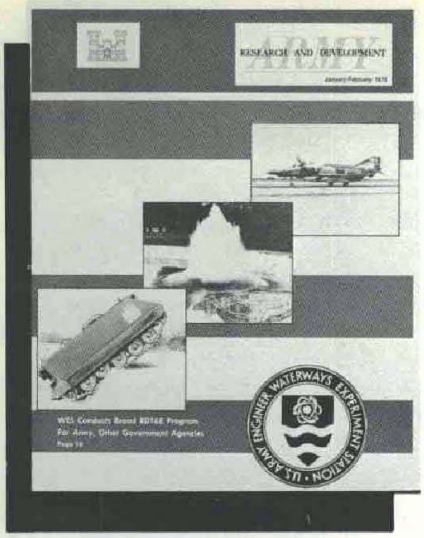
Turning now to the area of materiel superiority, historically it has probably been quantity of equipment rather than quality which has been the deciding factor in our past victories. By relying upon the enormous industrial capability of our country to outproduce our adversaries, we have essentially been able to inundate our enemies with equipment, producing an annual average, for example, of 50,000 aircraft, 20,000 tanks and 80,000 artillery pieces.

Unfortunately, this advantage is perhaps one we no longer enjoy. Other countries are gaining rapidly in their ability to produce materiel. But probably even more important is the fact that the advent of modern weaponry has produced lethalities never before seen in battle, with the consequence that loss rates will skyrocket. Wars will be decided more and more on materiel *in being* rather than on future production capability.

We saw some evidence of this in the conflict in the Middle East which, although not directly involving any of the superpowers, still saw more tanks lost by Syria and the UAR (United Arab Republic) alone than the U.S. possesses in all of Europe, including our prepositioned stocks, and more artillery lost on the Central Sinai than the U.S. has in Europe—and all this took place in just 19 days.

The UAR today has more SAMs (surface-to-air missiles) along the Suez than

(Continued on page 21)



ARMY RESEARCH AND DEVELOPMENT

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ABOUT THE COVER:

The U.S. Army Engineer Waterways Experiment Station (WES) is involved in a broad variety of research, development, test and evaluation activities for many U.S. Government and other agencies on a reimbursable basis. Shown, from left, are WES capabilities in development of analytical models for predicting cross-country vehicle performance; studying effects of underwater explosions; and development of improved pavement materials for airfields. The back cover is a montage of computer capabilities, integrated with interactive graphics, at the Computer Design Center, Edgewood Arsenal, MD.

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Grateful acknowledgement is made for the valuable assistance of Information Offices within the Army Materiel Command, Office of the Surgeon General, Office of the Chief of Engineers, Army Training and Doctrine Command, Army Forces Command, Office of the Assistant Chief of Staff for Force Development, Office of the Assistant Chief of Staff for Communications-Electronics, Computer Systems Command, and miscellaneous related activities. Use of funds for printing of this publication has been approved by the Department of the Army, Jan. 1, 1974.

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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FEATURES

DEPARTMENTS

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Selective Scanner . . .

Hellfire Demonstrations Show Major Progress

Development testing of a prototype Hellfire Weapon System demonstrated recently that a helicopter-launched missile can be guided first by an airborne laser designator, then switched to a ground designator, and hit a tank with pinpoint accuracy.

Project Manager COL John B. Hanby termed this result of a first-time experiment another major developmental accomplishment, "an advance toward a completely autonomous firing—designating and firing from the same aircraft.

"This capability should be tested later this month, and is one of the last major objectives we have to demonstrate before technical feasibility of the system is completely established."

The demonstration at Redstone Arsenal, AL, showed that the Stabilized Platform Airborne Laser (SPAL) would not break lock-on when a missile is fired from the SPAL helicopter and a single target is lased by two designators operating in the same code; also, the seeker's ability to recorrelate when the first designator is turned off and the remainder of the flight is supported by a second designator.

Hellfire is being developed for air launch from attack helicopters to provide the Army with a family of terminal homing seeker modules and a common airframe to engage a variety of tank and hardpoint targets. Hellfire is the first antitank weapon being developed especially for launch by helicopter.

Universities Receive Army Plasma Jet Equipment

Plasma jet studies equipment used by the U.S. Army Missile Command for more than a decade to test missile reentry devices is being turned over to Mississippi State University and Purdue University as a grant through the National Science Foundation.

Under terms of transfer of the equipment for use in research programs, MICOM will receive courtesy copies of university reports.

MICOM has used the plasma jet apparatus to examine effects of reentry in very rapid, high-temperature gas flow simulating heating and air flow conditions encountered by a missile during high-velocity flight, and for other research.

Mississippi State will receive the tunnel portion of the device, arc generators, cooling system and three 1.2 megawatt power generators. Purdue will get the fiberglass-lined 90-foot-long, 12-feet-diameter vacuum tank. NASA's Marshall Space Flight Center is aiding MICOM and Purdue in arranging shipment.

Designed and assembled under direction of Dr. Thomas Barr and Charles M. Cason of the Missile Research, Development and Engineering Laboratory, the plasma jet facility was first placed in operation by MICOM in 1961.

BMDSCOM Decreases Energy Consumption

How effective can energy conservation measures be at an Army installation? An impressive answer has been filed by the Ballistic Missile Defense Systems Command at Huntsville, AL, since the first quarter of FY 1973. During that 3-month period, heating and lighting needs totaled 5.1 million kwh.

The EC program included removal of 12,000 of 36,000 lighting tubes in the work areas of BMDSCOM headquarters, with a resultant 3-month decrease to 4.1 million kwh. Bulbs removed are used as replacements for burned-out tubes, and 4,000 more removals will effect additional economies.

Instructions require that all lights in the building be cut off within 30 minutes after the end of the working day. Thermostats are set to control heating to a maximum of 68 degrees. The air conditioning minimum is 80°. Heating, lighting and air conditioning are cut off in unoccupied areas.

What are the results? Good, very good! Energy consumption has dropped to 2.7 million kwh for the first quarter of FY 1975.

A Tennessee Valley Authority pamphlet given to all employes, lists 47 ways to save energy in the home.

HumRRO Assists Army in CATTS Development

CATTS is the acronym for Combat Arms Tactical Training Simulator, a computer-based device to train battalion command groups and advanced-course officers in command and control tactical operations—how to adapt to a variety of situations.

Under an 11-month contract awarded recently by the U.S. Army Research Institute for the Behavioral and Social Sciences, the Human Resources Research Organization (HumRRO) Alexandria, VA, will help the U.S. Army Infantry School, Fort Benning, GA, to use and test a demonstration model of CATTS.

HumRRO researchers at Fort Benning will aid in developing a manual or handbook for controllers to enable them to conduct CATTS training exercises, beginning early next spring.

The researchers also will participate in development of operational test criteria, procedures and materials the schools can use in the test program, including analysis and documentation of the prototype operation tests. Dr. Trueman R. Tremble Jr. will head the team. Dr. George C. Burgess is the monitor.

WRAMC Implements Telephone Health Library

What is believed the first military application of a new telephone health library concept, designed to provide supplemental medical information to patient and nonpatient personnel, has been announced by the Walter Reed Army Medical Center, Washington, DC.

Identified as "TEL-MED," the system consists of a series of pre-recorded audio cassette tapes three to four minutes in duration. Persons seeking information on a specific medical topic merely call the TEL-MED operator at WRAMC and request, by identification number, to hear a particular tape.

The operator then selects the requested tape, inserts it into the player, and the message is automatically transmitted into the caller's phone. The caller is not required to identify himself nor carry on any type of conversation.

William Schettler, chief of Audio Visual Services, WRAMC, indicated that the operation is designed to inform persons of early symptoms of an illness and to help them adjust to it. However, the system is not intended to serve as a replacement for the physician or dentist.

Envisioned as a significant aid to the WRAMC staff and patient population, TEL-MED was initially developed as a public health information system by the San Bernardino (CA) County Medical Society in 1972.

SAM D 'Captive Carry Flight Test' Successful

SAM-D capabilities were demonstrated impressively without an actual firing when the missile and its guidance components were mounted on the wing of a jet aircraft to run intercepts of a second jet during White Sands (NM) Missile Range tests.

The Captive Carry Flight Test marked the first time the SAM-D multifunction array radar performed search, track, target illumination and missile guidance tasks with an airborne missile and an actual moving target.

Raytheon Co., SAM-D prime contractor, conducted the experiment to provide the Army with guidance data that will be used during 16 missile proof-of-principal tests at WSMR.

Captive flight tests will continue throughout the proof-of-proposal flight tests. Prior to each firing, the Army will fly the same scenario with the aircraft to evaluate missile performance.

During captive flight tests, which can be repeatedly flown without expending the 17-foot-long air-defense missile, the SAM-D multifunction radar array acquires and tracks the missile into its mid-course flight path. During the terminal mode, the missile takes over, acquires and tracks the illuminated target.

SAM-D is being developed to counter the high-performance aircraft threat in the 1980s and beyond. The highly mobile, all-weather system is the only known air-defense weapon of its kind under development in the Free World. BG Charles F. Means is project manager for SAM-D.

HDL Unveils New Fuze Concept for Weapons

Aircraft deployment of fuze type weapons requiring no hard wire or radio frequency links, developed for Army, Navy and Air Force applications, was demonstrated recently by the U.S. Army's Harry Diamond Laboratories during tests at Aberdeen (MD) Proving Ground.

The new system provides pilots with instantaneous selectable fuzing options while approaching a target or preparing for cargo drops. An inductive loop imbedded in the launcher bulkhead transmits instructions to the rocket and permits communications with each rocket as the pilot prepares to fire the round.

A smaller loop in each fuze receives data and charges a capacitor which supplies power to complementary metal oxide semiconductor (CMOS) logic devices. No battery power is required before the fuze battery is activated by firing forces.

The concept permits interface with a fire control computer to set automatically the required time or function engagement for maximum effectiveness. Other reported advantages include elimination of multiple connections to each rocket pod, and the reduction of the rocket fuze inventory to only two fuzes for all encounters. The inductive data loops could easily be retrofitted at local maintenance depots. Two fuzes currently under development are a 2- to 20-second set time fuze and a multioption fuze. The latter permits air burst, impact, and delay after-impact firing, and is settable from 1 to 200 milliseconds.

Manned Balloon Flight Studies Atmosphere

Twenty related atmospheric sciences experiments, involving nearly 20 organizations, were conducted during a recent 11½-hour manned flight of a huge instrumented balloon which covered a distance of almost 305 miles.

Sponsored by the Atomic Energy Commission (AEC), National Geographic Society, and the ASL, Project da Vinci was launched Nov. 1 from Las Cruces, NM. Strong winds and storm threats terminated the flight short of its scheduled 36-hour goal.

Using about 150,000 cubic feet of helium, the 70-foot-diameter polyethelene balloon, capable of carrying more than 5,000 pounds, can fly at altitudes up to 18,000 feet. The crew consisted of a pilot and copilot, a meteorologist with the AEC, and a National Georgraphic Society photographer.

Project da Vinci was designed to obtain a comprehensive picture of a single air parcel as it crosses mountains, open plains, forests and cities; to test research instruments in airborne use; and to determine the usefulness of multiexperiment, manned balloon flight for lower atmospheric research.

ASL, in association with the University of Texas at El Paso, conducted balloon-borne and ground-based experiments related to balloon dynamics, atmospheric water-vapor and ozone concentrations, atmospheric particulate layers, thermal structure and turbulence and infrared radiation. Specific instruments included temperature, pressure and density sensors, particulate counter, 200-megawatt laser beam, infrared radiation sensors, capacitor microphones, and a Nike-Hercules missile radar.

Evaluation of all scientific data acquired during the flight, 30 reels of magnetic tape, will require six months to a year.

MERDC Initiates Qualified Products List Testing

The Organic and Chemical Coatings Research Team, Materials Engineering Division, U.S. Army Mobility Equipment Research and Development Center (MERDC) has announced initiation of qualified products list testing.

All work that was formerly performed at the Coating and Chemical Laboratory at Aberdeen Proving Ground, MD, will be continued at Fort Belvoir, VA.

Companies or government agencies that have inquiries or samples for qualification or testing should address their inquiries to: Commander, U.S. Army Mobility Equipment Research and Development Center, ATTN: STSFB-GMO (Materials Engineering Division), Fort Belvoir, VA 22060.

CLGP Prototype Tests Termed 'Significant'

Demonstrations of Cannon-Launched Guided Projectile (CLGP) prototypes scored hits on tank targets at ranges of 8 to 12 kilometers (5 to 7.5 miles), even with tests programed firing errors of hundreds of meters, at White Sands Missile Range, NM.

Termed by COL S. T. Post Jr., project manager for Cannon Artillery Weapons Systems, "a significant advance in defense technology," the CLGP allows conventional artillery to attack a variety of targets using indirect fire, with a high single-shot kill probability.

The system calls for a laser-equipped forward observer to designate a chosen target by pointing the laser beam at the target. While in flight, the CLGP senses the reflected laser energy and, by applying commands to its control fins, flies into the laser point spot on the target.

Now in the advanced development stage, the CLGP is being developed competitively by Texas Instruments, Inc., Dallas, TX, and Martin Marietta Aerospace Corp., Orlando, FL. The Office of the Project Manager, COL S. T. Post Jr., is located at U.S. Army Armament Command HQ, Rock Island, Ill.

When fielded, the CLGP will give every 155 mm cannon in the U.S. Army inventory the capability of attacking hard-point targets at long range as well as from behind defilade.

TACOM Studies Feasibility of Plastic Fuel Tanks

Corrosion problems often associated with vehicle metallic fuel tanks might ultimately be eliminated with either of two new plastic versions being evaluated in the Armor and Components Division, U.S. Army Tank-Automotive Command, Warren, MI.

Nylon and polyethylene gas tanks have been installed in ¼-ton M151 jeeps and ¾-ton M715 trucks as a possible replacement for conventional steel types. Both tanks are being subjected to tropical, desert and arctic conditions and meet proposed Department of Transportation safety standards.

In addition to being corrosion-proof, nylon and polyethylene tanks may provide improved crash resistance.

Comparing the suitability of nylon versus polyethylene tank construction, Harrison R. Duke, project engineer for the Plastic Fuel Tank Program, commented that nylon is stronger but considerably more expensive and time-consuming to produce.

Nylon tank production utilizes a technique termed roto-casting which involves placement of melted plastic into a rotating mold. Centrifugal force pushes the plastic against the mold wall where it hardens into the desired shape in about 15 minutes.

Polyethylene tanks may also be roto-cast but can also be produced by a faster, less costly method known as blow-molding which takes about three minutes.

Although both types of plastic tanks are more costly to produce than steel tanks, they involve virtually no replacement cost and require less cleaning of contaminated fuel.

TACOM initiated nonmetallic fuel tank tests about two years ago following widespread incidents of corrosion on the interiors of conventional metal tanks. A majority of these problems occur in vehicles stored for extended periods with fuel in their tanks.

MERDC Grants 3.7 Million for Generator Set

Development of a 10 kilowatt turbine engine driven (GTED) generator set, designed to provide greater mobility and reliability to ground and vehicular support systems, is ordered under a 3.7 million contract announced by the U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA.

First in a family of new military electric power units, the set is expected to be 450 pounds lighter than standard generators, has a 500-hour mean time between failure operating capability, and in test operations has required much less maintenance.

Operative on a variety of fuels, including no-lead gasoline, jet and diesel fuel, the generator can withstand temperature extremes of 125 degrees F. to minus 65 degrees. It is vibration-free, low-pollutant, and requires no external cooling.

R&D News . . .

DoD Announces Frankford Arsenal Closing, AMC Depot System Realignment

Frankford (PA) Arsenal will be closed and the U.S. Army Materiel Command (AMC) Depot System will be realigned, as part of the Department of Defense (DoD) effort to divert resources from support activities to combat capability and to realign activities within today's lower force levels.

The AMC realignments are in consonance with 111 base realignment actions recommended by the Secretary of the Army, Secretary of the Air Force, and Director of the Defense Supply Agency (DSA). The recommendations were approved by Secretary of Defense James R. Schlesinger in November.

Frankford Arsenal, established in Philadelphia in 1816, will be closed by the end of FY77 through transfer of functions and reductions-in-force. This action will affect 41 military and 3,494 civilian jobs of which 1,400 to 2,000 will be eliminated and the others transferred.

U.S. Army Armament Command (ARCOM) HQ, Rock Island, IL, will receive 329 civilian jobs in national procurement of small-caliber munitions and tracers; national procurement of fire control systems/devices, maintenance and cataloging functions.

Naval Ordnance Test Station (NOTS), Indian Head, MD, will receive 120 civilian jobs dealing with cartridge-activated/propellant-activated devices. All research and development missions/functions will be transferred to Army Materiel Command labs or subordinate commands.

Other activities that will receive arsenal missions/functions include the U.S. Army Tank-Automotive Command (TACOM), Warren, MI, 14 civilian jobs; U.S. Army Logistics Management Center (ALMC), Fort Lee, VA, 20 civilian jobs. Two military and 16 civilian jobs associated with tenant activities will be transferred to various locations.

As part of the AMC Depot System realignment, three depots have been designated as primary distribution points for secondary items—Sharpe Army Depot, CA, for the West Coast and Pacific area; Red River Army Depot, TX, for Central CONUS; and New Cumberland Army Depot, PA, for the East Coast and European area.

Sharpe Army Depot, Lathrop, CA, will transfer its aircraft maintenance missions to Corpus Christi Army Depot, TX, and its construction equipment and general equipment maintenance missions to Tooele, UT. As the West Coast Secondary Item Distribution Point, Tooele's level of supply activity will be increased. Sharpe will continue to operate a Supply Consolidated and Containerization Point for overseas shipments in the Pacific area.

This action will affect 22 military and 902 civilian jobs, of which 19 civilian jobs will be transferred and 883 eliminated.

Red River Army Depot, Texarkana, TX, will assume the secondary items mission for all commodities, with an increase of 268 civilian jobs. Conversion of Lexington-Blue Grass Army Depot, KY, to a depot activity under Red River will increase Red River staffing by 8 additional jobs by the end of FY76.

New Cumberland Army Depot, PA, will assume the secondary items mission for all commodities, as one of the designated primary distribution points, creating an increase of 465 civilian jobs.

Letterkenny Army Depot, Chambersburg, PA, loses its secondary items storage mission, except support of the maintenance mission, with a decrease of 193 civilian jobs. Conversion of Savanna Army Depot, IL, to depot activity will result in a slight increase in staffing for the overhead support requirement.

Conversion of Pueblo Army Depot, CO, to a depot activity results in transfer of certain missile maintenance and associated supply workloads to Letterkenny, with 69 civilian jobs added.

These three actions will cause a net decrease of 117 civilian jobs at Letterkenny, of which 50 will be eliminated.

Lexington-Blue Grass Army Depot, KY, will transfer its communications and electronics maintenance mission to Tobyhanna Army Depot, PA, and to Sacramento Army Depot, CA. It will be redesignated as a depot activity under Red River Army Depot and will retain its communications security and munitions missions, but will have a reduced electronics supply mission.

These actions will affect 2,858 civilian jobs, of which 641 civilian jobs will be transferred. Thirty military and 2,217 civilian jobs will be eliminated.

Pueblo Army Depot, CO, will transfer its missile maintenance mission, except Pershing, to Letterkenny and will be redesignated as a depot activity under Toole Army Depot, UT. Navajo, AZ, and Fort Wingate, NM, depot activities now under Pueblo will be reassigned to Tooele. Thirty-two military and 1,620 civilian jobs will be eliminated; 217 civilian jobs will be transferred.

Savanna Army Depot, IL, will transfer its weapons storage and ammunition mission to Sierra Army Depot, Herlong, CA, and will be redesignated as a depot activity under Letterkenny Army Depot, PA. Savanna will retain its conventional ammunition mission.

This action will affect 207 military and 274 civilian jobs, of which 30 civilian jobs will be transferred; the military and 244 civilian jobs will be eliminated.

Tobyhanna Army Depot, PA, loses its secondary items storage mission, except in support of the maintenance mission, which causes a decrease of 171 civilian jobs, of which 34 are eliminated.

Tobyhanna also is affected by conversion of Lexington-Blue Grass Army Depot to a depot activity, which results in a transfer of communications-electronics maintenance and associated supply workloads to Tobyhanna with an increase of 594 civilian jobs.

These two actions will cause a net increase of 423 civilian jobs at the Tobyhanna Army Depot.

Sacramento Army Depot, CA, loses its secondary items storage mission, except for maintenance mission support and a limited backup responsibility to Sharpe Army Depot, CA. Sacramento retains communications-electronics maintenance.

These actions will affect 170 civilian jobs at Sacramento Army Depot, of which 139 will be transferred; 31 civilian jobs will be eliminated.

Anniston Army Depot, AL, loses the secondary items storage mission, except in support of the maintenance mission. This action will affect 248 civilians, of which 205 jobs will be transferred; the remaining 43 civilian jobs will be cut.

Tooele Army Depot, UT, loses its secondary items storage mission, except in support of maintenance, causing a decrease of 248 civilian jobs.

Conversion of Pueblo Army Depot under Tooele will result in an additional 12 civilian jobs to meet overhead support requirements. Tooele's missile maintenance workload reduction will result in the loss of 125 civilian jobs.

The net impact of these actions will be a decrease of 361 civilian jobs at Tooele, of which 171 will be eliminated.

Closing of Frankford Arsenal and reorganization of the AMC Depot System is part of the over-all Defense effort that will eliminate headquarters and other positions involving about 11,500 military and 11,600 civilian billets. Once these actions are completed by 1977, it is estimated that DoD support costs will be reduced by more than $3.3 billion in the subsequent decade, making it possible by diversion to increase combat capability and effectiveness.

Battelle Forecasts $35.6 Billion For 1975 U.S. R&D Expenditures

U.S. Government and industrial research and development expenditures in the United States will reach $35.6 billion in 1975, an increase of about 11 percent—with inflation taking 8.6 percent—and the government accounting for about 52 percent of the total.

These statistics are forecast by Battelle's Columbus Laboratories as part of an annual prediction, based on data from the U.S. Bureau of the Budget, the National Science Foundation, the McGraw-Hill Survey—Business Plans for R&D Expenditure, and analyses by Battelle's Department of Management and Economic Analysis Research and other departments.

Increased R&D spending by industry is anticipated, as qualified by the uncertainties regarding continued deepening recession or of recovery. The estimate is that industry will account for about 42 percent of the total, colleges and universities 4.4 percent, and not-for-profit sources 1.5 percent.

U.S. Government expenditures are envisioned at about $18.5 billion, industry at $15.0 billion, universities and colleges $1.6 billion and not-for-profit R&D organizations $515 million. Industrial spending for R&D has been increasing steadily during the past decade (31 percent in 1964 and 40 percent in 1971).

'Instant Smoke Screens' Show Promise

ROCKET-LAUNCHED smoke disseminators are detonated at altitudes of 300, 200 and 100 feet to deliver an aerial smoke screen, 600 feet long and 400 feet high, in the path of attacking aircraft. Use of smoke as a camouflage and decoy measure is under investigation at Army Mobility Equipment R&D Center.

Concealment of military operations from the enemy by "instant smoke screens," disseminated by ground or air devices, is "showing much promise" in U.S. Army Mobility Equipment R&D Center experimentation at Fort Belvoir, VA.

The U.S. Army Material Command installation, the Army Camouflage Lead Laboratory Research, recently has shown that smoke screens and aerosols have high obscuration effectiveness against visual, infrared radar and microwave detection of combat forces.

Soldiers and equipment can be shrouded in an instant wall of smoke—actually emplaced in two seconds—or an aerial smoke screen 600 feet long and 400 feet high can be provided in five seconds by rocket-launched disseminators. The rockets are detonated in the path of attacking aircraft at altitudes of 300, 200 and 100 feet to delay or divert them.

MERDC scientists are studying effectiveness of rapidly disseminated aerosols for attenuation of infrared, radar and microwave sensors. Under way also is research on rocket propellant actuated fog oil generators and colored smoke combinations for hide and blend applications.

An MERDC source stated that demonstrations of smoke screens as camouflage may lead to decoy deployments.

Drug Implantation Technique Studied

Implantations of pharmacologic drugs in rats for long-duration slow release—in research directed to improved treatment of human diseases—have been achieved with biodegradable materials at the U.S. Army Institute of Dental Research, Washington, D.C.

The USAIDR is an element of the Walter Reed Army Medical Center, Office of the Surgeon General. Investigations of the potential of this long-duration slow release approach have been in progress since 1968, but implantation of drugs in rats is a recent development.

Biodegradable lactic acid derived copolymers were successfully used as the vehicle for slow and uniform release of pharmacologic agents in the rat bodies. Degradation time for this particular composition is approximately 100 days.

Vitamin D_3 was fused into a copolymer composed of polylactic and polyglycollic acid and implanted in the backs of albino white rats. Monitoring of the implantation site indicated that the unique release system provided a safe, positive uniform method of drug administration.

A comparison of this method of drug administration and the conventional injection method revealed the following: After a 48-hour post injection period, only 20 percent of the vitamin D_3 remained in the rat tissue; 60 percent was still present after 42 days when the implantation technique was used.

The subcutaneous implantation method has been tested only in rats. However, USAIDR research in progress indicates definite implications for future use in humans. For example, drugs may eventually be administered on a semiannual or annual basis, thus relieving the patient of daily reliance on his memory or ability to take a prescribed medication.

Potential advantages are seen in the treatment of conditions such as diabetes mellitus, pernicious anemia, malaria, allergies, subacute bacterial endocarditis and long-term birth control. Additionally, the method is applicable in maxillofacial surgery to alter wound healing "at the site."

$1 Billion Solar Energy Plant Proposed

Construction of an estimated $1 billion solar energy plant to provide power requirements for a city of about 10,000 persons was considered at a recent solar energy international seminar at White Sands (NM) Missile Range.

Scientists and engineers from the United States, France, Japan and Italy exchanged ideas and information about solar energy at the seminar sponsored by the National Science Foundation and cohosted by WSMR and New Mexico State U.

White Sands Missile Range has the largest solar furnace in the United States, second in energy output only to the largest in the world at Odeillo, France, but it does not have the capability of storing energy for power or heating requirements. It is used for the study of thermal radiation effects on electronic components of weapons systems.

The proposed solar energy plant would produce electrical energy by generating steam from the sun's heat to power large generators. Conventional electrical generators are fueled by oil, coal or natural gas. The new plant would be planned to become operational about 1980. Prof. Tetsuo Noguchi, head of the Japanese Solar Research Laboratory's Project Sunshine, indicated that Japan's conversion to total solar energy capabilities is programed for the year 2000.

Among the topics discussed at the WSMR seminar were "Solar-Thermal Power Systems Based on Optical Transmission," and "A Solar Power System and Component Research Program." Leading U.S. academic participants included Dr. S. H. Bomar Jr. and J. D. Walton Jr., Georgia Institute of Technology which coordinated the seminar arrangements, and Dr. Robert L. San Martin, New Mexico State University. Dr. Lorin L. Vant-Hull, University of Houston, TX, and Dr. C. Robert Easton, Huntington Beach, CA, teamed to discuss solar-thermal power systems.

George S. Kaplan, National Science Foundation, in discussing solar power systems, suggested that the best geographical location for the proposed $1 billion plant would probably be in the southwestern United States.

Reverse Osmosis Aids Pollution Control

Reverse osmosis, a process developed originally for purification of contaminated water for field use in combat environments, is being applied to the reclaiming of liquid and solid effluents in pollution control at Rock Island Arsenal, IL.

The U.S. Army Armament Command recently announced this application has proved successful in more than a year of experimentation in the metal plating plant. ARMCOM is a major commodity command of the Army Materiel Command.

In the reverse osmosis process, one component of a solution is separated from another component by means of pressure exerted on a semipermeable membrane.

With respect to the RIA program, a spokesman explained that water of extremely high quality is obtained. More than 95 percent of the salt and 100 percent of most organics are rejected, making the water safe to drink.

Moreover, the reverse osmosis system is saving tax dollars. Water cost at RIA for metal plating has been about 45 cents for 1,000 gallons. With all the water reclaimed, the cost is about 30 cents for 1,000 gallons.

The RIA spokesman said that although all the effluents are going into a municipal sewage system, no additional burden is imposed by discharge of chemical and corrosive wastes.

Instrumentation is used to monitor and control all phases of the completely automatic large-scale reverse osmosis system. Alarms are sounded for control personnel if necessary. Should corrective action not be taken within a reasonable time period, the system shuts down without disruption of RIA operations.

HDL Verifies Safeguard 'Hardness' to EMP

Tests deploying the Army's Repetitive Electromagnetic Pulse Simulator (REPS) in North Dakota have verified the "hardness" to nuclear electromagnetic pulses (EMP) of the Safeguard Ballistic Missile Defense System.

The test series was conducted by the U.S. Army's Harry Diamond Laboratories (HDL), Washington, DC, under sponsorship of the Huntsville, AL, Division U.S. Army Corps of Engineers and the Ballistic Missile Defense System Command (BMDSCOM). The purpose was to determine the vulnerability and subsequent hardness of the Stanley R. Mickelsen Safeguard Complex in North Dakota against an EMP environment.

REPS is considered another significant step of a 2-year period of cooperative effort between HDL, the Boeing Corp. in Seattle, WA, Bell Telephone Laboratories in North Carolina, and HQ Army Safeguard Command, Huntsville.

HDL has had responsibility during this period in the joint planning of tests, development of equipment such as REPS to support the tests, conduction of tests, and publication and distribution of the data for use by project organizations.

HDL has developed, under BMDSCOM and CE sponsorship, a series of simulators including cable driving pulsers of varying rise times, fall times, and output from a few to several thousand volts.

HDL also devised a series of field illuminators varying from a small 9-foot diameter loop pulsed by 25 kilovolt pulser, to a several hundred kilovolt repetitive biconic pulser used in conjunction with a 500-foot dipole antenna. This latter unit was used extensively in a test series at a Safeguard Remote Sprint Launch Site in November 1973.

Support equipment HDL has engineered includes a network of optically coupled trigger systems to synchronize recording oscilloscopes, digital clocks that provide a scope face readout of date and time for data recording, and an automatic remote controller for the REPS to permit synchronization of all data recording equipment.

REPS is the largest simulator deployed at the Safeguard Complex to date. This state-of-the-art unit is capable of producing a pulse in excess of several billion watts of peak pulse power every few seconds—an extremely useful feature.

The pulser can be precision triggered, using the digital logic, for synchronous pretriggering of recording equipments via the HDL optical trigger network. This greatly reduces data recording time and errors caused by false internal triggering of recording equipment.

REPS has an adjustable output from 0.75 megavolts and produces an output pulse with a varying rise time. The pulser uses a 16-stage triggered Marx generator with a total useable energy storage in excess of 1,000 joules.

The simulator has an unusually fast output rise time, obtained by using a low-inductance pulser output circuit. A 200-pf self-healing, gas-peaking capacitor is used in conjunction with a self-breaking spark gap in an atmosphere of sulfur hexaflouride.

A 9-foot diameter biconic housing for the pulser forms the center of a 1000-foot long, 9-foot diameter, wire cage antenna as the radiator of the EMP simulation pulse. Pulser operation is controlled from a small trailer. All command and control functions are communicated between the pulser and the trailer via pneumatic lines or fiber optics.

Primary power is transmitted from the trailer to the pulser by a high-pressure hydraulic line. A hydraulic motor in the pulser drives an alternator for the source of all pulser electrical power.

These techniques result in complete electrical isolation between the pulser and the ground except for radio-frequency terminating resistors at the ends of the antenna.

During the test series at the North Dakota Safeguard site, REPS provided over 1,000 pulses daily for nearly three weeks. Importance of this form of nuclear weapon effects simulation is reflected by its flexibility and the reduced cost of conducting a site assessment, in lieu of laboratory simulations, or the more costly underground and atmospheric nuclear tests.

Historically, Department of Defense concern for the threat of EMP to electrical and electronic equipment originated in the mid-1950s.

During Operation PLUMBBOB at the Nevada Test Site in 1957, HDL researchers were among the first to measure EMP successfully. Considerable effort has since been directed to protection of critical defense electronic and electrical equipment from this interference. With the Nuclear Test Ban Treaty of 1963, the effects of atmospheric nuclear experiments must now primarily be simulated.

As the Lead Laboratory for the U.S. Army's Nuclear Weapons Effects Research/Testing Program, HDL has researched the simulation of EMP by developing a family of simulators. REPS, built by Physics International Co., San Leandro, CA, is designed uniquely to provide a repetitive EMP pulse to increase its versatility.

Effect of a nuclear burst above the atmosphere is predicted to cause an intense EMP field over hundreds of thousands of square miles. Requirements for reliable EMP simulators to help verify national defense capabilities are being satisfied with the deployment of simulators such as REPS.

Sprint II Launch-Station Shell Designed for Safeguard Defense

An improved 45-ton steel and concrete interceptor missile launch-station shell for the Site Defense, Ballistic Missile Defense Program has been delivered.

Modified from the tube-within-a-tube Safeguard Sprint interceptor launch concept, the first-of-its-kind launch station is designed, when installed underground, to protect the Sprint II from the weather, the exhaust plumes of adjacent missiles, and from enemy nuclear weapon effects.

The basic elements of the Site Defense concept include the Sprint II, its launch station, radar, a commercial computer and associated software.

Sprint II is the U.S. Army's hypersonic surface-to-air missile being developed to provide close-in defense against enemy reentry vehicles should the ICBM threat exceed the Safeguard System capability.

Covered by hinged concrete doors that open in less than a second at launching, the improved launch station shell is a 31-foot-long cylinder 52 inches in diameter. Near the top of the cell is a compartment that contains the launch section, including power supply.

MASSTER Tests Night Devices for 'Copter Repairs

Feasibility of efficiently performing aircraft maintenance at night, under lighting conditions not normally used, is being studied by researchers at Modern Army Selected Systems Test, Evaluation and Review, Fort Hood, TX.

Included in the study of routine aircraft maintenance at night are night-vision goggles, chemical lighting devices, and head lanterns.

The AN/PVS-5 night-vision goggles amplify existing light to allow the user to see at night Chemiluminiscent lights consist of chemically filled flexible plastic tubes that emit a glowing light. The head lanterns are similar to those worn by miners, except that red and green lenses are used instead of a white light.

Transmission changes, engine changes, main rotor changes and daily and intermediate inspections of the Army's UH-1 (Huey) helicopter were among maintenance tasks performed in the first phase of the test. Data collected will determine the potential of each lighting device.

The test began with a week of daylight maintenance, and then went into the nighttime phase by using standard floodlight devices. While testing the new devices, each task was conducted twice at night to obtain a valid comparative determination. Each task also was timed by a data collector to provide productive time values

The U.S. Army Transportation School at Fort Eustis, VA, provided two helicopter technical inspectors to conduct an independent evaluation of the quality of maintenance by inspecting the aircraft during daylight hours.

During second-phase tests, ground and air detectability readings will be conducted for each type of lighting device. Aircraft will be flown over and near the ground maintenance site as night lighting device are being used. An observer will attempt to locate the site in much the same manner as an enemy might do.

MECHANICS from 528th Transportation Company wear night vision goggles while making repairs on helicopter rotor assembly at night, during tests at MASSTER.

AMC R&D Liaison Office . . .

Improves Infantry Support Through Soldier Response

Primary responsibility for information interchanges regarding new and improved clothing, weapons and equipment to enhance combat effectiveness of the individual soldier is assigned to the U.S. Army Materiel Command Infantry R&D Liaison Office (IRDLO).

Commanded by COL Robert B. Tully, the R&D Liaison Office located at the U.S. Army Infantry Center, Fort Benning, GA, is a Class II Activity. Reports are submitted directly to the director of Research, Development and Engineering, HQ Army Materiel Command.

Establishment of the activity, at the close of 1968, resulted largely from recommendations of former Army Chief of Staff GEN William C. Westmoreland and former AMC Commander GEN Frank S. Besson. Their intent was to provide a system to insure continued improvement of infantry support.

GEN Besson emphasized that creation of such an activity would complement the center's mission and enhance the over-all feedback of soldier reaction information between the center and R&D agencies.

IRDLO operations are now expanded to Army divisions worldwide. MSG Michael S. Anderson is the operation sergeant and is assisted by SFC Clarence J. LaRue Jr. When additional personnel are needed, "snowbirds" or "blackbirds" are available. Snowbirds are persons waiting to attend the Officers Advanced Course at Fort Benning. Blackbirds have completed the course and are awaiting reassignment.

The operational philosophy is that if an item will withstand the rigors of combat when employed by the infantry soldier, it can be adapted for use by other soldiers—what works for the combat soldier should work for the whole of the Army.

Soldier reaction is determined through informal evaluations, such as personal interviews, briefings, show and tell displays, and written questionnaires.

Among items that have been evaluated are the M-1 steel helmet and chin strap, plastic collapsible canteen, fabric foxhole cover, duffle bag, M-56 pistol belt, entrenching tool and carrier, arctic and tropic clothing, and plastic insignia.

Frequently, an Army installation or activity will request evaluation of an item of questionable quality or which has received negative response. For example, the U.S. Army Institute of Heraldry requested that a study be made of the subdued plastic insignia.

Liaison visits to AMC commodity command installations, colleges and universities are used to elicit comments and inform personnel of current developments. A review of a recent Liaison Office monthly report revealed that more than 2,000 persons were contacted via displays, briefings and inquiries.

The liaison visits included Rice University, University of Houston, Old Dominion University, activities at Fort Benning, U.S. Army Natick (MA) Laboratories, and the U.S. Army Sergeants Major Academy, Fort Bliss, TX.

Typical of techniques used to gather soldier response was the recent Sergeants Major Academy questionnaire presented to students. An information copy of results was submitted to the IRDLO visitors. Specifically, students were queried as to what one item of military equipment or clothing they felt needed improvement.

Items most frequently mentioned for improvement were the pistol belt, poncho, fatigue uniform, field jacket, individual load-bearing equipment, and the M-16 rifle. In regards to the field jacket, students suggested that the British jump smock be adapted as a replacement. They particularly stressed the need for more pockets.

All feedback information received by the R&D Liaison Office is thoroughly evaluated. Recommendations may then be made for development of either a new piece of equipment or for a modification to an existing item. Responsibility for development of a requirement for a new item rests initially with the Army Infantry Center's Combat Development Directorate.

Review and approval must then be obtained from the U.S. Army Training and Doctrine Command and the Department of the Army. A Required Operational Capability (ROC) document is the final authorization for Army laboratories to proceed with development of a new item. This procedure is less involved if only a modification to an existing item is recommended.

Key mission requirements of the Infantry R&D Liaison Office, as assigned by the AMC commander, include:

COL Robert B. Tully
Commander
R&D Liaison Office
U.S. Army
Infantry Center
Fort Benning, GA

- Monitoring and correlation of all equipment activities impinging upon life support and combat effectiveness of the individual soldier.
- Advise commanders of the infantry community and the Infantry Center, regarding R&D state-of-the-art and new equipment developments.
- Interview overseas returnees for the purpose of gaining firsthand knowledge of the soldier's reaction to the items which have been issued to him and his ideas for improvements.
- Advise the Army Infantry School or other Army service schools concerning programs of instruction interfacing with planned or existing developmental programs affecting the infantryman.
- Advise the AMC Director of Research, Development and Engineering of any recommendations that may result in a change to existing equipment.
- Insure continuing effective liaison with Logistics Assistance Officers (LAO) on matters of AMC responsibility and mutual interest.

The AMC R&D Liaison Office welcomes new ideas or suggestions for improvements to any infantry item. Comments may be addressed to: USAMC Infantry R&D Liaison Office, AMX-LR, Fort Benning, GA 31905.

ECOM Solicits Bidders on Interactive Computer Panel

Opinions of about 90 potential bidders on a high-technology procurement item, prior to locking a Request for Proposals (RFPs) into final form, are being solicited by the U.S. Army Electronics Command, Fort Monmouth, NJ.

Assistant Secretary of the Army (R&D) Norman R. Augustine suggested this innovative approach for procurement of an Interactive Computer Presentation Panel (ICPP) Advanced Development Program. The ICPP program is managed by the Army Tactical Data Systems (ARTADS) Project Manager's Office.

The ICPP will be a 4 x 4-foot display panel, interoperable with central computer complexes; it will provide the means for rapid and efficient display of the total area military command and control situations.

Interactive features will enable command and control elements to enter, modify or delete military situation displays, or request, within a specified range, a selected ground point.

A flat panel, multicolor display technology is desired to provide military symbology, graphics, and alpha-numerics integrated with a military map.

The letter to possible bidders included specifications, tradeoff study requirements and other procurement aspects. It states, in part:

"In order to review and consolidate the industry input and obtain the expected benefit of providing you with the best possible government solicitation, we must have your answer by Dec. 6, 1974.

"This program will be of mutual benefit to both government and industry by providing earlier identification of requirements and a greater chance for free exchange of ideas before the formal procurement process commences."

Solicitation of comments is expected to result in a 2-phase contract. During a 7-month period each of two selected contractors will develop the design plan and specification, and ICPP and proposals for Phase II, which involves an 18-month period during which successful contractors will develop and fabricate advanced development/feasibility models.

WSMR Tests New Artillery Meteorological System

Six weeks of firing, observation and data collection, termed the most comprehensive artillery meteorological experiment known among NATO countries, were drawing to a close at White Sands (NM) Missile Range as the *Army Research and Development Newsmagazine* went to press.

Under test is an automated artillery meteorological system for Army combat operations. The program is being conducted by the Atmospheric Sciences Laboratory, a WSMR element of the U.S. Army Electronics Command headquartered at Fort Monmouth, NJ. The prototype artillery subsystem is PASS.

Artillery experts observing tests in the program included representatives from the United Kingdom, West Germany, Canada, Norway, the Netherlands and the United States. The objective was to acquire information that will significantly improve the timeliness and accuracy of meteorological information required by artillery field commanders.

PASS is part of a larger automatic meteorological system (AMS) that will use computers and improved communications within a corps for more effective application of weather information from Army and Air Force sources. In addition to artillery, 19 other Army combat users are expected to benefit from the improved weather information.

ARTILLERY gun crew members check out one of two 8-inch howitzers used in the Atmospheric Sciences Laboratory's prototype artillery subsystem tests to develop better techniques for using weather data to improve accuracy of artillery fire.

Atmospheric Science Laboratory scientists Dr. Kenneth Barnett and Alex Blomerth planned and coordinated the PASS experiment. ASL scientists will analyze results to improve the accuracy of meteorological corrections used in aiming cannons and in locating enemy artillery by sound ranging.

Data will be compared with that collected by using several methods under combat conditions. ASL scientists also are comparing different kinds of meteorological equipment, as well as computers and improved communications between artillery meteorological units in Army divisions and corps.

COL William C. Petty, director of ASL, indicated that PASS was the most comprehensive field experiment in artillery meteorology known among the NATO countries.

Equipment used in the experiment included 50 microphones; instrumentation for extensive wind, temperature and atmospheric density measurements by the ASL Meteorological Team; a specially equipped airplane loaned by the National Center for Atmospheric Research at Boulder, CO; a computer for real-time processing of data; and U.S. Army 8-inch howitzers.

In the WSMR tests, a simulated corps with four divisions was placed into a combat situation, with a "friendly" area to the south and "enemy" area to the north of Launch Complex 39.

Two 8-inch howitzers fired from LC-39 to an impact area about nine miles to the north. Shell impact locations and times were accurately located for ballistic and sound ranging studies. Enemy gun positions were simulated by shell impact and by explosives detonated at several sites.

Simultaneously, a computer assembled wind, temperature and air density observations from 10 sites and provided corrections compared immediately with the shell impact location and howitzer aiming, to test theories of correction.

Army commands and agencies participating in the PASS tests included the Field Artillery Center at Fort Sill, OK, the Texas National Guard at El Paso, and the U.S. Army Armaments Command, Frankford (PA) Arsenal, and the U.S. Air Force Global Weather Central. The GWC recorded prognostic weather information for use in analyses.

R & D NEWS

ECOM Unveils 'Improved' Photo Processing Method

Claims of time-saving, cost-cutting processing of photographic film are being issued with increasing frequency by several Army R&D installations, and the Electronics Command has entered this arena of competitive effort.

Miss Marylyn Levy, a chemist in ECOM's Combat Surveillance and Target Acquisition Laboratory, and Harmon A. (Kirk) Willey, also a chemist, have reported a "new" much simpler process for developing color photographs.

Among claims for their process are that it is much faster (4 steps instead of 9 and 11 minutes as compared to 53 in conventional processing) and it requires fewer solutions; also, that it is cheaper for government use because the formulas of the materials are known, eliminating the need to stock proprietory items.

Finally, and most significant in this "Era of the Environmentalists," the process is reported to be nonpolluting; also, it can be used for most color negatives, transparency prints and photo papers.

Prideful of their ECOM affiliation, Miss Levy and colleague Willey have termed their processes "ECOM chemistry." Since it is simple, it is expected to be attractive to enterprising amateur photographers with home labs. The process is nonpatentable because nothing is specifically new about their "universal developer."

The process eliminates the use of ferrocyanide bleach, which when discarded from commercial photo processing labs undergoes conversion to a free cyanide in the presence of light and oxygen.

This factor is of concern to the Environmental Protection Agency since minute quantities of free cyanide can poison small organisms. The "new" process uses the sodium iron salt of ethylene diamine tetraacetic acid, considered much less toxic.

The codevelopers believe their system has potentially important impact on U.S. Government agencies offering audio-visual services. Approximately 24 different solutions are presently required to process all the negative materials now commercially available. The ECOM all-purpose process may reduce the requirement to as few as three solutions.

In recommending that the chemistry of their system be included in the General Services Administration supply system, the codevelopers believe it can be of benefit to all audio-visual operations throughout the U.S.—due to saving of time, labor and materials, and the small stock inventory needed.

This broad-scale potential application is considered a "serendipitous byproduct" since the codevelopers were working on a military surveillance project when they discovered basics of the process.

"ECOM Chemistry" innovated by Marilyn Levy and Kirk Willey, reportedly is a faster, cheaper, nonpolluting way of developing color photographs.

R&D Efforts Emphasized at AFCEA Conference

Chairman of the Joint Chiefs of Staff GEN George S. Brown, in a recent address to the Armed Forces Communications-Electronics Association in Washington, DC, stressed that "we must not decrease emphasis on research and development" as critical to maintenance of a strategic deterrent to war.

"To the contrary," he said, "we must call upon industry to provide the United States with a continuing technological margin, while keeping in mind that our goals must be affordable and reliable. This caveat represents, perhaps, the greatest challenge to you in the days ahead. . . . Together we must be certain we make our R&D investments in high payoff areas. . . ."

Stating that caution is in order, he continued: "The consolidated telecommunications program of the Department of Defense exceeds $3 billion. Almost another $2 billion is spent each year for automated data processing support to management information systems.

"About a billion dollars of that almost $5 billion total goes for assets to support the worldwide military command and control system, known to all of us as WWMCCS. Although it is called a system, we dignify it today with such a designation; it must really become a system—to provide immediate communication from our National Military Command Center to any military force in the world.

"Together with an automatic data flow, storage management and display subsystem, this is a unique and far-reaching capability for which we have been striving since the early 1960s. We are not finished yet; in fact, we are at this moment embarked on an architectural effort that will guide the development of WWMCCS through the 1980s.

"All of this means that we are refining our capability to talk to our forces in the field and to act on information received from them. This leads to a word of caution: being able to communicate does not automatically confer the capability of command. Forces in the field must operate through an established command structure.

"This is true whether we are in time of crisis, a contingency operation, or a full-fledged war. We must be able to get information needed to make decisions and we must be able to convey those decisions to the people who will implement them.

"Filtering the information which comes up the chain and precisely framing decisions into commands which go down the chain is my job and the job of those in the Unified Command structure. What we need most from the communications and electronics industry are responsive and reliable systems that help us to do that job. . . ."

GEN Brown turned at this point to a discussion of the role of U.S. Armed Forces in serving "The cause of freedom with justice. . . ."

Readers Indicate R&D Newsmagazine Preferences

Readers of the *Army Research and Development Newsmagazine* who responded to the survey questionnaire carried in the May-June 1974 edition have indicated they think our publication is "excellent" in most rating categories.

The information provided by results of the survey will serve as a helpful tool for the editorial staff in deciding what kinds of feature articles and special sections should be published during 1975 to please our readers.

Percentages in the various categories do not total up to 100, due to the fact that some readers did not respond to all of the questions. For example, 60 percent of those who returned the questionnaire considered the over-all readability of the Newsmagazine "excellent." Thirty percent gave this category an "acceptable" rating. Only a few of the remaining 10 percent checked the "mediocre" blank.

Fifty-nine percent of the responses gave an excellent rating to the quality of the research and development news section, as opposed to 29 percent who opted for an "acceptable" evaluation.

Other results are:

	Excellent	Acceptable
Feature articles	52%	34%
Special Sections	39%	40%
Editing, layout	50%	34%
Over-all quality	74%	25%
Balance of news	34%	46%

Queried as to what sections of the *Army R&D Newsmagazine* are the most informative, our readers indicated the following order of preference: (1) R&D News, (2) Staff Features, (3) By-lined Articles, (4) Selective Scanner, (5) Speaking On, (16) Conferences & Symposia, (7) Personnel Actions, (8) People in Perspective, (9) Awards, (10) Reader's Guide, (11) Women in Army Science.

Suggestions and comments regarding the Newsmagazine will be carefully considered by our editorial staff for future editions. Since our publication was reduced from a monthly to a bimonthly edition, and from 48 to 32 pages, plus cover—as directed by the Army Ad Hoc Authorization Committee on Periodicals—the space limitation precludes favorable action on some suggested additions.

Included among the suggested subjects for future articles are more medical R&D results; Human Performance Factors; Government-Industry Research Efforts; Reliability and Maintainability of Materiel; Computer Systems; and Environmental Control.

Many of our readers expressed a desire that the *Army R&D Newsmagazine* be published on a monthly basis. That would be highly desirable to keep our news items more timely. However, decisions relative to scheduling, distribution, etc., are made by the AAHA Committee. Currently, the national shortage of certain types of paper and escalating publication costs are restrictive factors.

Newsmagazine Lists Highlight Articles Published During 1974

Publication of a complete index of all articles published in the Army Research and Development Newsmagazine during the past year admittedly would be desirable. Space available permits a listing of headlines of only the more important highlight articles.

JANUARY-FEBRUARY 1974— Development of Energy Resources in Accelerated Interagency Effort.
96 Research Papers Listed for ASC.
TACOM Seeks Improved Military Vehicle Maintenance Procedures.
AMC In-House Research Personnel Brief ASA (R&D) on Advances in Aircraft Development.
Foreign Technology: Switzerland's Skyguard Fire Control System.
ECOM FY-73 Report Lists R&D Achievements.
Picatinny Arsenal in Research and Development.
Computer-Aided Design Finding Many Applications at ECOM.
ABMDA Developing Technology for Infrared Signature Measurements.
R&D Leaders Attend AMC Lab Chiefs Parley.
Development of a Stress Corrosion Test for Armor Alloys.

MARCH-APRIL — Military Posture Statements, RDT&E Budget Presentations Advise Congress Regarding Views of Top Defense Leaders.
SLAR Finds Application as Research Tool.
Interactive Computer Graphics in Materiel Acquisition.
Night Vision Goggles—Sight for the Blind
AMRDL Focuses on Superior Combat Aircraft.
Secretary of Defense and Army Staff Chiefs Brief ASAP.
AMC PM Annual Meeting Draws VIPs Array.
ASC Slated at Military Academy.
National JSH Symposium Scheduled at MIT.
ISEF Winners Return.

MAY-JUNE— Defense RDT&E FY 1975 Budget Proposals Sent to Senate Armed Services Committee.
CE Continuing Fibrous Concrete Test Program.
ERTS-1 Provides Data: CE Takes Inventory of Inland Dams.
FDA Approves Army-Developed Meningococcal Meningitis Vaccine.
Designing Army Aircraft to the Environment.
Army Night Vision Technology Advances Toward Services Components Commonality.
Antiballistic Missile System Evaluation.
USAAMRDL Reducing Gas-Turbine Pollution.
AMMRC Researchers Investigate Structural Effects From Combat Damage.
Another Kind of Armor Problem: Suppression of Infrared Radiation From Army Aircraft.

JULY-AUGUST— International Development & Standardization in AMC.
WSMR Assembles Most Precise Meteorological Satellite Weather Pictures.
Army R&D Achievement Awards.
Army Science Conference Features Awards.
NLABS Enzymatic Conversion Process to Alleviate Energy Problems.
Comparative Assessment: U.S. Army/USSR Ground Forces Materiel Acquisition Processes.
TACOM-TRADOC Advanced Planning Briefing for Industry.
Top Department of Defense, Army Leaders to Join 250 Attendees at 13th ORSA Symposium.
NJSHS Program Offers Science Careers.
25th ISEF: Outstanding Students Selected.
New Test and Evaluation Funding Procedure to Start in FY 1975.

SEPTEMBER-OCTOBER— Management Principles for Defense Research and Development.
Expanded Responsibilities Assigned to New Corps of Engineers R&D Office.
ASA(R&D), CRDA Advanced Concept Team.
AMARC Publications Released: First Volumes of Report Portend Major Impact on Army RD&A.
X-ray Aids Analyses of Shaped-Charge Jets.
Optical Design of Day/Night Periscopes.
AMMRC Concentrates on Titanium-Coated Graphite Fibers.
Terrain Information System for Future Combat.

NOVEMBER-DECEMBER— Cost/Schedule Control Systems Criteria: Practicable Army-Industry Approach to Acquisition Management.
Army Research Office Plans Relocation in Spring.
Armed Services Considering 'Aerocrane'.
Army Research Institute: Developing Agency for the Behavioral and Social Sciences.
ASA(R&D) Initiates Awards Program: Concept Requires Annual Evaluation of In-House Labs.
Army Sponsors TIAC Review.
20th Annual AUSA Meeting.
Assessing Soviet Progress in Small Arms Research and Development.

'Army Laboratory of the Year' . . .

Night Vision Laboratory Recognized by ASA (R&D) Award

"Army Laboratory of the Year" honors, as announced by Assistant Secretary of the Army (R&D) Norman R. Augustine, in a program he initiated this year to upgrade activities in Army in-house labs, will recognize the Electronics Command's Night Vision Laboratory, Fort Belvoir, VA.

The Army Materiel Command nominated the Night Vision Laboratory for the Laboratory of the Year award after a high-level committee reviewed the 1974 accomplishment of its 21 laboratories.

Competition for this first-of-its-kind distinction—to be conducted on an annual basis hereafter—was so close, in the judgment of a high-level ad hoc committee, that the U.S. Army Institute for Surgical Research was declared the runner-up. This was a departure from the awards program as originally announced by Mr. Augustine in the November-December edition of the Army R&D Newsmagazine.

The U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, was selected by the ad hoc committee for the Special Award for the Most Improved Laboratory, based on its 1974 progress.

In reporting to Secretary Augustine the results of its deliberations, following interviews with top representatives of seven Army laboratories that were considered for the awards—based on nominations submitted by commanders of all Army laboratories—the judges stated:

"The committee had particular difficulty in comparing research related to 'hardware' as contrasted to research related to 'people' and also in identifying a base line from which to measure improvements for the award year. The committee is satisfied that reasonable selections are possible and that the awards should be continued."

Members of the committee have been requested by chairman Dr. Richard A. Montgomery, who also serves as vice chairman of the Army Scientific Advisory Panel (ASAP), to submit their observations to him for consolidation, and for consideration with respect to mechanics of the future awards selection.

Other members of the committee were Dr. John Allen, Deputy Director of Defense Research and Engineering (Research and Advanced Technology); Dr. John Martin, Deputy Assistant Secretary of the Air Force (R&D); Dr. James Probus, Director of Navy Laboratories; and Dr. Herbert Ley, now an ASAP consultant. Formerly Commissioner of the U.S. Food and Drug Administration, Dr. Ley earlier was a key staff member with the Office of the Chief of R&D, Department of the Army.

The citation for nomination of the NVL for the top award states, in part, that the selection was justified "by virtue of having developed from earliest inception the technologies basic to observation and enhancement of restricted or infrared background light," as related to combat and other operational requirements under cover of darkness.

As noted in the November-December edition of the Army Research and Development Newsmagazine, the Night Vision Laboratory selection also was justified by "having achieved international acclaim and recognition as the leader in the field; and for successfully delivering to the Army, on a timely basis, prototype and production elements for systems requiring operation under limited visability conditions.

"This nomination is based on this laboratory's outstanding performance in meeting Army needs as well as recognition by the entire Department of Defense, industrial community and the technical community of the world as one of the leaders, if not the leader, as a technical center of excellence for research and engineering of night vision technology and devices.

"This laboratory has done an outstanding job during the year as the Army's lead laboratory in its area. It has been recognized for such acts by the Joint Logistics Commanders (JLC) giving it the lead in developing a joint position for the JLC on the Department of Defense program for FLIRS. In recent months it has been nominated by the Joint Directors of Laboratories as the lead coordinating laboratory for the three services in night vision technology.

"Throughout the year this laboratory has successfully carried out its assignments in a timely manner in providing prototypes and preproduction devices to meet Army urgent requirements existing for night vision equipment. . . .

"The laboratory has done a creditable job on engineering development assignments, while at the same time continuing to maintain a strong program for developing next-generation light amplifiers and IR imagery systems with high reliability and reduced cost of future night vision equipment. . . ."

The Army Surgeon General's nomination of the U.S. Army Institute of Surgical Research for the Army Laboratory of the Year Award consisted mainly of a listing of its major areas of R&D effort in new methods of treatment of severely burned patients, many of whom would not have survived without the benefit of USAISR advanced technology. Listed also were the numerous publications in professional journals reporting on discovery of new techniques.

The ad hoc committee of judges for the awards conducted interviews with leaders of the Night Vision Laboratory, Institute of Surgical Research, Cold Regions Research and Engineering Laboratory, Research Institute for the Behavioral and Social Sciences, Aeromedical Research Laboratory, Corps of Engineers Construction Engineering Research Laboratory, and the Air Mobility R&D Laboratory.

AMRDL Contracts Include AH-1G Multispar Concept

Demonstration of the multispar concept for the AH-1G helicopter main rotor blade and research on new composites for helicopter windshields and windows are required in contracts announced recently by the U.S. Air Mobility R&D Laboratory, Moffett Field, CA.

Hughes Helicopters, Division of Summa Corp., is conducting a $1,173,000 27-month effort to optimize design and demonstrate the performance and operational potential of the multispar concept for the AH-1G main rotor blade.

Irving E. Figge, project engineer with USAAMRDL's Eustis (VA) Directorate, noted that recent investigations of the multitubular spar rotor blade concept have indicated significant benefits can be achieved. Included are potential estimated 10-50 percent savings over current metal designs.

The first USAAMRDL aviation research contract with sole emphasis on helicopter windshields and windows was awarded to Sikorsky Aircraft Division, United Aircraft Corp. The $319,000 effort is aimed at correcting high-cost maintenance problems. (Similar work on windshield materials at the U.S. Army Materials and Mechanics Research Center, Watertown, MA, was reported in the *Army R&D Newsmagazine*, May-June 1974 edition, page 9.)

Transparencies are now designed and manufactured to fit the general vehicle contour. This approach has limited the choice of materials, limited possible configurations, and has often compromised functional characteristics, degrading over-all helicopter performance and cost-effectiveness.

The Sikorsky Aircraft Division received $69,338 and the Boeing Vertol Co. $76,005 to evaluate capability of the C-81 Rotorcraft Flight Simulation Program to predict performance, dynamic loads, stability and control of articulated rotor helicopters.

Boeing Vertol Co. also will build and test a system to stabilize aerodynamically induced swinging and spinning of external helicopter loads, under a $344,000 task.

The company designed, produced and tested an experimental Active Arm External Load Stabilization System (AAELSS), comprised of two rigid pendants driven by servomotors, during an earlier phase of the program. The contractor will now design and make an improved AAELSS II that will attach to the fuselage of a cargo helicopter.

Techniques to reduce visual detection of Army helicopters are being tested in Pennsylvania, using full-scale AH-1G and OH-58 helicopters, under a $72,000 contract awarded to Boeing Vertol Co.

By combining information from a previous contract that used AH-1G helicopters in a laboratory simulation, and data collected through the new contract, Boeing Vertol will verify validity of the simulation technique for predicting visual detection probability and range.

Goggles Shield Against Nuclear Flash

Adequate eye protection against temporary blindness caused by a nuclear blast flash and practicality for field use are goals of a goggles development program announced recently by the U.S. Army Natick (MA) Laboratories.

Designed primarily for military vehicle drivers and aircraft pilots, the goggles will embody an electro-optical concept developed by the Atomic Energy Commission's Sandia (NM) Laboratory. They will blink from transparent to opaque within 50 millionths of a second, thus cutting off the peak brilliance of hazardous flashes.

A key element is a sheet of transparent ceramic composed of lanthanum-modified lead zirconate titanate (PLZT). G. H. Haertling and three other Sandia scientists have patented the variable density optical filter, consisting of a 10-millimeter-thick wafer of PLZT overlaid with interdigital electrodes of gold over chromium and deposited in lines 2 millimeters wide and about 40 millimeters apart. This composition is sandwiched between crossed polarizers, each similar to the lens in polaroid sunglasses.

When 900 volts are applied to the electrodes, the plane of light passing through the first polarizer is rotated so that it can pass through the second. Only about 20 percent of the light is transmitted, permitting the wearer to see normally.

Initially, a group of small photodiodes, located above the bridge of the nose, detects the flash and automatically drops the voltage rapidly when exposed to bright light. The system darkens to an optical density of three, (O.D. 3) in 50 millionths of a second, transmitting only 0.1 percent of the light.

The unit is presently powered by a 200-hour capacity 5.4-volt battery with a converter expected to occupy less than two inches when fully miniaturized.

Project Engineer Dr. Edward Healy has emphasized that the present laboratory model was constructed merely to demonstrate operating principles. A configuration for field use will provide maximum peripheral vision and decrease weight to less than eight ounces.

3 HQ AMC Personnel . . .

Earn Master's Degrees in Systems Management

Master of science degrees in systems management were awarded recently to 109 graduates of a 2-year program offered by the University of Southern California at its Washington, DC, center for residents of the greater metropolitan area of the nation's capital.

Three of the graduates are staff members of HQ U.S. Army Materiel Command, Alexandria, VA. Seventy-seven are military officers (31 Air Force, 14 Army, 20 Navy, 8 Marine Corps), and the highest ranking graduate is MG Peter R. DeLonga, Air Force. Eleven are Navy commanders and the highest ranking Army graduate is a retired colonel.

Administered by USC's Systems Management Center in Washington, the 2-year program offers a multidisciplinary approach including systems management, human factors and systems technology. The HQ, AMC graduates are:

Roger W. T. Hanson, a general engineer assigned to the Plans and Programs Division in the Research, Development and Engineering Directorate, joined AMC in 1968. He has worked on the Hawk and Land Combat Support Systems at the Army Missile Command, Redstone Arsenal, AL, and has a BS degree in engineering from Northeastern University.

James E. Tragesser, assigned as an environmental control analyst in the Environmental Control Office, Plans and Analysis Directorate, joined AMC in 1969. He has a BGS degree in sociology and psychology from the University of Nebraska and was recently named an honorary faculty member of the U.S. Army Logistics Management Center.

LTC Homer L. Brem Jr. is serving as an aviation safety officer in the AMC Safety Office. He joined AMC in 1970 and was initially assigned as an aeronautical engineer. He has a BS degree in petroleum engineering from Oklahoma U.

The USC master's program is offered on-campus and at 46 off-campus study centers, including Washington, DC, Western Europe, Japan, Okinawa, Philippines, Hawaii, Alabama, Califoria, Florida, Kansas, Kentucky, Maine, Maryland, Montana, New York and Virginia.

AMMRC Utilizes Ultra-High-Speed Photography For Ballistics Evaluation of Armor Materials

Ultra-high-speed photography is being used for ballistic evaluation of composite armor materials, under extreme temperatures (−65° F. to 190° F.), at the U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA.

Developed by Joseph M. Rogers of the AMMRC Organic Materials Laboratory, the technique permits deformation characteristics and/or behavior tests on bulk polymers, fabrics and coatings designed for personnel armor or aircraft windshields.

The EG&G multiple microflash system has been used to provide multiexposed photographs of woven fabrics taken during ballistic impact. These have depicted various features of the transient response of the fabric and projectile during and after the penetration process.

For example, high-speed photographs have furnished measures of the shape, magnitude, and growth rate of the fabric out-of-plane deformation, loss of projectile velocity and energy.

Other determinations include the rate of projectile tumbling after penetration, the time taken for penetration to occur, and estimates of the average retarding forces exerted on the projectile during its interaction with the fabric.

This type of information is helping to characterize the various dynamic deformation modes of the fabric and the energy absorbtion processes which accompany fabric responses.

Multiple microflash photography also is being employed in the investigation of the transient response of bulk polymers to ballistic impact. For example, with a series of polyurethane block copolymers synthesized at the AMMRC, it has been found that energy loss increases with increasing impact velocity.

Estimates also are being made of the kinetic energies of the fragments generated from the polyurethane specimens for comparison with this projectile energy loss, to assist in further understanding of the energy partitioning processes operating during ballistic impact and penetration.

Stress-wave propagation in transparent plastics was studied by observation of the dynamic strain and birefringence produced by mechanical impact, to obtain basic information about the mechanical and optical response of polymers. Instrumentation and techniques were developed to achieve projectile alignment, intense monochromatic illumination, and approximate 1-dimensional wave propagation in the impacted specimen.

The study was photographed with a Beckman and Whitley Model 326 dynaflax camera, which recorded two rows of 16mm images on 35mm film at 36,000 frames per second with one microsecond exposure time per frame. Over a range of dynamic strain rates, the dynamic strain-fringe constant for the material tested was found to be essentially rate independent.

Scale-model projectiles or actual shell fragments, ranging from 2.0 to 200 grains, are launched at varying velocity levels through 5,000 ft/sec. Dynamic impact data are obtained at the rate of 100 million frames per second, through the use of image converter cameras, multiple microflash photography, and flash X-ray which freezes images in one microsecond.

Equipment used in these studies includes: Beckman and Whitley image converter camera with framing rates up to 100 million frames per second; Beckman and Whitley Model 300 rotating prism camera with framing rates up to 1,500,000 frames per second; EG&G multiple microflash unit Model 502 with a flash duration of one microsecond (frequency variable from 25 Hz to 100 KHz); field emission flash X-ray, Model 314.

The environmental chambers, 20 x 20 x 25 inches, were designed with composite glass-armored viewing ports adapted for high-speed camera applications.

MERDC Demonstrates Fuel Air Explosive Mine Neutralization Capabilities

By James A. Dennis

Fuel Air Explosive (FAE) landmine neutralization capabilities and other FAE blast effects were demonstrated recently to Army general officers, high-level users and developers during three live firings at Fort A.P. Hill, VA.

Conducted by the U.S. Army Troop Support Command (TROSCOM) Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA, the test firings were viewed by more than 40 U.S. Government officials.

GEN William E. DePuy, commander, U.S. Army Training and Doctrine Command and TRADOC Deputy Chief of Staff for Combat Developments MG Robert McAlister were among the high-level observers, along with MG H. R. Parfitt, Engineer Center commander; BG Edward Hirsch, director of Requirements, Office of the Deputy Chief of Staff for Operations and Plans, HQ DA; BG Harry A. Griffith, director, Research, Development and Engineering, Army Materiel Command; BG John E. Sterling, deputy commander, TROSCOM; and COL T. R. Hukkala, MERDC commander.

Firings demonstrated the combat applications of FAE blast effects for detonating and neutralizing high-explosive (HE) landmines of both U.S. and foreign manufacture, inflicting casualties to personnel in foxholes, producing mobility kills on wheeled vehicles, and destroying artificial and natural camouflage.

FAE munitions employ foliage-discriminating fuzes that actuate on target contact, explosively rupturing thin-walled warheads and dispersing highly volatile liquid chemicals into aerosol clouds. The clouds are detonated automatically by delay detonators from center-burster charges that formed the FAE clouds (Fig. 1).

Capability to destroy artificial and natural camouflage and to expose battlefield emplacements was demonstrated vividly by the first FAE explosion. The blast denuded a 90-foot diameter area of thick, heavy underbrush, trees and a tactically emplaced Army camouflage net (Fig. 2).

A second FAE warhead explosion destroyed a 2½-ton cargo truck, instantly setting the truck on fire, blasting away major parts, and severely damaging the frame and engine. Effects obviously would have been fatal to personnel in the truck as well as in the two nearby foxholes where wooden targets were shattered (Fig. 3).

Landmine neutralization, currently the primary Army application of FAE, was demonstrated by a third detonation at the center of a mined area containing U.S. and Russian HE landmines. Antitank and antipersonnel mines were cleared from an area 175 feet in diameter. FAE explosions were shown to detonate landmines by actuating the mines as a tank or soldier would, and also to produce malfunctioning damage that could also neutralize landmines.

FAE neutralization has been proven highly effective in previous MERDC test firings against single-impulse-pressure and pull - fuzed antitank and antipersonnel mines, double-impulse-fuzed antitank mines, and the latest types of complex fuzed landmines. Included are mines with long-impulse, seismic - infrared, magnetic - influence, electronic, and hydraulic fuzes.

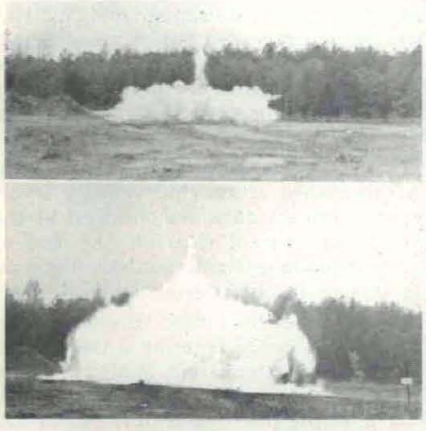


Fig. 1. FUEL AIR EXPLOSIVE (FAE) cloud formation is shown in top frame of photo. The clouds are automatically delay-detonated (lower frame) by the center-burster charges.

Results of recent underwater FAE mine neutralization tests have also proved that FAE munitions — which actuate and detonate above the water surface — are equally as effective in detonating tactically emplaced underwater antitank mines as they are in clearing landmines emplaced underground.

Fig. 2. TRADOC Commander GEN William E. DePuy discusses Army tactical requirements for FAE mine neutralization equipment at camouflage destruction site. James A. Dennis is at left.

High-explosive antitank mines were detonated with 100 percent effectiveness in up to 7½ feet of water, and to a radius of 26 feet from the exploding FAE warhead.

Antitank mines detonated within the 26-foot radius of the FAE explosion were enhanced traveling through the water, causing actuation and detonation of underwater mines to radii up to 65 feet. Depth of the water did not appear to be a significant factor in FAE neutralization of underwater antitank mines.

Reliable FAE neutralization of underwater antitank mines is considered a highly significant advancement in Countermine Warfare that will increase the mobility of U.S. Combat Forces.

Development and fielding of FAE mine neutralizers will permit breaching of underwater mines in assault river crossings and beach landings without putting personnel in the water or subjecting them to minefield defensive weapons fires.

Success in FAE mine neutralization research, which is part of the high-priority Army Countermine Program for which MERDC is the Lead Laboratory, has led to a 2-systems approach in developing detonating equipment.

The Fuel Air Explosive System, Helicopter-Delivered (FAESHED) Mine Neutralizer, a near-term system, is undergoing DT III testing at the U.S. Army Test and Evaluation Command. The Surface-Launched Unit, Fuel-Air Explosive (SLUFAE) Mine Neutralizer is being developed as a quick-response, all-weather, day or night system.

The FAESHED Mine Neutralizer consists of two Navy CBU-55/B weapons mounted on an Army UH-1H helicopter. One weapon is attached to each side of the helicopter with standard universal store racks, kellet pylons and antler assemblies.

Fig. 3. FAE blast effects on 2½-ton cargo truck would have been fatal to personnel in the truck as well as in two nearby foxholes where wooden targest were shattered during tests.

A fire-control box provides for releasing the right or left weapon or both weapons simultaneously. Reference lines on the lower aircraft bubble and a rod on the instrument panel comprise the sighting systems.

The CBU-55/B FAE dispenser con-

tains three individual BLU-73/B FAE bombs, each equipped with a mechanical time fuze that can be set between 1.0 and 9.7 seconds. Release of the bomb extracts the arming wire and initiates the delay function of the dispenser fuze.

After elapse of the preset delay-time, the base-cover of the dispenser is removed by explosion of a mild detonation cord. Base-cover removal causes extraction and deployment of the stabilizer attached to the aft (No. 1) bomb.

Fig. 4. FAESHED Mine Neutralizer, consisting of two Navy CBU-55/B weapons mounted on an Army UH-1H helicopter, breaches a live minefield.

Drag-force from deployment of the stabilizer causes the bomb to extract from the dispenser. A low-break-strength line connects the aft bomb to the second bomb so that continued deceleration of the aft bomb causes stabilizer deployment for extraction of the second bomb and extension of the No. 1 fuze probe. The third bomb is similarly extracted. The stabilizers also control the terminal velocity of the bomb and the ground orientation at impact.

Fuze functioning is initiated by ground contact with a probe extending from the bomb fuze. The stand-off probe initiates the explosive sequence that ends with cloud detonation while the bomb is above the surface of impact. If the bomb fails to function on impact, a self-destruct device will detonate the burster charge and destroy the bomb two minutes later.

Development of the FAESHED is complete and the system has been type classified Limited Production Logistic Control Code T with OT III scheduled for FY75. Type classification standard is planned for 3QFY76. (Fig. 4).

The SLUFAE Mine Neutralizer system is capable of rapid assault breaching of defended enemy minefields from defilade or concealed standoff positions distances up to 700 meters.

The system consists of a rocket-delivered FAE round and a 30-tube armored launcher mounted on the M548 full-tracked cargo carrier (Fig. 5). The launcher contains an elevating mechanism to permit SLUFAE-round launching at 30° quadrant elevation on slopes of ±10°, and a firing control intervalometer to fire single rounds or ripple fire all or any selected number of the 30 rounds that impact in a linear pattern over a 100- 200-meter distance.

The SLUFAE round is composed of an FAE warhead containing 85 pounds of propylene oxide (PO) fuel, a central explosive burster charge, a foilage-discriminating probe-fuze, two cloud detonators, a rocket motor containing 8.5 pounds of propellant, a shroud fin-stabilizer, and a ring-slot parachute for retarding the SLUFAE round to achieve repeatable impact velocities necessary for reliable FAE cloud formation and detonation.

Actuation of the firing control intervalometer initiates the rocket motor propelling the SLUFAE round from the launcher extracting the arming wire and actuating the mechanical time fuze. The fuze acts as the range timer and is fully armed when the fuze arming vane has been subjected to 75 knots air speed for 0.9 seconds.

SLUFAE round impact ranges and round-to-round spacings are achieved by varying time settings of the fuze from 1.0 to 9.7 seconds in 1/10th second increments. Rundown of preselected fuze settings actuates explosive links that deploy the ring-slot parachute and extends the 4-foot fuze probe after the parachute retards the SLUFAE round descent to prevent fuze-probe damage.

Contact with target surfaces functions the probe fuze, detonating the burster charge to disperse the PO fuel into an aerosol cloud 12′ x 54′ after having first actuated and projected the cloud detonators so that they enter and explode the FAE cloud at about 150 thousandths of a second after burster charge initiation.

Detonation of the FAE cloud produces blast effects sufficient to neutralize or detonate both conventional and complex, long- and double-impulse-fuzed landmines and explosive booby traps.

Accuracy firings during FY75 have proven that the SLUFAE system of 30 rounds can clear an 8-meter-wide breach through a 100-meter minefield to a range of 700 meters. Accuracy results, compiled as standard deviations about the mean impact point, are 8.5 feet in deflection per 1,000 feet downrange and 20 feet in range per 1,000 feet downrange.

Over-all test firing results indicate a high probability of extending the range to permit minefield breaching by the SLUFAE system to a range of 1,000 meters.

The SLUFAE round is being developed for MERDC by the Naval Weapons Center, China Lake, CA. The U.S. Army Missile Command (MICOM), Redstone Arsenal, AL, is developing the launcher.

Capable of breaching minefields from concealed or defiladed positions behind forward edge of the battle area (FEBA), the SLUFAE neutralizer will be difficult to counter, will permit maximum exploitation of the surprise element in tactical minefield breaching, and the subsequent rapid passage of combat elements through the safe breach to assault enemy positions.

The neutralizer will have a high degree of mobility with quick mission response capability; it will be able to move rapidly in support missions with Armored or Mechanized Infantry Task Forces.

The primary contribution to Army combat power will be the highly significant gain provided in ground or water-crossing mobility by quickly and effectively clearing safe lanes through minefields emplaced on the surface, underwater, or underground.

Fig. 5. SLUFAE Mine Neutralization System consists of a rocket-delivered FAE round and a 30-tube armored launcher on M548 cargo carrier. SLUFAE round is shown in insert.

JAMES A. DENNIS has been engaged in RD&E in demolitions and mine warfare at the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA, since 1960, and is now with the Mine Neutralization Division of the Countermine/Counter Intrusion Department.

In 1971, he received the MERDC Commander's Award for Technical Achievement, and holds numerous performance citations for his work. He has completed Officers Candidate School (OCS), infantry and artillery schools, and has taken several engineer officers' courses and special weapons courses.

During his career in the Army, from which he retired as lieutenant colonel in 1960, he was involved in the application of explosives as an infantryman and engineer in Africa, Sicily, Europe, and the Pacific Theater during World War II and in the Korean War.

Edgewood Arsenal CAD-E Center Eases Materiel Design

This article reports on what is termed "another significant achievement" in the 5-year-old Computer-Aided Design and Engineering Program (CAD-E) to make available to scientists and engineers in U.S. Army laboratories and arsenals the most advanced technology in this field.

Advanced computer capabilities are integrated with interactive graphics, automated drafting and digitizing, and numerical control technology in Edgewood Arsenal's preparation of technical data packages for military materiel acquisition programs.

Currently, the Computer Design Center at Edgewood Arsenal (a part of the Aberdeen (MD) Proving Ground and an element of the U.S. Army Materiel Command) is considered the most advanced operational facility of its kind in the Army. The Electronics Command is developing comparable facilities at its headquarters in Fort Monmouth, NJ.

Several other Army research and development installations also are in varying stages of applying this new integrated technology to their programs. The Edgewood center is continuing with expansion of its capabilities to meet requirements presently being generated. The equipment provides a capability for designing, drafting and fabricating in a continuous sequential mode.

Manual engineering design and drafting procedures are being streamlined by use of Computer Aided Design and Engineering (CAD-E) technology, which is generating a greater amount of analytical data for the engineer in a shorter time frame—thereby increasing his design latitude during the military materiel development effort.

Various Edgewood Arsenal end items, from binary rounds of chemical ammunition to equipment for demilitarization of chemical weapons, have been computerized from the original conception through detailed drawings and onto experimental prototypes for field testing.

CAD-E technology is rapidly finding widespread Army acceptance as an economic necessity in view of requirements to produce greatly improved materiel with decreasing manpower and funding resources. Edgewood Arsenal has acquired an automated drafting and digitizing machine (ADDM) as a pilot facility through the Army Materiel Command CAD-E program for the purpose of investigating the benefits of such a system in engineering/manufacturing.

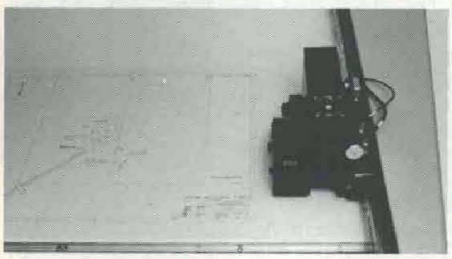
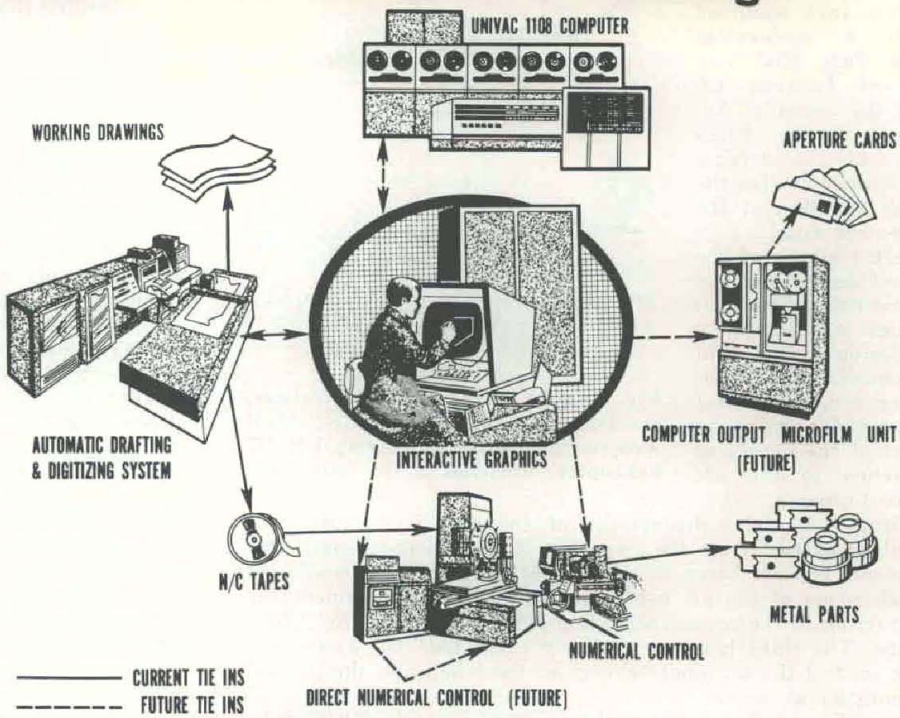


Figure 1



Computer Design Center at Edgewood Arsenal, APG, MD

Comprising the system's equipment is a 5- by 12-foot automated drafting table and various control consoles containing a mini-computer and other electronic equipment related to monitoring and measuring functions.

Mounted over the table is a drafting and digitizing head, suspended from a gantry and armed with a series of pens for drafting, and an optical line-following device. The digitizing console is equipped with a closed-circuit-TV monitor, providing the operator with a magnified view of the drawing and enabling him to input automatically the geometric data into the computer.

Vernon Pearl, the arsenal's project engineer for the new design center, said the digitizing of a concept drawing is the first step to input geometric data, including certain physical properties of arbitrary shapes, into the computer. This function is accomplished by tracing in lieu of preparing computer-language programs. Engineering calculations also can be generated (Figure 1).

A material density factor can be input to allow calculations to be made about an object or shape constructed of non-homogeneous material. In minutes, without manual definition, volume, surface areas, polar moments of inertia, radius of gyration, and centers of gravity of the part can be determined (Figure 2).

Before the introduction of the ADDM, all component parts geometry had to be manually described and fed into a computer through punch cards before it could be messaged through a computer analysis program. Initial digitized data now is manupulated to produce such end results as scaling, perspective views, subassemblies and component details.

Basically, the drafting and digitizing system is presently restricted to 2-dimensional work, but isometric and 3-dimensional views are producible. A feature of the automated drafting and digitizing system is its ability to produce numerical control (NC) tapes for automated fabrication of components for military materiel and equipment. This feature is extremely attractive in that it eliminates a large percentage of manual programing previously required for NC tape preparation.

The system can accurately and automatically follow a drawn outline of a geometric shape, compensate for the cutter radius, and automatically produce NC tapes. Feed rates and spindle speeds are fed manually onto the tape through a teletype. The system can verify tapes it has generated or produced by other programing methods. Time required is about 50 percent less than normal methods.

"Surprisingly," Pearl said, "this operation does not require specialized programing skills. It produces NC tool-path

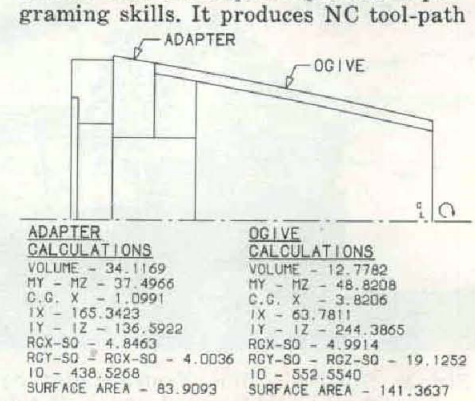


Figure 2

tapes with minimum information supplied by shop personnel."

The ADDM has become an integral part of the design and drafting process although it lacks the quick response required to modify the initial data. This problem was solved early in 1974 by addition of an interactive graphics system (IGS).

The IGS includes a 21-inch cathode ray tube (CRT) and light pen, a 16K mini-computer, a display generator and a disc storage device.

IGS enables the designer to carry on "visual conversation with the computer." His efforts can be outputted on the CRT screen. As the concept and design work proceeds, the designer interacts instantaneously with the computer, using the light pen to modify and verify each step.

The system includes a 16K mini-computer equipped with a teletype writer for input-output functions. The display generator contains all the digital logic and analog circuitry required for communicating with the display processer.

Software routines allow various geometric elements such as lines, rectangles, arcs and characters to be generated rapidly on the CRT screen. The elements, or any group of elements, can be positioned, moved, deleted, recalled, mirrored, scaled and rotated at any time.

Concept designs, subassemblies and individual components generated on the screen are transferred to the arsenal's UNIVAC 1108 computer on magnetic tape for analysis. Repetitive details and frequently used drawing symbols can be recalled from the disc library for incorporation.

Operational routines permit components to be automatically dimensioned—by touching the line, circle or arc to be dimensioned with the light pen, then touching the area where the dimension must appear. Complete with allowable tolerances and extension lines, the dimension is automatically displayed.

Completed details are transferred over the communications link to the ADDM. Hard-copy drawings for the total data package then are made quickly and untouched by human hands. Once in the computer data base, the drawings can be updated rapidly to conform with the latest engineering change proposals. Design and drafting jobs which formerly required weeks to complete are reduced to days.

An example of these savings is on the Safeguard ballistic missile defense system. Nineteen of its electronic schematics were recently completed in two weeks, saving more than 238 manhours.

CAD-E Accomplishments. Although operational for only a short period, the Edgewood systems have produced more than 450 computer-generated drawings. Formal TDP drawings are currently being prepared for a binary chemical projectile as well as equipment for various chemical demilitarization projects. In all cases, preparation time is about half of that required by manual methods.

Earlier projects accomplished by using existing CAD-E equipment include:

- Determining the minimum and maximum liquid fill for tolerance stack-ups on the M60 tank 105mm projectile.
- Design and proofing of crimping die for attaching voicemitter to the M17 gas mask.
- Digitizing analog strip chart data from a laboratory atmospheric constituents detector device for converting to a shifted frequency curve, and replotting for comparison with a known infrared spectrum to determine similarities.
- Scribing gas mask sections and various relay panels for cutouts, using the same tapes which produced the original drawings.
- Accurately determining the maximum-minimum tolerances on a complicated eye lens for the M25A1 mask, and using this geometric data in conjunction with a shadow graph for inspection of produced parts for acceptability.
- Digitizing aerial photos to determine forest growth rates.
- Producing numerous NC tapes for prototype hardware on such projects as Binary, Ring Airfoil Grenade (RAG) and SEAS at a 50 percent cost reduction over conventional methods.
- Evaluating different projectile design approaches by determining flight stability in projectiles from rough sketches and layout drawings.

Future Plans. Heavy use of the current IGS has made it necessary to install an additional CRT, expected to be operational in 1975.

A communication link to an existing UNIVAC 1108 computer will provide for a large processing capability, unlimited storage and access to various other peripheral equipment—serving the objective of larger design programs such as pattern recognition and shell analysis.

Other plans call for acquisition of a computer output microfilm unit which, through a magnetic tape input, could produce a microfilm replica of the drawing, and eliminate the need for an original hard-copy drawing.

Oils Study Reveals Potential Savings of $2 Million

Cost avoidance of more than $2 million a year could be realized if the oils and filter-change interval of diesel-engine-driven generator sets using MIL-L-2104 C lubricating oil were extended from 100 to 200 hours.

Investigators at the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA, made this preliminary estimate during an oil-analyses study of the generator sets. A 2-phase test program was conducted to determine whether the industry-standard, oil-change interval is warranted. Phase 3 testing also is being done by MERDC for the Project Manager's Office, Mobile Electric Power, under the Army's Military Adaptation of Commercial Items Program (MACI).

In the first phase, 13 preproduction DoD generator sets and 7 basic engine models underwent 5,000 hours of testing at MERDC and Aberdeen Proving Ground (APG), MD. Oil samples were taken for chemical analyses at each of the standard 100-hour oil-change intervals and spectrochemical analyses were made every 25 hours.

Oil samples from both locations were analyzed at MERDC. With the aid of an MERDC computer, data were organized and plotted for each generator set against time-in-service hours, and studied for trends based on seven American Society and Testing Materials (ASTM) chemical tests, namely: viscosity at 100° and 212° F.; flashpoint, pentane and benzene insolubles; total acid number and total base number.

Samples of wear metals were studied with an MERDC direct reading spectrograph programed to determine silicon, iron, copper, aluminum, chromium, lead and tin. Wear metal buildup also was plotted against service time (hours).

Phase 1 involved 52,392 hours of engine-running-time, with the engine running 24 hours daily, 7 days per week; 520 oil samples were characterized by chemical tests and 2,080 samples were characterized for wear metals by the direct-reader spectrograph.

Calculation - computation plots of Phase 1 were made available to a number of technical groups for study and evaluation. Their consensus was that the standard 100-hour oil change interval was conservative.

Phase 2, initiated during February 1974 with four production model generator sets (2-60kw and 2-100kw), utilizing two basic engine models (Allis Chalmers Model 3500 and the Caterpillar Model D-33 T). These sets at a nearby contractor's site are run 5 days a week, 24 hours daily. Oil samples are delivered to MERDC for analyses.

The major difference between Phase 1 and Phase 2 is that for Phase 2 the oil-change interval is determined by condition of the oil.

Based on more than 10,000 test hours of running time, 120 oil samples have been characterized by chemical tests and 420 characterized for wear metals by the direct reading spectrograph. The results are:

- A 600-hour repeatable oil-change interval has been maintained with four oil-change cycles completed for the 60-kw generator sets.
- A 1,000-hour repeatable oil-change interval has been maintained with three oil-change cycles completed for the 100-kw generator sets.

The Phase 2 test plan calls for 5,000 hours of endurance testing, to provide a sufficient data base to determine a realistic oil-change interval. However, it already has become apparent from the data that the standard oil-change interval of 100 hours may be increased without adverse effect on operation.

Results to date have prompted the Project Manager's Office, Mobile Electric Power, to recommend an interim oil-change interval policy of 300 hours or six months for Diesel Engine Driven (DED) 15-200kw Generator Sets under normal operating conditions.

Army Waterways Experiment Station . . .
'Mecca' for Broad Variety of Research, Development, Engineering

Descriptive superlatives, based in observation of facilities and ongoing programs of the U.S. Army Engineer Waterways Experiment Station, come easily to the many thousands of annual visitors to this research, development, test and evaluation complex.

Situated at Vicksburg, MS, near the Mississippi River which provided the desired geographical environment to spawn its establishment, WES is a 600-acre reservation that might properly be termed the "Mecca of the Engineer's World." Visitors have termed it the most complete collection of capabilities in the world for its comprehensive areas of RDT&E effort.

Entering its gates for technical assistance, consultations, training and general information during the past year were 7,791 official visitors, 226 representatives of 46 nations, 13,468 grade school, college and university students, and casual observers from all parts of the U.S.

Included in the many highly specialized fields of RDT&E interest to the Army, numerous other military and U.S. Government agencies, and many civilian enterprise organizations, are programs representative of a majority of the scientific disciplinary areas.

Working for its many customers on a reimbursable basis, WES performs basic and applied research, develops methods and techniques, tests materials and equipment, and provides consulting services in its special competence areas.

Some current activities are in such fields as hydraulic testing by use of physical and mathematical modeling; soil mechanics; engineering geology; rock mechanics; improved pavement materials and techniques; expedient construction methodology; nuclear and conventional weapons effects; protective structures; vehicle mobility improvement; environmental relationships; methods of control of aquatic weeds affecting navigable and recreation waters; dredged materials research; water quality; and nuclear and chemical explosives excavation technology.

Since 1949, WES has operated under direct jurisdiction of the Office of the Chief of Engineers. In addition to programs and specialized tasks for the Chief of Engineers and Corps of Engineers field offices, work at WES is sponsored by the Army Materiel Command, Defense Nuclear Agency, Atomic Energy Commission, National Aeronautics and Space Administration, U.S. Navy and Air Force, Tennessee Valley Authority, Advanced Research Projects Agency, Defense Civil Preparedness Agency, Environmental Protection Agency, Department of Transportation, Panama Canal Company and others.

When certain conditions are met, WES services also can be used by State agencies and foreign governments.

Establishment of the Waterways Experiment Station had its origin in 1927 when the Mississippi River, like a rampaging angry giant, wreaked devastation through the valley areas surrounding it—demolishing property and flooding fertile farmlands across a broad region.

Location of WES Projects

Responding to demands for improved technology and control measures to minimize recurring devastation, Congress authorized a hydraulics facility, later to become known simply as WES or "the lab," to assist the Mississippi River Commission in formulating and implementing plans to protect the lower valley against future flooding.

COL G. H. Hilt is serving as the 18th director of WES, with LTC R. K. Hughes as deputy director and F. R. Brown as technical director. WES has about 1,450 employes conducting a work program totaling almost $45 million in FY 1975.

Seven engineering research laboratories are responsible for accomplishment of the over-all mission in their specialized fields. These laboratory "nerve centers" are Hydraulics; Soils and Pavements; Concrete; Mobility and Environmental Systems; Weapons Effects; Explosive Excavation Research; and Environmental Effects.

Other facilities provide technical support in instrumentation, electronic computation and data processing, special library services, technical reports preparation and publication, and perform additional work for the Army Corps of Engineers within areas of expertise.

The Engineering and Construction Services Division, for example, provides utilities, light and heavy construction support, and mechanical shops facilities. All normal administrative services are readily available. This concept provides for operational flexibility and effective use of staff capabilities. Centralization of common-use support facilities avoids duplication of equipment and personnel.

The WES professional staff includes more than 400 graduate engineers and scientists who are recognized specialists in civil works, hydraulics, soil mechanics, concrete research and experimentation. Others are experts as sanitary, agricultural, electrical, electronic, mechanical, and materials engineers.

Additional scientific personnel include ecologists, physicists, chemists, foresters, mathematicians, agronomists, botanists, biologists, limnologists and geologists.

The WES in-house technical capability is backed up by services of leading consultants, on a contract basis, who are drawn from among recognized authorities at universities and in industrial or professional life.

The combination of these talents produces a technical capability of such breadth and versatility that WES can successfully undertake expanded programs in either present or additional investigative fields.

Hydraulics Laboratory. Modeling technology is the most versatile tool available to the hydraulic engineer, water resource planner, and scientist.

During almost 50 years of experience in the field of hydraulic investigations, WES has developed what is recognized as the world's largest and best-equipped capability for practical application of experimental hydraulics.

The Hydraulics Laboratory functions in the technical fields of river, tidal, water-wave, and structural hydraulics. Basic and applied research and supporting engineering design are conducted through theoretical and mathematical analysis, laboratory and field experimentation, and field measurements.

Investigations in hydraulics include cavitation, turbulence, sedimentation, density currents, frictional effects and wave action. Advanced knowledge of these subjects is acquired for practical application in hydraulic engineering.

Advanced engineering design technology, for example, is applied to development, improvement, and maintenance of waterways and harbors for navigation, flood control, power generation, and other purposes. Design criteria for hydraulic structures are developed and standardized through field tests of structure

performance together with analyses of field experimental data.

Improved techniques for operation and maintenance of Corps of Engineers projects also are developed by laboratory and field experimentation.

The Hydraulics Laboratory provides technical guidance to other Corps hydraulic laboratories on tests to determine the plan and design of proposed or authorized projects. For example, WES designed a model of Chesapeake Bay.

Located on Kent Island, MD, near Matapeake, it will be the largest estuarine model in the world, including not only the bay itself, but also the rivers which empty into the bay.

As reported in the July-August 1973 edition of the *Army Research and Development Newsmagazine*, page 9, this $15 million project involves the cooperation of the Army Corps of Engineers, the five States bordering on the Bay, the U.S. Navy, the Smithsonian Institution, and eight major U.S. Government departments or commissions.) Completion of construction is scheduled by June 1975 and WES will be responsible for operation of the model.

Both fixed- and movable-bed models are used for investigations of inland waterways. Objectives include:

- Determine the best locations of river lock-and-dam structures, best arrangements and designs of their appurtenant elements, and necessary adjacent riverbank realignments to eliminate hazards.
- Develop effective high-velocity and other channels to carry flood flows safely through urban areas.
- Determine effectiveness of a wide variety of flood-control measures in channels and backwater areas of the Mississippi River and its tributaries.
- Devise and test plans for development or improvement of rivers for navigation, using such open-river regulation works as dike systems, channel realignments, cutoffs, dredging, or revetments.

Tidal estuary problems most frequently encountered are:

- Methods for maintenance dredging in navigation channels and docking areas, either by reduced shoaling or improved dredging procedures.
- Developing new harbor areas or increasing the channel dimensions of existing harbors.
- Protection and maintenance of offshore entrance channels.
- Control of saltwater intrusion.
- Determination of diffusion and flushing patterns of industrial and sanitary wastes and other pollutants.
- Protection of coastal areas from hurricane surges.

This modeling program often involves reproducing to scale such interrelated hydraulic or sedimentation phenomena as tides and tidal currents, wave action, littoral currents, movement and deposition of channel shoaling material and beach sands, and intrusion and mixing of sea water. To simulate prototype salinity, salt is used extensively in estuarine models.

Wave action studies generally are concerned with one or more of three types of problems (1) over-all layout of a harbor for best locations and dimensions of wave-control structures to provide required protection, (2) structural design of breakwaters and wave absorbers to provide stability against wave forces; and (3) inlet and beach stability criteria.

F. R. Brown
Technical Director

COL G. H. Hilt
Director

LTC R. K. Hughes
Deputy Director

Models are used also to determine the proper types and alignments of breakwaters; locations of piers, spending beaches, and wave absorbers; location and shape of navigation openings; and effects of dredged cuts and fills. The largest such model at WES is the Los Angeles-Long Beach model.

Model studies are used to investigate the hydraulic performance of dams, spillways, stilling basins, outlet works, sluices, control gates, high-pressure valves, locks, pumping plants, surge tanks, dry docks, and many other problems to discover structure design that provide optimum performance at minimum cost.

Characteristics of flow into density-stratified lakes are studied to further technical knowledge of the hydrodynamics of lakes and rivers in the interest of water quality. Results are used in development of techniques for describing and predicting the characteristics of flow into, through, and from density-stratified lakes.

The Soils and Pavements Laboratory, the second laboratory added to WES, was formed to assist in the design and construction of flood control methods. About two years after WES was established, soil technicians began conducting mechanical analyses of samples of bed load and sediment from the Mississippi River. These studies were soon extended to include analyses of soils for levees.

World War II, the Korean and Vietnam Wars brought changes to the works of this laboratory, as did other changes in life styles. Activities now include: research, investigations and testing services in soil mechanics; structural foundation design; embankment design and slope stability; also, seepage analysis, airfield pavement design, geologic explorations, rock mechanics, expedient surfacing, soil stabilization, dust control, and soil dynamics.

Many of these projects are of both national and international importance, e.g., the six drill rigs owned by WES operate at projects all over the United States, Canada, the Canal Zone and Marshall Islands.

Phenomenal growth has occurred in recent years in the spectrum of ground vehicle and aircraft types, and in the quality of pavements required to accommodate them. WES has the latest and most sophisticated equipment to test materials used in pavement systems and to develop improved testing techniques.

In addition to capabilities for pavement tests on a prototype basis, WES can conduct scale-model pavement tests. Special carts are equipped with specific landing-gear configurations and loaded to the desired weight. WES has also developed a portable laboratory for nondestructive tests of prototype pavements.

Other unique equipment is available for research and testing, including a cyclic load triaxial device for determining the liquefaction susceptibility of sands and other granular materials, as well as to perform resilient modulus tests of pavement materials.

The direct-shear machine, also designed and constructed at WES, is used to determine the residual shear strength of clays and clay shales. The torsion-shear device can apply an infinite amount of shear displacement to a soil specimen, and has been used particularly when clay shales occur, as in the Panama Canal studies.

Dynamic load test devices are used to provide data to determine soil properties for high-explosive field test sites and defense installation sites.

A research program is studying and developing geophysical methods for economically and effectively locating subsurface cavities. These underground cavities cause reservoir leakage which may weaken foundations of large structures.

A new road-building concept has materialized at WES, called the membrane-encapsulated soil layer (MESL) road. This concept involves encasing a moisture-susceptible soil in a waterproof cover to form a foundation layer from otherwise undesirable construction materials. Developed primarily for military road construction, to permit the use of native soils, MESL is also applicable for use in airfield construction and in conventional pavement construction.

A MESL roadway was placed at the entrance to Fort Hood, TX, in 1972 and is still supporting heavy traffic.

WES has been, for many years, the

(Continued on page 18)

(Continued from page 17)
principal developer and tester of landing mats for expedient surfacings for the Army and Air Force. This research has reduced weight and cost per square foot —very important when the material must be air transported to landing sites.

Soil stabilization R&D has reached a point at WES where, given a soil type and material to be used, results can be reliably predicted. A Soil Stabilization Manual has been prepared to provide comprehensive criteria for the design of stabilized roads and airfields in the theater of operations.

Another area of concern is the effects of earthquakes on earth dams or other structures, and the design of structures where safety of operations might be in question. An instrumented dam is used for tests to measure accelerations and displacements of a nearby underground atomic explosion.

The Concrete Laboratory. As the world's largest user of mass concrete, for military construction and also for a billion-dollar Civil Works Program, the Corps of Engineers uses this facility to investigate ways and means of making concrete stronger, more durable and less expensive.

When concrete research and testing activities were consolidated and expanded to include testing of concrete aggregates for riprap for carrying out the flood-control plans on the Mississippi River, the Concrete Laboratory was transferred to WES in 1946.

This research includes developing specifications for mixes with reduced cement-to-aggregate ratios and substituting less costly materials for the most expensive ingredient, portland cement; also, reduction in the amount of portland cement through the use of fly ash or other pozzolans.

Often, the investigation is needed to develop the best possible concrete for a particular purpose, using local materials.

The use of fly ash (or other pozzolan as a concrete supplement) is cheaper and generates less heat during the hardening process. Thermal stresses sometimes develop in massive structures as concrete hardens because of temperature gradients from center of structure to outer surfaces.

WES studies have demonstrated that concrete for massive dams can be made with as little as one bag of cement to a cubic yard of concrete, using about twice that much fly ash and filling in with gravel, cobblestones and water.

Some concrete is intended to provide protection against nuclear radiation or against X-rays. In this case, the requirement is for as much weight as possible, such as substituting iron ore or even pieces of iron and steel for the aggregate.

The other extreme is foam or cellular concrete, light enough that blocks of it will float on water. It can be used for bomb crater damage repair. Such concrete has been used to absorb shocks transmitted through the ground which, if not absorbed, could have had severe effects on underground structures.

The laboratory has also experimented with reinforced concrete, employing unusual materials instead of steel rods and bars. Some of the experiments have included fiberglass-reinforced plastic rods, which are stronger and noncorrosive, and split stalks of bamboo.

Special cements which may be modified to cause concrete to harden more slowly or more rapidly also have been investigated. Expansive cement is used to obtain a tight fit in such projects as plugging tunnels.

The laboratory consists of over 90,000 square feet of working space, and is equipped with many types of unusual apparatus. Some of the testing, however, is conducted in the field, such as an exposure station at Treat Island, ME. Specimens are exposed there at mean tide elevation and subjected to alternating cycles of freezing and thawing, or wetting and drying, under severe conditions.

The Mobility and Environmental Systems Laboratory has contributed research results of worldwide adaptability. The principal mission of this laboratory is conducting investigations in Army cross-country mobility and the impact of the environment on military operations. Analytical or mathematical models are developed for these studies. WES has been engaged in certain aspects of mobility research for some 25 years, and currently participates in Tank-Automotive Command mobility research.

Over the years, MR has encompassed the effects of the terrain-vehicle-driver system on vehicle performance in on- and off-road operational environments. A comprehensive analytical model simulates the speed performance of ground-crawling vehicles in known conditions.

This model has proved a valuable tool for specifiers of new vehicle concepts, designers of new vehicle systems, procurers of vehicles where performance can be quantitatively evaluated, and military planners in the selection of proper vehicle mixes. Further research will be performed on the model to improve the prediction accuracy and applicability.

Vehicles can be instrumented and operated across selected terrain routes to establish factors for soft soils, slope, rough ground, trees, river crossings, and other pertinent factors.

Field investigations are complemented by laboratory studies. Results of tests on single wheels and tracks are integrated with field data to produce such typical terrain-vehicle relations as drawbar pull versus vehicle cone index, work versus stem diameter, and vertical acceleration versus vehicle velocity.

The laboratory has devices where soil of a known type and consistency, with relation to moisture content, density, and strength parameters, is prepared and placed in soil bins to form a continuous test bed. An electrically propelled track is then passed over the test bed under various conditions and loads. Instrumentation records all pertinent parameters during occurrence.

The Lunar Rover wheels in support of NASA's Apollo Program were tested in this facility. WES also has evaluated an ingenious track system for possible use in unmanned extraterrestrial explorations, e.g., on Mars. It exploits the elastic behavior of a metal band to provide a large, track-like contact area without the mechanical bits and pieces that make conventional tracks more costly in terms of mechanical efficiency.

WES has also tested concepts for all-terrain vehicles, such as the Riverine Utility Craft for the Marines. This vehicle proved exceptionally mobile in water and soil so soft that no other known vehicle could operate on it. Its only limitation appears to be that it does not operate well on firm ground.

Airborne remote sensors are evaluated for their potential as environmental data-gathering tools for base planners and managers. Aircraft shelter camouflage has been researched, and a computer model for quantifying obscuration of targets by vegetation has been developed.

One critical phase of terrain characterization in which the laboratory has developed capabilities is that of characterization for special activities using data collected by NASA's Earth Resources Technology Satellite (ERTS).

The multi-spectral scanner on board the ERTS-1 measures and transmits data pertaining to the quantity of radiant energy reflected from small patches of the earth's surface in the green-yellow, red, and near-infrared bands of the electromagnetic spectrum.

With the aid of a small PDP-15 computer and a special instrument for "writing" photographs from tape-recorded data, the laboratory is using ERTS-1 information for several Corps projects. ERTS was also used during the 1973 spring flood for gathering information on its advance.

The Weapons Effects Laboratory (WEL) research probes effects of nuclear and conventional weapons on structures, terrain, and waterways.

Through theoretical, analytical, and experimental methods, the WEL provides data for offensive and defensive operations. Investigations are concerned chiefly with the design of protective structures to resist blast, and with the study of underwater and underground shock effects.

Experimental work to support theoretical and analytical studies includes small-scale, high-explosives field tests, special laboratory simulation tests, and full-scale nuclear and nonnuclear tests.

Extensive laboratory facilities have been developed to supplement nuclear and high-explosive field tests for development of criteria for the design of protective structures, both underground and underwater. Results support national security and the peaceful uses of atomic energy.

Basic effects of explosions are studied for probable damage to dams, airfields, terrain features, or underground protective installations. However, the Vietnam War resulted in considerable re-

search on the effects of conventional weapons, particularly as concerned protection of personnel and aircraft from missile fragments.

These programs usually include the participation of a number of other U.S. Government and private research laboratories. Operation MINE SHAFT near Cedar City, US, Operation MIDDLE GUST near Crowley, CO, and the Mono Lake tests in California are examples.

Geologic investigations, site survey and construction, instrumentation, explosives handling, and other research projects were performed in a coordinated weapons effects test program.

Research data obtained from these programs are provided to military service agencies, other laboratories, or used directly by elements of WES to evaluate explosion effects on targets and systems.

Primary areas of investigation include cratering and debris formation by large underground explosions, dynamic blast loading effects on structures, and assessment of underwater explosion effects.

Analytical techniques and computer software developed for military programs have also been adapted by WES engineers and scientists to help solve civil-oriented problems. Among these are environmental hazards posed by conventional demolition blasting of obsolete facilities, and prediction of possible damage to dams as well as to other large hydraulic structures by earthquakes.

The nature of earthquake forces—together with the detailed structural design of dams, intake towers, lock walls, etc., and the interaction of these structures with the surrounding media—result in earthquake engineering problems of a highly complex nature.

WEL is applying its capability to handle dynamic problems associated with explosions in an effort to improve earthquake damage predictions. The goal is development of safer and more rational design procedures for large structures in earthquake-susceptible areas, by using physical models as well as state-of-the-art finite element computer programs.

WEL operates a number of special testing and blast simulation facilities, including the large-blast-load generator. This is used for simulating the pressure-time histories of blast loadings from kiloton and megaton weapons; also, to investigate phenomenology and evaluate response of underground protective structures. Dynamic pressures up to 500 psi, with minimum rise time of 2 to 4 milliseconds and durations up to approximately 2 seconds, can be produced in a chamber 23 feet in diameter and 10 feet deep.

The Big Black River test site for underwater explosions occupies 40 acres about 10 miles southeast of Vicksburg, sufficiently remote from habitated areas to permit detonation of explosive charges up to several hundred pounds.

The facility is equipped with 36 channels of high-speed and 70 channels of medium-speed electronic recording equipment to record data on airblast, ground motion, or water shock from the explosive tests. High-speed motion picture photography is also used in data acquisition.

A TNT casting facility is used to melt and cast charges in various shapes and sizes up to 300 pounds in weight.

The Explosive Excavation Research Laboratory (EERL), the former Nuclear Cratering Group, located at Livermore, CA, covers the entire spectrum of excavation with explosives. This ranges from conventional drilling and blasting with small charges of chemical explosives to massive excavation by nuclear explosions.

EERL is collocated with the Lawrence Livermore Laboratory (LLL) to facilitate technical interchange directed toward peaceful applications of nuclear explosives in industry and science. Among areas of mutual interest are the response of earth materials to dynamic stresses, explosives chemistry and performance, and hydrodynamic code development.

The major current emphasis is on the development of improved and economical large-scale rock excavation techniques using chemical explosives in civil works and military engineering projects, including spillways, railroad cuts, and highway cuts.

This laboratory will be transferred to Vicksburg by the end of this fiscal year and will become a part of WEL.

The Environmental Effects Laboratory (EEL) was formed as a result of the National Environmental Policy Act of 1969. This dictated that impacts on ecosystems resulting from physical modifications to the environment must be evaluated in all study phases of both civil and military construction projects.

EEL acts as a coordinating and central management group for the WES environmental research program in addition to providing significant technical input to the program. The interdisciplinary team concept is used in the solution of environmental problems by the knowledge and interplay of a number of engineering and scientific disciplines.

A strong systems analysis approach examines and defines the total system and the pertinent interrelations of its parts. Prediction of physical, biological and chemical consequences of various programs is always included in the analysis. This is particularly important in the analysis of environmental problems to minimize initiation of costly programs that may soon prove inadequate.

Scientists of EEL have successfully modeled one system used for about 10 years by a commercial firm for disposing of cannery waste through overland flow. Although the system was scientifically and economically intriguing, it was not understood in terms of basic principles. Tests were designed to prove and understand the theory that water sprayed on a slope of at least two percent will be clean after some distance of overland runoff.

Special study groups are concerned with the treatment and management of wastewater, urban runoff, dredged materials, and other wastes or pollutants resulting from, or associated with, military and engineering activities. Efforts include preparation of a design manual to optimize the design and waste treatment facilities in recreation areas constructed by the Corps of Engineers in response to public needs. Ecosystem modeling is using mathematical and physical simulations of biological and chemical processes.

A laboratory building and greenhouse contain experimental laboratory facilities, an automated water-quality monitoring system, and environmental chambers with control of temperature, light, and humidity for models of natural ecosystems. Complex ecosystems can thus be examined that would be difficult if not impossible to study in a natural setting.

Parameters of current interest and concern, including heavy metals and pesticide residues, are determined on a routine basis. Soil and sediment analyses, particularly as they relate to water quality and aquatic ecology, also are included in the laboratory capabilities.

Analytical research personnel have access to normal and more sophisticated instrumentation, including automated wet chemistry, liquid scintillation and proportional radioisotopic counting, atomic absorption, X-ray emission spectrometry, X-ray diffractometry, gas chromatography, and electron microscopy.

The interdisciplinary makeup of EEL enables it to support the Corps of Engineers Dredged Material Research Program, a long-term effort funded at about 30 million, in several areas. The laboratory study provides information on the basic effectiveness of alternate treatment processes of various types of dredged materials, information as to the adequacy of various effluent quality parameters, and information needed to scale up to future field pilot studies.

A major flood on a river is not the only impetus to keep waterways navigable. Normal processes of shoaling, aggravated by storms and augmented by actions of man, produce annual dredging requirements totaling hundreds of millions of cubic yards of sediment in many separate operations.

WES has contributed for nearly half a century to the nation's security, growth and welfare. More than 1,000 active projects are indicative of its extensive involvement in research, development and testing program vital to national welfare.

Director COL G. H. Hilt commented: "The WES programs change continually as the needs and emphasis of the scientific and engineering communities change, whether it be helping to control and develop the nation's mighty rivers or providing military airfields and roads.

"Our mission is concerned with designing vehicles capable of operating in all parts of the world and on all types of terrain; also, for lunar and extraterrestrial navigation, developing construction materials for protective structures, defending against a nuclear war, or keeping the environment healthy.

"WES will continue to meet whatever challenges the future may hold."

Atlanta II Conference . . .

Cites 6 Initiatives for Improved Army-Industry Effort

Inflation has accentuated the U.S. Army's critical need to rely increasingly upon improved communications and cooperatively integrated effort with industry to obtain the utmost return in military materiel acquisition with dwindling dollar and manpower resources.

This fundamental operational requirement to improve effectiveness of joint effort research, development, test, evaluation and acquisition activities was stressed May 30-31, 1974, at an Army-Industry Conference in Georgia termed *Atlanta I.*

Directed toward establishment of the required liaison framework around which to build better industrial understanding of the Army's immediate and reasonably predictable acquisition goals, Atlanta I was focused on the basic Army question to industry: *What can we do to help you to help us?*

Atlanta II in Atlanta, GA, Feb. 4-5 provided an opportunity to exchange viewpoints on initiatives to be considered in respect to 21 programs proposed, by way of industrial response to Atlanta I, at a HQ Army Materiel Command July 25 meeting with industrial officials.

AMC Deputy Commander for Materiel Acquisition MG George Sammet Jr. reported on six R&D-related initiatives developed by AMC to advance toward Army-industry cooperative effort. Specifically, these are: R&D Advance Information; Point of Contact for Small Programs; Product Improvement as an Alternative to New Development; The Not-Invented-Here Syndrome; Incentives for Industry Capital Investment; and Duplicatory Testing.

Initiative I is the result of an Army study of communications deficiencies, requirements for changes in Army Regulations to permit improved transfer of information without jeopardizing proprietory information; information provided by foreign governments with dissemination restrictions, and sponsorship of unclassified scientific meetings.

Industry will now be provided with all of the data on the R&D Planning Summaries except proprietary and restricted dissemination information. Advanced Planning Briefings for Industry (APBIs) also will be upgraded greatly to improve communication. As the responsible agency for determining Army materiel requirements, the Army Training and Doctrine Command (TRADOC) will cosponsor APBIs with the AMC.

Another major effort is being made by the Defense Documentation Center to effect policy changes that will make available to contractors and potential contractors "the great bulk" of documents that now require special release authority. A DoD distribution category to accomplish this has been published.

Effective Feb. 1, each AMC major command technical industrial liaison office (TILO), HQ AMC TILO, and a new West Coast TILO in Pasadena, CA, will be equipped to provide industry with the opportunity to review the following documents on microfilm: R&D Planning Summaries; Catalog of Approved Requirement Documents (CARDS); Program Data Sheets; and AMC Major Thrusts (with respect to materiel objectives RDT&E effort).

Initiative II, Point of Contact for Small Programs, is directed toward providing small contractors with a friend at HQ AMC and each commodity command and laboratory where they can bring problems for solution. Large contractors are staffed with liaison and technical officers but most small contractors are ill-equipped to deal with the government's maze of directives, procedures and forms.

John Stolarick has been appointed at HQ AMC as a point of contact. His function is to bring together the contractor and the individual in AMC or in the field best able to answer his question or solve his problem.

Initiative III, Product Improvement, was placed in proper perspective by GEN William E. DePuy, TRADOC commander, during an APBI at the Army Tank-Automotive Command. There he stated that, in his opinion, 90 percent of the Army materiel acquisition requirements should be met by product improvement of existing systems, and only 10 percent by new developments.

Management of Product Improvement Programs by the Army Materiel Command has been improved by decentralization of authority from the Deputy Chief of Staff for Logistics, Department of the Army. AMC now has increased dollar thresholds and greater management authority in this area.

Recognized, however, is that upgrading of a system through product improvement must be effectively managed, since it may have great impact on the logistics support far down stream in the materiel life cycle. Results of this program on selected systems is being monitored closely. Pilot programs developed by major subordinate commands are being used to develop future policy and procedures for this approach.

Initiative IV, the Not-Invented-Here Syndrome, pertains to the complaint of industry leaders and individual inventors over the years that when their ideas compete with those developed in the Army they come out second best. To the degree that this complaint may have merit, the AMC is taking corrective action by improving evaluation procedures.

Independent evaluation committees have been established at HQ AMC, and each separate activity, composed of qualified engineers and scientists who have no vested interest in any proposal. The committees will review the evaluation, comments and recommendations of the assigned evaluator, and arrive at an unbiased evaluation.

AMC does approve and fund for an average of 19 percent of the proposals submitted by industry and, during FY 1972 through 74, invested more than $55 million in unsolicited proposals submitted by industry. The change in policy is being incorporated in regulations.

Initiative V, Industry Capital Investment, is an AMC response to the concern of industrial contractors that if they invest heavily as developers in production equipment for a follow-on buy and then, through competition, fail to receive a contract, losses can be substantial. A survey of AMC commodity commands evidenced little basis for this concern. The survey conclusion that the degree of risk a contractor is willing to assume through capital investment necessarily is one that he alone can judge.

The Army position is that to remove all risk from this area of interest by government guarantee, subsidy, or by providing government-furnished capital equipment, would remove all elements of competition and incentives for effective management and business ability.

Initiative VI is in a similar area of industrial concern, Duplicatory Testing of Military Systems. Army studies have validated this to a degree justifying some corrective action. Army Regulation 1000–1, Basic Policies for Systems Acquisition, dated Nov. 5, 1974 and effective Jan. 1, 1975, establishes the broad policy that contractor and AMC developmental tests should be integrated into one cycle.

Pending publication of appropriate AMC regulations, a policy letter will direct that development testing shall be structured as an integrated test cycle to assure that the contractor, developer, evaluator and tester interact to minimize test cost and maximize the use of test data. The Coordinated Test Program (CTP) will be used as the key management tool for control of the Single Integrated (Contractor/Developer/Tester) Development Test Cycle.

Contracts will be structured to assure that development hardware is not submitted for government testing until the contractor has demonstrated that contract requirements have been met essentially, and the developer has a high level of confidence that government testing will be successfully concluded.

Requests for Proposals (RFPs) will include the test requirements to which a system will be subjected during development. Executed contracts will include tests to be conducted by the contractor, by the government, or jointly. Insofar as possible, contracts will require that testing to demonstrate compliance with contract hardware specifications be conducted by the contractor.

In this connection, for compliance testing beyond the contractor's capability, developer testing facilities will be offered for contractor personnel use.

When DD Form 250 is used to move development testing hardware from the contractor's facility for government testing, the policy requires that it be annotated appropriately to show that the materiel is to be used for test purposes only —and not to denote acceptance of hardware as meeting achievement of contract compliance requirements.

Speaking on...

(Continued from inside front cover)

the U.S. possesses throughout the world. It appears unlikely that the United States will enjoy a quantitative equipment superiority on the battlefield of the future.

The Soviet Union outnumbers the U.S. in terms of artillery, riflemen, tanks, surface-to-air missiles, armored personnel carriers, tactical aircraft, submarines, antiship missiles, surface ships, ICBMs, throwweight, and tactical nuclear rockets.

Only in the areas of attack helicopters, strategic bombers, number of ballistic missile warheards, and aircraft carriers does the U.S. possess any significant numerical advantage.

In view of this, whatever edge we possess in the materiel area must come increasingly from qualitative superiority rather than quantitative superiority—and thus from R&D rather than manufacturing leadership. I hasten to distinguish between quality and sophistication. More and more, our materiel must evidence ingenuity of design rather than complexity; simplicity of maintenance rather than enormity of support; and elegance of concept rather than a concept of elegance.

Complexity of design has simply not served us well this past decade. The fact that we truly are committed to the pattern of dependence upon qualitative superiority is evidenced by the very low ratio of procurement to R&D expenditures in the Army budget. This ratio today runs about 1.5 to 1.

A growing pressure being placed upon our materiel program stems from the need to increase substantially the effectiveness of the individual fighting man—a need which, in turn, stems from the growing cost of maintaining that fighting man in the force. Today, the ratio of military personnel related costs to the costs of equipping our forces, including R&D, is about 2 to 1.

Looking for a moment at the Soviet Union's answer to this dilemma of seeking a military edge in times of rising costs, we see a continued reliance upon quantitative superiority. However, more recently, and particularly in the case of the equipment observed during the 1973 Middle East war, we note a distinct shift toward quality. . . .

Unfortunately, thus far it appears as if the Soviets have somehow found the formula for having both quality and quantity at the same time. Three of the systems observed in the Middle East are particularly striking in this regard; the SA-6, the BMP, and the ZSU-23, at least the last two of which are sufficiently sophisticated and costly that I would hazard to say they would never survive a DSARC (Defense Systems Acquisition Review Council)!

As it happens, the great majority of individuals who make up our Army have had little or no direct experience with research and development. I believe it would be fair to say that the attitude of many toward research and development is probably reflected in what Casey Stengel once said in connection with some other matter: "I've had no experience with that sort of thing. And *all* of it has been bad!"

The growing burden being placed upon qualitative superiority, the increasing pressures being imposed by inflation, and the demands of sharply rising personnel costs, all create the need for a carefully considered "strategy" for the conduct of research and development.

I would like to propose one such strategy. I do not pretend that it is necessarily the best strategy. Further, I am certain that there will be those who will disagree with this strategy. However, it does provide a framework within which, until we find a better one, we intend to compose the Army's research and development program. This strategy consists of seven basic elements.

- First, devote highest priority to the preservation of the technological base (6.1, 6.2, 6.3a budget categories) at the present real dollar level, and concentrate on improving the management and ROI thereof. It is from the tech base which much of the future strength of the Army will come. It is also from the tech base that we, or our adversaries, will reap whatever technological breakthroughs the future may hold.
- Second, as the next highest priority, rely upon product improvement as the basic and most effective means of maintaining a quantitatively adequate force structure. We must never confuse ourselves that quality can be a complete substitute for quantity of military hardware.
- Third, as the next priority, focus a limited number of all-new system developments in areas where quantum jumps in capability can potentially be realized. Fully fund these programs to move through the acquisition process at an optimum pace, even at the expense of the large body of systems being pursued.
- Fourth, concentrate whatever funds remain on the demonstration, where possible in *hardware* form, of other promising components and systems.
- Fifth, do not attempt to match USSR hardware in kind, but rather seek alternate means of circumventing and negating their strengths (for example, do not attempt to match the Soviet armor threat on a tank-per-tank basis . . . but rather rely upon antitank missiles to offset numerical disadvantages).
- Sixth, avoid, wherever possible, applications of technology which result in extensive sophistication; instead, seek ingenuity of design and reductions in associated personnel costs.
- Seventh, rely upon the technology of our Allies to fill out our own R&D efforts, achieving this through the mechanism of joint procurement rather than joint development.

Now all that is philosophy. The question is, do we really mean it? I would submit to you that we do indeed and, as evidence of that, I would like to cite a few specific actions that have taken place, mostly during the past year.

First, with regard to the continued erosion of the "tech base" over the past decade, in the FY 76 Budget we are requesting an increase in basic research and exploratory development of 21 percent.

With regard to the matter of upgrading equipment, we have major programs under way to improve the COBRA (combat aircraft), the M60 tank, the CH-47 (transport aircraft), the HAWK and the TOW missiles, and a number of other systems—all at the expense of dollars which might have been spent on the development of new items had we elected to do so. Thirdly, we are fully funding our Big 5 (materiel development) programs, even though this forces other items altogether out of the budget.

With respect to the fourth point, only recently we decided to complete the Heavy-Lift Helicopter prototype program, but not conduct Engineering Development and not procure the helicopter.

This decision was made despite the fact that all our studies indicated the HLH to be both a useful and a cost-effective system. The fact remained that it simply could not offer the quantum jump that the same expenditure of money in other areas could be expected to return.

With regard to the matter of attempting to offset Soviet forces, not in kind but rather in ingenuity, I would point to the TOW and the DRAGON missiles as extremely cost-effective means of countering the enormous numerical advantage in tanks possessed by Soviet and Pact forces, or to SAMS as a means of countering the air threat.

Turning to the avoidance of complexity in design, actions on the CHEYENNE program, the MBT (Main Battle Tank) 70, and the redesign of the SAM-D all suggest the seriousness of the assault on high unit cost.

Lastly, our willingness to rely upon foreign-developed equipment to save development dollars is indicated by the fact that three of the four systems proposed in the recent SHORAD competition were developed in Europe and would be produced in the U.S. were they to be selected.

With this strategy as a framework, how then do we manage our materiel acquisition activities to assure maximum return on investment? There are those critics who would answer in Will Rogers' terms, namely, "I am less concerned about the return *on* my investment than I am the return *of* my investment!" Similar sentiments have been expressed by Governor Reagan who noted, "If the gov-

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ernment had given the contract 200 years ago to produce the electric light, that company today would still be called General Candle!"

One thing we do know, and know with certainty, is that the solution to whatever management difficulties we have encountered in the past does not reside in creating more layers of management.

One government agency is already said to have a listing in the telephone book . . . and I am happy to say that that agency is not the Defense Department . . . for an "Associate Assistant Administrator in the Office of the Assistant Administrator for Administration!" To the contrary, the Army has been trying very hard, and I might say very successfully, to reduce overhead in management, that is, to increase our "tooth-to-tail" ratio.

For example, in the last three fiscal years, the size of the Army Staff has been reduced from 7,560 down to 3,531. Over one-third of that reduction has been in the form of pure job eliminations. The rest take the form of transfers in consonance with a policy of decentralizing management.

One of the major efforts undertaken during the past year toward improving the R&D and procurement process was the establishment of the Army Materiel Acquisition Review Committee, or "AMARC," which we all truly hope will, in fact, make "a mark" on the Army.

About 175 recommendations were made by that committee, each of which is being given careful consideration. Many have already been implemented. Perhaps the most significant of all the recommendations was to create a series of Development Centers which would draw together the Army's in-house resources in specified technology areas into a single organization in a single geographical area.

Major Development Centers would be established for: Armaments, Ground Mobility, Air Mobility, Missiles, Items for the Individual Soldier, Communications, Combat Support, and a Washington Area Center concentrating mainly on the field of electronics.

The AMARC Committee felt that such a realignment would pull together a critical mass of capabilities; would eliminate interface problems which had been encountered in past system developments; would assist in focusing emphasis on research and development which heretofore has perhaps tended to be submerged in the demanding day-to-day logistical responsibilities of the Commodity Commands; and would increase operating efficiency.

I would like to mention, briefly, one other key management change which we are bringing about, one which has been referred to as "TRACE," for "Total Risk Assessing Cost Estimate."

There is, in my opinion, a great deal of evidence which suggests that the major contributor to cost overruns, or cost growth as some students of semantics would rather have it known, is not mismanagement per se.

Rather, it is the failure to recognize at the very initiation of a new program —at the very outset of the cost estimating process—the realities of the risks attendant to all R&D activity.

The very same American industry which has on occasion had problems with defense contracting is at the same time dominating the world's commercial aircraft market, the world computer market, the world communications market and the world space program.

This would suggest that the problem is not one of a lack of technical capability or of management competence on the part of the defense industry but, rather, is attributable to procedures unique to defense contracting.

By and large, under the enormous competitive pressures of "selling" new R&D programs, funding estimates have recognized only those tasks which can be specifically foreseen in advance. Our track record would suggest that, over the 8-year period, which is not atypical of the development process, one simply cannot foresee every single task that will be required or every single difficulty that will be encountered.

Some things will simply go wrong. They always have and they always will, even in the best-managed R&D programs. It is not clear what specific problems may arise, but it is eminently clear that some problems will arise. One might refer to these as "certain uncertainties."

The TRACE costing approach tries to recognize this fact at the very outset, and allow sufficient margin in our cost estimates to accommodate these uncertainties before they evidence themselves—before we make a decision whether or not we wish to pursue the program at all.

All major R&D efforts started by the Army during the past year have used the TRACE cost-estimating philosophy. By embracing this form of simple realism with ourselves, and by continuing to emphasize tough management in order to minimize the uncertainties that do arise, I believe we will be able to take a significant step toward the goal of promising only that which we can produce and producing that which we have promised.

The final topic I would like to address concerns the matter of candor in the Army's relations with the Congress, the public and the defense industry. Much has been said in recent times about ethics in government and industry. In the case of the Army, Secretary Callaway has said that he does not claim infallibility of his staff . . . but he does demand integrity.

I believe we are succeeding in implementing a policy of absolute, total unequivocal openness in our dealings with the Congress and the public. I further believe that this policy is assisting in achieving a better understanding of the legitimate needs of the Armed Forces. It has been my privilege, for example, of having 126 "one-on-ones" with Senators, Congressmen and key staff members during the past year to discuss the Army's R&D program.

This same candor must apply, I believe, between the government and its contractors insofar as propriety will permit. As just one point in this regard, it has been suggested for a number of years that there should be benefits to be gained, both in terms of contractor efficiency and in terms of better government solicitations, if prospective bidders were given the opportunity to see and comment upon government specifications and other significant technical requirements to be included in a Request for Proposals prior to its formal release.

The Army Materiel Command tried something like this not too long ago on an important program. Their experience was encouraging and I would like to announce to you today a broader program which the Army will implement in its research and development activities on a one-year trial basis. Therein, for a selected but significant set of procurements, the specifications and other technical requirements will be made available to industry for a brief period of time in advance of the RFP in order to obtain comments thereon.

Further, to help industry focus on *providing* what the Army wants, rather than having to dilute its attention toward guessing *what* we want, we will emphasize strongly that all RFPs are to list the specific evaluation factors to be used in the order of their relative importance.

I believe we can all be proud indeed of the accomplishments of the Army/industry team. It is this team which, over the years, put up the first earth satellite in the Free World, boosted the first manned space flight managed development of the atomic bomb, and deployed the Free World's first ballistic missile defense system on the very day specified over four years in advance.

It was this team which conquered such diseases as malaria and yellow fever and Venezuelan Equine Encephylomylitis, and which pioneered the use of night vision devices, helicopters in combat, improved conventional munitions, and antitank guided missiles.

These are all examples of what I mean by Return on Investment. If we are to continue to add to this list, we must recognize the changing pressures that are acting on our R&D activities. Further, we must respond to these changing pressures in a positive and energetic manner, for the business of providing materiel to equip our Armed Forces, to paraphrase Don Meredith, "is not what it used to be . . . and it never was."

13th Annual ORSA Symposium . . .

Stresses Methodology Progress, Value of Operations Research

U.S. Army Operations Research and Systems Analysis, a complex technique to aid high-level decision-makers in Army Force Planning, the acquisition of major weapon systems, and related problem areas, is progressing as an in-house capability of a new group of civilian and military ORSA professionals.

Presentations at the recent 13th annual U.S. Army Operations Research Symposium at Fort Lee, VA, clearly evidenced the trend from the use of outside contract agencies to Army officers and civilian employes with master or higher degrees in ORSA methodology. Results of their studies are supporting decisions involving billions of dollars for weapons.

Themed on "The Value of Operations Research to the U.S. Army," the symposium attracted about 300 participants. The U.S. Army Concepts Analysis Agency (USACAA), commanded by MG Hal E. Hallgren, was the sponsor. Co-hosts were the U.S. Army Logistics Center, commanded by MG E. M. Graham Jr., and the U.S. Army Quartermaster Center and Fort Lee, commanded by MG Dean Van Lydegraf, USACAA. Deputy Commander and Technical Director John T. Newman presided as chairman.

Keynote speaker GEN Henry A. Miley Jr., commander of the U.S. Army Materiel Command, emphasized that the continually mounting pressures upon the U.S. Army to maintain a state of maximum combat readiness, with steadily decreasing manpower and funding resources, impose upon ORSA practitioners a need to "address real-world problems."

"Blue teams" and "Red teams," that is, proponents and highly critical "devil's advocates," GEN Miley explained, "must exhaustively consider every conceivable aspect of the proposed major weapons systems acquisition. The emphasis, he said, must be upon systems designed to meet realistically the foreseeable requirements at an "affordable" cost.

"Once a decision is made to proceed with engineering development of a weapon system—that is, to carry the life cycle process from design concepts to production of the desired end item of materiel—the pressures begin to build up inexorably," GEN Miley said. "Changing course becomes increasingly difficult. . . . The time fuze is clicking. All the gears in the exceedingly complex production process must mesh together on schedule as realistically as possible. . . ."

Banquet speaker, Paul D. Phillips, Principal Deputy Assistant Secretary of the Army (Manpower Reserve Affairs).

KEYNOTE SPEAKER GEN Henry A. Miley Jr., commander of the U.S. Army Materiel Command, at AORS with (left) MG Dean Van Lydegraf, commander of the U.S. Army Quartermaster Center, Fort Lee, VA; and Abraham Golub, technical adviser, Office, Deputy Chief of Staff for Operations and Plans, HQDA.

After referring briefly to some of the Army research, development, test and evaluation programs that had encountered insurmountable "real-world" problems—including the Cheyenne aircraft, the Main Battle Tank joint development program with the Federal Republic of Germany, and the Scout vehicle—GEN Miley said that, in theory, ORSA people should have been able to help decision-makers avoid such mistakes.

The basic trouble, he explained, is that during the long period of research, development, test and evaluation of a new item of military materiel, which may range up to eight years or longer, many conditions change. The parameters that were used in considering all the known factors pertaining to a decision to proceed with development of a major weapon system are affected by these forces.

"We have to develop systems that will satisfy a most carefully analyzed need. We must give due consideration to simplicity of operation, training requirements, ruggedness, durability, reliability and maintainability under extremes of the combat environment. . . .

"I think we should take a hard look at the close contact environment of the battlefield . . . where a tank may have a useful life of an hour or less. . . . I think we are sometimes paying too much for sophisticated equipment we may not need. . . ."

Principal Deputy Assistant Secretary of the Army (Manpower and Reserve Affairs) Paul D. Phillips was the banquet speaker on the subject of the role of ORSA in problem solving for the Volunteer Army. BG Phillips (USA, Ret.) was a pioneer in Army operations research with the Research Analysis Corp., now merged into General Research Corp.

Secretary of the Army Howard H. Callaway devotes about 70 percent of his efforts to the problems of making the Volunteer Army a success, Phillips stated, and about $43 million a year is being spent for recruitment advertising. Still the pressures of pushing ahead to meet scheduled requirements have not permitted an ORSA approach to "many of the exceedingly difficult problems of the Volunteer Army," Phillips stated.

Among the problem areas he mentioned as being particularly in need of ORSA methodology are manpower utilization (most effective distribution of some 800 skills), training techniques, morale and incentives; also justification "to ourselves, the Secretary of Defense and to the Congress, the programs we have for discharging soldiers who do not measure up during initial training.

"Secretary Callaway has come down hard on maintaining the quality of the Volunteer Army, and proving to Congress that the recruitment program and the incentives offered to build toward this goal are cost-effective," Phillips stated. "We have many areas for ORSA. We need your help. . . ."

Many of the contributions of ORSA to research, development, test, evaluation and acquisition of Army materiel were detailed in a featured address by Dr.

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SOCIAL HOUR dignitaries at AORS are (l. to r.) BG Richard H. Thompson, director of Logistics Plans, Operations and Systems, Office of the Deputy Chief of Staff for Logistics; HQ DA; MG Erwin M. Graham, commander, U.S. Army Logistics Center, Fort Lee, VA; MG Frank A. Camm, deputy chief of staff for Operations and Plans, HQ DA; and MG Hal E. Hallgren, commander, U.S. Army Concepts Analysis Agency, Bethesda, MD.

ONLY WOMEN participants at AORS were 23-year-old Morita Bruce, USALMC, Fort Lee, VA, and Lynne S. Taylor, 24, AMC HQ.

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Hugh M. Cole, now a private consultant but long identified with Army ORSA activities. His subject was "The Impact of ORSA on the U.S. Army—Historical Overview," and he discussed ORSA progress dating to the early 1950s.

Featured also on the opening-day program was an address by Abraham Golub, technical adviser to the Deputy Chief of Staff for Operations and Plans, HQ DA. Speaking on "Present and Future ORSA Trends—A Forecast and Plans," he vigorously deplored the tendency to apologize for known ORSA shortcomings.

Golub conceded that some of the ORSA performed was "marginal or bad" during the 1960s, when many who could not qualify as trained professionals entered the field, but said he was "proud of the Army's over-all ORSA record.

"Our problem, as in every discipline, is that there is good ORSA, bad ORSA and a fraction that falls somewhere in between. Our goal, of course, is to minimize the bad—and we've been making good progress toward that goal. . . .

"As a final comment on this business of self-criticism, I reject the notion that we need to establish academic criteria for professionalism or a formal set of ethical standards. I maintain that in the years ahead the most stringent performance standards will be met by Army ORSA analysts through peer group pressure and by our structured system of reviews. . . .

"I believe the word is already out that you are likely to be shot out of the saddle if you report an inadequate analysis to any of these groups. . . . Thus, by internally developed procedures, we automatically institute standards of professionalism and ethics."

Golub said that due to the continuing inflation and the trend toward reduced research, development, test and evaluation funding, cutbacks inevitably will lead to greater dependence upon the Army's in-house ORSA capabilities. "That era is coming and you had better harness your in-house resources accordingly.

"Fortunately, the organizational changes within the Army during the past 18 months anticipated the aforementioned trend. The establishment of the Concepts Analysis Agency, TRANSANA (U.S. Army TRADOC Systems Analysis Activity) in the Training and Doctrine Command, the Operational Test and Evaluation Agency (OTEA), together with the Army Materiel Systems Analysis Activity, consolidate many of our OR test functions and responsibilities. These organizations will provide a much-strengthened in-house capability.

FORMER commander and director of the U.S. Army Harry Diamond Laboratories, Dr. Leslie G. Callahan Jr. (center), now a professor in Operations Research (OR) at Georgia Institute of Technology (GIT), poses with 4 of some 150 military officers who have obtained master's degrees in OR systems analysis at GIT since 1969. From left are CPT Edward Simms, CPT L. G. O'Toole, MAJ Neil Hyde, and MAJ Thomas Wilson.

"This centralization of our in-house talent will give the Army the organizations which not only can manage and conduct large segments of the OR effort, but which can also act as the essential 'colleges' in which newcomers to the field can learn the trade.

"The Army Materiel Systems Analysis Activity, born of the Weapon Systems Laboratory at the Ballistic Research Laboratories, is the prototype of this type of college. Apprenticeships at doing OR studies are fairly long, but the resultant talents and skills are very good indeed.

"I look for much the same level of quality in education and training over the next few years from CAA, TRANSANA and OTEA because of the amount of experience and talent we are consolidating in these organizations. . . ."

Golub then turned to the development of professionally trained ORSA specialists within officers ranks during recent years, saying: "Prior to 1968 there was only a handful of officers with ORSA credentials. Scattered as thinly as they were, they could do little except review other people's work.

"Today there are nearly 600 Army officers on active duty with graduate degrees in operations research, and more are being trained each year. With that kind of talent to add to the civilian resources, it is not surprising that organizations like CAA and TRADOC are beginning to produce quality work.

"My own observation is that the ORSA-trained Army officer brings his own special enthusiasm and specialized knowledge of the military which effectively complements the civilian's long experience and continuity. They work well together, and the best part is that more and more of these young officers are given the opportunity to be practitioners.

"In this regard, we are beginning to enter another interesting phase: The first of these ORSA-trained officers are beginning to enter the 0–6, 0–7 grades (colonel, general). In the years ahead, their increasing influence in more responsible positions signals not only a more perceptive and more penetrating review of the fine grain detail of our analyses, but also a better understanding and acceptance of our products. . . ."

The Training and Doctrine Command's development of a set of standard scenarios for use in computer simulations—including Blue and Red forces with weapon types appropriate to the time frame, and detailed terrain data for representative battlefields in different parts of the world—was cited by Golub as a "healthy capacity for the integration of our efforts. Somewhat the same thing is happening with regard to simulation models.

"From the earliest planning for the

YOUTHFUL GROUPINGS of operations research specialists attending their first AORS were evident at the social hour. From left are Dr. Victor E. LaGarde, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS; Vincent G. Calfapietra, U.S. Army Electronics Command (ECOM), Fort Monmouth, NJ; Paul Bocher, U.S. Army Satellite Communications (SATCOM) Agency, Fort Monmouth, NJ; Richard Caccamise, ECOM HQ; and J. Douglas Sizelove, Army Material Command HQ.

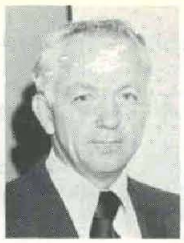
AORS OFFICIALS, MG Hal E. Hallgren (right), AMCA commander, and John T. Newman, AMCA deputy commander, technical director and symposium presiding chairman, chat during registration.


COL Louis F. Dixon


William A. Bayse


Keith Myers


Dr. Marion Bryson


Richard J. Trainor


Edgar B. Vandiver III


BG R. H. Thompson

creation of the Concepts Analysis Agency, I have advocated making CAA the Lead Laboratory for all Army force analysis and force structuring models.

"Now, don't misunderstand what this means; CAA is not going to do all force analyses in the Army. They will become the focal point for collective knowledge about all such models, and for maintaining up-to-date information on inputs and model improvements.

"This should make available the best force structuring models for major studies and should lead to a better, and commonly shared, understanding of these models throughout the Army ORSA community. Incidentally, we are now examining a plan to designate some of the other major Army study agencies as Lead Laboratories in other subject areas."

Near the end of his address, Golub cited another category of operations analysis that is coming into vogue, known as "Net Assessments." Promoted by a Blue Ribbon Defense Panel in 1970, they were defined as integrated systematic analyses of existing and proposed programs as they established capabilities and limitations of the United States versus possible antagonists.

Golub said the objective of Net Assessments is to identify asymmetries in military capabilities that can be exploited or need to be remedied by changes in governmental programs or allocations of resources.

WORKING GROUPS. Symposium highlights included two 4-hour sessions of six concurrent working groups, a special presentation on "Utilization of ORSA Techniques at the U.S. Army War College," and a panel discussion. The panel was comprised of the chairmen of the working groups, and the discussion was followed by a review and critique.

"The Army Force Structure Process" working group was chaired by William A. Bayse, director, Methodology and Resources Directorate, U.S. Army Concepts Analysis Agency, Bethesda, MD.

Richard J. Traynor, director, Systems Review and Analysis Office, Office of the Chief of Research, Development and Acquisition, HQ DA, headed a group on "Materiel Acquisition Process."

BG Richard H. Thompson, director of Logistics, Plans, Operations and Systems, Office of the Deputy Chief of Staff for Logistics, HQ DA, presided over discussion of "Logistics Matters."

"Weapons Effectiveness Analysis" was the subject for a working group chaired by Keith Myers, assistant director for Integrated Studies, U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD.

The scientific adviser of the U.S. Army Combat Developments Experimentation Command, Dr. Marion Bryson, one of the real pioneers in Army ORSA activities and program chairman for many of the ORSA Symposia, presided over the group discussion on "Operations, Plans, Doctrine and Concepts."

Another well-known ORSA specialist, Edgar B. Vandiver III, Office of the Deputy Under Secretary of the Army for Operations Research, chaired the working group on "Methods of Assessing the Value of ORSA."

COL Louis F. Dixon, director, Automatic Data Processing/Management Information Systems, U.S. Army War College, headed "USAWC Utilization of ORSA Techniques".

Sixty technical papers were presented and discussed during working group sessions and the special presentation by Army War College personnel. Abstracts were published in the program and the papers will be published in symposium proceedings.

Most of the papers were representative of the young group of officers and civilians now coming to the forefront in U.S. Army ORSA activities. Others were given largely by staff members of the General Research Corp., McLean, VA, and Institute for Defense Analysis, Washington, DC.

SELECTED PAPERS. One 4-hour general session was devoted to the presentation of six selected technical papers. COL J. R. Witherell, USACAA, opened with "Conceptual Design for the Army in the Field," followed by Richard J. Trainor's "Overview of Materiel Acquisition for the U.S. Army."

Joseph G. Stenger, U.S. Army Logistics Center, Fort Lee, VA, presented "The Medical Planning Project." Keith Myers followed with "The Survivability of Personnel and Equipment in a Combat Environment." U.S. Army Foreign Science and Technology Center staff member John Aker offered an interesting insight into "The Importance of Soviet Military Operations Research."

Judged by audience response, one of the most interesting presentations was "An Overview of Land Battle Modeling in the United States." Dr. Seth Bonder, formerly with the University of Michigan faculty and now with Vector Research, Inc., was the presenter.

Participants in the symposium included U.S. Department of Defense officials, high-level U.S. Army officers, representatives of more than 10 major commands and 15 service schools, numerous laboratories, arsenals and depots, the Command and General Staff College as well as the Army War College, and ORSA specialists from several foreign countries.

Social Hour. "The Youth Movement" in ORSA was clearly evident during a social hour that attracted virtually all participants on the opening night of the symposium. Conversation with members of several of the small groups engaged in lively discussion established their professional qualifications.

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Dr. Seth Bonder *Vector Research, Inc.* **presented "An Overview of Land Battle Modeling in the U.S."**

REPRESENTATIVE of a predominance of youthful officers and civilians who attended AORS are (l. to r.) MAJ Harry White, Picatinny Arsenal, Dover, NJ; CPT Philip Cooper, U.S. Army Concepts Analysis Agency, Bethesda, MD; MAJ Gil Brauch, HQ Military Traffic Command, Washington, DC; MAJ Thomas Carney, HQ Training and Doctrine Command, Fort Monroe, Hampton, VA; and Dr. Sam H. Parry, Naval PGS.

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One of the group pictures that were taken included MAJ Harry White, Picatinny Arsenal project manager for selected ammunition. He has a master's degree in applied mathematics and has been in operations research for six years. With him was CPT Philip Cooper, Army Concepts Analysis Agency, who has been engaged in OR analysis for three years and has a master's degree in engineering from Arizona State.

MAJ Gil Brauch, assigned to HQ Military Traffic Command, Washington, DC, said he has been in operations research for about two years and that his qualifications include an MS degree in industrial management from Georgia Institute of Technology.

Other members of the group were MAJ Thomas Carney and Dr. Samuel Parry. MAJ Carney is assigned to HQ Training and Doctrine Command, where he has been a program analyst since 1971. He has an MS degree in OR from the Naval Post Graduate School in Monterey, CA. Dr. Parry has a PhD in OR from Ohio State and has been a professor of OR at the Naval Post Graduate School for 10 years.

"Fascinating Field for Women." Female practitioners in the field of operations research and systems analysis are still relatively rare, but their numbers are increasing from the ranks of recent graduates of universities and colleges. Only two women attended the 13th Army Operations Research Symposium, and they are representative of this youthful influx of talent.

Lynne S. Taylor is a 24-year-old employe in the Plans and Analysis Directorate, HQ U.S. Army Materiel Command. Based upon two years of experience in her present position, she considers ORSA a "fascinating field for women."

Graduated from Temple University in 1971 with a bachelor's degree in mathematics, she entered the Army management intern program in the quality assurance field in 1972. Her first job was with HQ Army Weapons Command, since changed to Armament Command, at Rock Island (IL) Arsenal. She has completed 18 semester hours toward a master's degree in ORSA at George Washington University, Washington, DC.

Morita Bruce, a 23-year-old blonde with poise and confidence normally associated with older persons, started her career as an operations research analyst as an Army management intern with the Red River Army Depot, Texarkana, TX. Like Miss Taylor, she considers ORSA a "fascinating field for women."

Currently engaged in production engineering studies and analysis, Miss Bruce earned a bachelor's degree in science and engineering, specializing in operation research, from Arizona State University in 1972 and a master's in the same field from Texas A&M University in April 1974. She became an employe of the Army Logistics Management Center, Fort Lee, in June 1974.

ORSA Graduate Program. Dr. Leslie G. Callahan (COL, USA, Ret.) takes understandable pride in the outstanding success of the ORSA graduate program offered at Georgia Institute of Technology. He became a professor there following his retirement as an officer well known to the Army research and development community.

In 1965 Dr. Callahan, then an officer, became the first director of the Avionics Laboratory, HQ U.S. Army Electronics Command, and in 1968 became commander of the Army's Harry Diamond Laboratories. An assignment followed with the Office of the Assistant Vice Chief of Staff, HQ DA.

The ORSA Graduate Program at Georgia Tech began in 1969 and has produced about 150 MS recipients. Currently, there are 10 to 20 master's degrees recipients annually, most of them captains or majors taking advantage of the Army's advanced studies opportunities. The Naval Post Graduate School, Monterey, CA, offers a similar program, and an increasing number of universities are offering ORSA courses.

More than 40 civilians also have graduated from Georgia Tech since 1969 with MS degrees in applied statistics and operations research and a number have received doctorates.

DLSIE Display at AORS XIII. Upon their entry into the $3.7 million building named for former (deceased) Army Materiel Command Deputy Commander LTG William B. Bunker, symposium participants were greeted by a display set up by the Defense Logistics Studies Information Exchange, known as DLSIE. A closing day guest speaker also discussed the services provided by this agency.

DLSIE issues catalogs of mathematical models and provides for a system of collecting, storing and disseminating logistics research and management information for use by Department of Defense components, their contractors, grantees and other U.S. Government agencies. DLSIE also publishes an annual bibliography of logistics studies and three quarterly supplements.

AMC Briefing Expansion . . .
Includes Medical Department, CE, ARI



Dr. James J. Richardson Raymond A. Deep Dr. Orval E. Ayers

Expansion of the Army Materiel Command monthly briefings of the Assistant Secretary of the Army for R&D, the Chief of Research, Development and Acquisition, and members of the Army General Staff, on three selected areas of high interest research has been announced.

Since the initiation of this program several years ago, presentations have been scheduled only for researchers employed at AMC activities. The program was extended in December to include the Army Medical Department, the Corps of Engineers, and the Army Research Institute for the Behavioral and Social Sciences.

Each month two of the briefers will be AMC personnel and one will represent AMEDD, the Corps of Engineers or the Army Research Institute. Topics selected will be representative of the technology base program of each agency.

The change in programing was announced by Dr. Marvin E. Lasser, chief scientist, Department of the Army, and also the Director of Army Research. Dr. Ivan R. Hershner Jr. is the coordinator on his staff and Dr. Gordon L. Bushey is the AMC monitor.

Topics selected for the late November briefing, each limited to 15 minutes, and the presenters were representative of the Research, Development and Engineering Laboratory, Missile Command as follows:

- Aeroelastic Sled Testing, by Raymond A. Deep, Aeroballistic Directorate.
- Flexible Body Effects on Rocket Accuracy, Dr. James J. Richardson, Ground Equipment and Materials Directorate.
- Solid Fuel for Chemical Laser, Dr. Orval E. Ayers, Propulsion Directorate.

Raymond Deep is chief of the Aerodynamics Group and has been employed by the U.S. Government for 22 years in aerodynamics and systems analysis. He has an MS degree in engineering from the University of Alabama at Tuscaloosa and has performed post graduate work in aerospace engineering at the University of Michigan.

Dr. Richardson has been employed by MICOM since 1960 except for four years of service as an Army officer. He has a BSME degree from North Carolina State University, an MSE from the University of Alabama in Huntsville and a PhD in theoretical and applied mechanics from the University of Illinois. He has worked as a flight test engineer on several missile systems, as a lead engineer in projects involving aircraft mounted equipment, and has published results of his research in professional journals.

Dr. Ayers has been involved with research and development of solid propellants with MICOM for 15 years, and is respon-

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Innovations Mark DoD MTAG Meet

Two innovations marked the Department of Defense Manufacturing Technology Advisory Group's fifth annual meeting at Corpus Christi (TX) Army Depot.

For the first time, standing subcommittees for metals, nonmetals, electronics, munitions, inspection and testing, and CAD/CAM (Computer Assisted Design/Computer Assisted Manufacturing) performed their reviews prior to the meeting. This enabled the chairmen to present executive summaries to the more than 150 U.S. Government attendees prior to the sessions.

The other "first" was the passive participation of industrial representatives, invited by the Office of the Assistant Secretary of Defense (Installations and Logistics), to familiarize themselves with programs of the Army, Navy and Air Force—with the goal of joint effort to reduce costs of defense materiel.

The Manufacturing Technology Program provides the interface for translating technology developed and proven in research and development into viable cost-effective production processes. Key members of the joint services comprise the DoD Manufacturing Technology Advisory Group (MTAG), which is responsible for avoiding duplication of effort and for identifying persistant defense-oriented manufacturing problems—and finding solutions.

Former Deputy Assistant Secretary of Defense for Production Engineering and Materiel Acquisition Fred Randall was the banquet speaker. He was introduced by Army Materiel Command Director of Research, Development and Engineering BG Harry Griffith. Randall currently is a senior vice president with Vought Systems Division of LTV Aerospace Corp.

In speaking on the "Impact of Manufacturing Technology on the National Economy," Randall explained that economic and material shortage constraints demand a redoubling of effort for development of manufacturing technology.

"It is of paramount interest that the government and industry cooperate in this vital program. We must do our part—and a major part it is—in solving the problems facing our country," he stated.

"You are part of the world movers. This country's continued leadership in manufacturing, its defense posture, and the standard of living we have all enjoyed is to a large extent dependent upon your programs in the next few years. It's later than we think."

The meeting, which was planned and hosted by the Production Engineering Branch, RD&E Directorate, AMC, included a tour of the Corpus Christi Army Depot. The modern helicopter repair depot utilizes a great deal of hardware and technology spawned by the Manufacturing Technology Program.

ARO Biannual Review Meeting . . .
Considers Operations Research Areas

Operations Research, one of the 49 basic theme areas in which the U.S. Army Research Office (ARO) supports research, was subjected to a biannual review recently by Army and ARO-supported contract personnel, and other military services participants.

The 2-day meeting at the University of Florida, Gainesville, followed the 13th annual U.S. Army ORSA (Operations Research and Systems Analysis) Symposium, which attracted about 300 Army, academic and industrial or nonprofit research organization specialists to Fort Lee, VA.

Presentations of current problem areas, summaries of OR research progress and general discussion sessions during the review were directed to methodologies for solutions of problems and determination of future OR program requirements.

Army installations represented at the review included HQ U.S. Army Materiel Command, Alexandria, VA; the U.S. Army Air Mobility R&D Laboratory, Moffett Field, CA; White Sands Missile Range, NM; Edgewood Arsenal, Aberdeen, MD; HQ U.S. Army Electronics Command, Fort Monmouth, NJ; Construction Engineering Research Laboratory, Champaign, IL; Picatinny Arsenal, Dover, NJ; Ballistic Research Laboratories, Aberdeen PG, MD; Concepts Analysis Agency, Bethesda, MD; AMC Inventory Research Office, Frankford Arsenal, PA; and Army Research Office, Durham, NC.

Other participating agencies included the U.S. Air Force Aerospace Research Laboratories, Wright Patterson AFB, OH; Office of Naval Research, White Oak, MD; and the Naval Postgraduate School, Monterey, CA.

The home institutions of the academic representatives included the University of California, Berkeley; Massachusetts Institute of Technology; and Stanford, Yale, Rice and George Washington Universities.

Abstracts of the presentations and summaries of the discussions will be published by the Army Research Office under the title: Proceedings of the Chief Investigators' Conference and Review of the Basic Research Theme, Operations Research.

AMC Briefing Expansion . . .

(Continued from page 26)

sible for developing and evaluating new storable fuels for use in the Army high-energy chemical laser programs.

Currently, he is a research group leader. His research has been reported in technical papers, journal publications and a dozen patents and patent disclosures. He has a BA degree from Berea (KY) College, an MS in physical organic chemistry from Auburn University, and a PhD in organic chemistry from the University of Alabama (Tuscaloosa), the latter under the Army long-term training program.

Abstracts of the presentations follow:

Aeroelastic Sled Testing. Failure of Improved Hawk missile wings, which occurs in certain flight regimes, has been the subject of intensive investigations. Theoretical analyses, supplemented by limited rigid body wind tunnel testing, point to overpowering hinge moments as the probable cause. Projected solutions involve aerodynamic wing redesign.

Substantial levels of aeroelastic deformations must precede breakup under this hypothesis, but conventional wind tunnel techniques cannot provide necessary aerodynamic data under controlled conditions in the regime of interest.

As a result, a series of tests of the Improved Hawk has been initiated on the high-speed track at Holloman Air Force Base. . . . Results to date indicate that high quality aerodynamic measurements can be obtained from sled tests using actual missile components at realistic test conditions.

Flexible Body Effects on Rocket Accuracy. One of the major objectives of the Army Missile Command is development of more accurate free rockets. This will require a corresponding increase in our ability to predict the response of rockets to forces encountered during the launch and flight phases.

Classically, analyses have considered rockets as rigid bodies. However, trends toward large length-to-diameter ratios, high axial accelerations and greater accuracy requirements all preclude further neglect of flexible body effects. This presentation defines some of these effects, describes a flexible body analysis called MSLVIB for rockets in the launch phase, offers examples of the application of MSLVIB to existing systems, and discusses present and future work in this area.

Studies to this point have led to derivation of the equations of motion of a rocket of nearly arbitrary cross sectional properties. Model solutions have been obtained to investigate the effects of roll rate, constraints (e.g., placement and nature of shoes) and axial acceleration on frequency and mode shape.

A steady-state analysis has been completed to study the effects of these parameters as well as launcher-free flight transition forces, mass offset, thrust misalignment, and aerodynamic forces on steady-state response. Present effort includes a transient analysis and further studies into the inclusion of launcher forces and displacements.

Solid Fuel for Chemical Laser. A chemical laser has been operated from hydrogen generated from a solid-propellant grain. The grain composition is made up of sodium borohydride and iron oxide. The reaction proceeds as follows:

$$3NaBH_4 + 2Fe_2 \longrightarrow 3NaBO_2 + 4Fe + 6H_2$$

The grain leaves a solid "clinker" residue and generates pure H_2 gas (>99%). The grain is processable in an air atmosphere (does not require dry box or inert atmospheres) and leaves an inert residue. Effort is progressing towards procuring sodium borodeuteride to confirm the feasibility with deuterium.

MRC Schedules 'Special Functions' Seminar

Mathematics research results usable for solution of many differential equations arising from physical sciences problems will be discussed at an Advanced Seminar on Special Functions, Mar. 31-Apr. 2, at the Mathematics Research Center (MRC), University of Wisconsin.

Some of the frequently encountered special functions are the hypergeometric function of Euler and Gauss, Legendre polynomials, Bessel functions, Riemann's zeta function, and Hermite and Laguerre polynomials.

Certain of these special functions have been understood since the beginning of this century. However, many of their deeper properties have been discovered more recently and are being applied in varied fields such as engineering mechanics, heat and radiative transfer problems, and coding theory.

Speakers selected to inform seminar attendees of some of these new results and applications include Prof. F. W. J. Olver, University of Maryland, who will discuss the asymptotics; Prof. Walter Gautsch, Purdue University, who will survey computational methods; Prof. K. M. Case, Rockefeller University, whose subject is applications in inverse scattering problems; and Dr. Neil Sloane, Bell Telephone Laboratories, who will report on applications in coding theory.

Programed also is a discussion of handbooks on special functions and computational problems. The Bateman Manuscript Project summarized the state of knowledge in 1950, but recent work is widely scattered in the scientific literature.

Seminar information can be obtained from Prof. Richard Askey, Mathematics Research Center, University of Wisconsin, 610 Walnut St., Madison, WI 53706.

AMSC Announces Analysis/Computers Meet

"The Analysis of Large-Scale Systems in Army Research and Development" is the theme of the U.S. Army Mathematics Steering Committee's 1975 Army Numerical Analysis and Computers Conference.

Scheduled Feb. 11-12 at the U.S. Army Troop Support Command (TROSCOM), St. Louis, MO, the conference will feature four invited speakers and 30 to 40 contributed papers.

Invited speakers include keynoter Dr. Robert J. Eichelberger, technical director of the U.S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, MD; Prof. Charles W. Gear, University of Illinois: Prof. David J. Farber, University of California (Irvine); and Prof. Herman Goldstine, Institute for Advanced Study, Princeton, N.J.

The Conference on Numerical Analysis and Computers is one of three annual conferences sponsored by the AMSC to promote exchange of mathematical expertise among Army scientists and engineers. The others are the Conference of Army Mathematicians, and the Conference on the Design of Experiments.

Proceedings of the conferences are published by the Mathematics Division of the Army Research Office (ARO), Durham, NC. Further information can be obtained by calling or writing to Dr. Jagdish Chandra, Mathematics Division, U.S. Army Research Office, Durham, NC 27706.

ARO to Review Nonlinear Systems Research

The U.S. Army Research Office (ARO), Durham, NC, will review its basic research program in mathematical analysis of nonlinear systems Mar. 20-21 at the U.S. Army Air Mobility R&D Laboratory (USAAMRDL), Moffett Field, CA.

Technological questions leading to nonlinear problems will be discussed in presentations by Army personnel. Summaries of the latest research results from academic investigators supported by ARO also are programed.

Technology requirements posing nonlinear mathematical problems include elastic-plastic analysis of projectile impact, heat conduction models in interior ballistics, analysis of the stability of complex flows in highspeed bearings, calculating buckling loads of shells, and structures whose geometry is not mathematically perfect.

Academic investigators scheduled to report on research pertinent to such problems include Prof. R. S. Rivlin, Lehigh University; Prof. J. B. Keller, Courant Institute; Prof. R. E. Kalman, University of Florida; and Prof. H. B. Keller, California Institute of Technology.

The biannual review of research in the analysis of nonlinear systems, like those of the other basic research themes under which ARO organizes most of its contracts and grants research support, serves a variety of purposes. Primarily, the research program is evaluated for quality and relevance to Army needs.

Important also is the interaction among Army and academic scientists in the context of current and anticipated problems.

Abstracts of all presentations at the theme review and summaries of the discussions will be published by ARO under the title "Proceedings of the Chief Investigators' Conference and Review of the Research Theme 'Mathematical Analysis of Nonlinear Systems.' "

For information contact: Mathematics Division, U.S. Army Research Office, Box CM, Duke Station, Durham, NC 27706.

Army BRL Scientists Take Part in Japan Lectures

Thirty scientists from the United States and other nations recently addressed scientists and engineers in numerous Japanese universities and industrial activities as an addendum to the 15th International Symposium on Combustion in Tokyo.

The lectures were presented during the week preceding and the week following the symposium. Scheduling was arranged by subcommittee chairmen Leland A. Watermeier, chief of the Interior Ballistics Laboratory, U.S. Army Ballistic Research Laboratories (BRL), and Prof. S. Kumagi, University of Tokyo.

Dr. Philip M. Howe of BRL's Detonation and Deflagration Dynamics Laboratory was among those who spoke before the Japanese Industrial Explosives Association (JIEA). His topic was "Oscillatory Behavior in Detonating Solid Explosives."

Other JIEA lecture participants were Dr. R. van Dolah and Dr. R. Chaiken, U.S. Bureau of Mines; Dr. C. Brochet, University of Poitiers, France; and Dr. A. Dremin, Academy of Science, USSR. Topics included "Nonsteady Detonation Phenomena in Liquid and Solid Explosives," "Development of New Industrial Explosives," "Low Velocity Detonation," and "Explosives Sensitivity."

A Japanese federation of economic organizations, collectively known as Keidanren, heard key presentations by BRL's Leland Watermeier. He discussed "Experiments on Electrical Control of Solid Propellants Burning," and "Unstable Burning Experiments in Solid Rocket Propellants."

Also included on the Keidanren agenda were Dr. R. L. Altman, National Aeronautics and Space Administration; Prof. R. L. Coates, Brigham Young University; and Prof. F. Solymosi, University of Azeged, Hungary.

ECOM Sponsors Wire and Cable Symposium

More than 1,000 persons, representing about 300 U.S. companies, 20 federal government agencies, and about 170 foreign countries, attended a December meeting of the 23d International Wire and Cable Symposium at Atlantic City, NJ.

Sponsored by the U.S. Army Electronics Command (ECOM) and industry, the symposium reflected a noticeable increase in foreign representation and total number of technical paper presentations. More than 50 papers were featured.

Dr. Helmut Martin of Kabelmetals, West Germany, was specifically recognized for his "outstanding" technical paper, while Robert J. Oakley of Northern Electric, Montreal, Quebec, Canada, received "best presentation" honors.

MG Hugh F. Foster, Jr., commander, ECOM and Fort Monmouth, delivered brief remarks at a final banquet.

Technical Conference Considers R&D Concepts

Discussions of new research and development concepts and on-going programs highlighted a recent 2-day semiannual technical conference at Edgewood Arsenal, MD, attended by research representatives of the Canadian and British governments and U.S. Department of Defense.

Edgewood Arsenal chemists Dr. Edward J. Poziomek and Thaddeus Novak were recognized for presenting the "best" paper in the research science category, titled "Organophosphorous Testers as Donors and Solvents in Studies of Charge-Transfer Phenomena."

John Bane, a chemist with the Manufacturing Technology Directorate, was cited for a paper titled "Abatement of Sulfate in Waste Water at Newport (IN) Army Ammunition Plant."

Career Programs . . .

Dr. Wright Selected for SARS Fellowship Program

Dr. Thomas Wright

Dr. Thomas W. Wright, chief of the Solid Mechanics Branch, U.S. Army Ballistic Research Laboratories (BRL), has been selected to spend a year at Cambridge University, England, under a Secretary of the Army Research and Study (SARS) Fellowship.

Designed as a means of developing talent considered to be of potential value to the Army, SARS Fellowships permit a recipient to reside, for a period of not less than six months nor more than 12 months, at an instituation of higher learning or research facility in the U.S. or abroad.

Programed for assignment in the university's Department of Applied Mathematics and Theoretical Physics, Dr. Wright will conduct post-doctoral research in the mathematical analysis of shock waves in solids. This SARS project is of particular interest to the Army because of the continuing need to assess the damaging effects of Army weaponry, especially shock waves on mechanical systems.

These effects are frequently associated with impact of projectiles on tank armor. Results of this research could lead to the design of novel devices to penetrate armor and ultimate improvements in vehicle armor designs.

A graduate of Cornell University, Dr. Wright has bachelor's and master's degrees in civil engineering and his PhD in mechanics. A member of Chi Epsilon, Tau Beta Pi, Sigma Xi, and Phi Beta Kappa national scholastic honor societies, he has held a Ford Foundation Special Engineering Fellowship and a National Science Foundation Cooperative Fellowship.

Dr. Wright has been employed at BRL since 1967. He has authored numerous articles and technical papers.

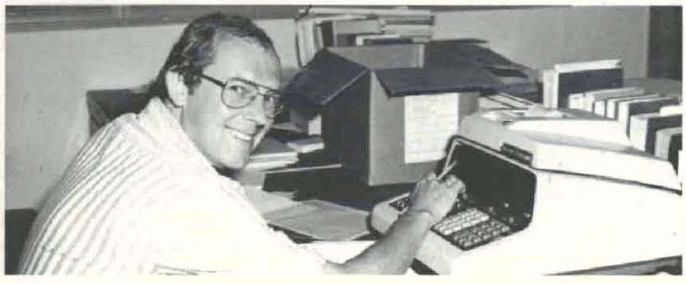
S&E Exchange Engineer Assigned to Picatinny

Objectives of a scientific and engineering exchange program between the United States and the Federal Republic of Germany are making it possible for Jerry Rotter, a German engineer, to work a year at Picatinny Arsenal, Dover, N.J.

Rotter was assigned to Meppen Proving Ground, the West German center for testing various weaponry, when he was selected for his research and development efforts at Picatinny. His duties have enabled him to make comparisons of German and American weapons R&D methods.

The 32-year-old graduate of the University of Stuttgart has observed that in the United States most of the military R&D is accomplished by conracts and grants awarded by government agencies. In West Germany, he commented, most of the defense R&D is accomplished by nongovernment agencies.

With respect to his current activities, he works "a lot more with my hands. Back home, I had more of a desk job." While at Meppen Proving Ground, he was in charge of a group that worked only with ammunition larger than 40mm. Much of his current effort is in the strain gauge field and instrumentation of shells.



Jerry Rotter, exchange engineer from FRG

ALMC Announces Installation Management Course

A new 3-week installation management course, designed specifically for managerial personnel from Army Materiel Command installations and activities, has been announced by the U.S. Army Logistics Management Center, Fort Lee, VA.

The purpose is to improve over-all management effectiveness by providing skills to cope with contemporary problems. Students will examine the organization and responsibilities of such activities as the Army Industrial Fund, nonappropriated fund activities, ecology and abatement control, and management of real property and family housing.

Potential selectees for the course should be assigned to a key management position at an AMC installation. Military personnel should have eight years commissioned active service and civilians should be in the GS-11 category or above. Waivers may be granted on an exception basis.

The introductory course is scheduled in January and the course will be repeated in March and May. Additional information may be obtained by calling AUTOVON 678-50008-2184 or by writing to: Commandant, U.S. Army Logistics Management Center, AMXM-LS, Fort Lee, VA 23801.

Awards...

APG Employes Get Systems Analysis Award

Outstanding technical achievements in support of operations research and systems analysis efforts were recognized recently when two Department of the Army employes were presented with the U.S. Army Materiel Command's Annual Group Systems Analysis Award.

Dr. William J. Sacco, acting chief of the Shock Trauma Branch, Biophysics Division, Edgewood Arsenal, MD, and Wayne S. Copes, a scientist with the U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD, are the recipients. Both men began their science careers as enlisted personnel in the Scientific and Engineering Program.

They were cited specifically for a unique systems analysis approach which they used in studying the effects of shock and trauma on patients at the Maryland Institute of Emergency Medicine (MIEM). Medical guidance was provided by Dr. R. A. Cowley and his associates at MIEM.

Their studies can be applied to experiments in wound ballistics which provide the criteria used in evaluating antipersonnel weapons and personnel protective systems. Improvements in the care and treatment of seriously injured people in both the civilian and military community are also believed possible.

CRREL Hydrologist Receives 1974 ASCE Prize

Dr. George D. Ashton, hydrologist with the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH, is the 1974 recipient of the Karl Emil Hilgard Hydraulic Prize of the American Society of Civil Engineers.

Cited for his research on ripples on the underside of river ice covers, Dr. Ashton investigates thermal processes associated with ice cover formation and break-up mechanics of ice jams. He is co-chairman of the American Society of Civil Engineers Task Committee on the hydromechanics of river ice, and has a PhD in mechanics and hydraulics from the University of Iowa.

Schmidt Receives BRL's 1974 Zornig Award

John G. Schmidt, special assistant to the director of the U.S. Army Ballistic Research Laboratories (BRL), Aberdeen (MD) Proving Ground, was presented recently with BRL's 1974 Zornig Award.

Schmidt was cited for his effectiveness in integrating and documenting the BRL scientific program and for the development of posture reports and other documents which are representative of over-all BRL accomplishments.

BRL Director Dr. Robert J. Eichelberger presented the award, one of the two highest offered annually by the laboratories, along with a plaque listing the names of former recipients, and a gold lapel pin. Schmidt began his tenure at BRL in the Ballistics Measurements Laboratory in 1946.

Personnel Actions . . .

Miley Announces Retirement; Deane Nominated

GEN Henry A. Miley Jr., commander of the U.S. Army Materiel Command since Nov. 1, 1970, has announced that he will retire soon.

GEN Henry A. Miley Jr.

GEN Miley was graduated from the United States Military Academy in 1940 and has served continuously on active duty. He was promoted to 4-star rank when he took control of AMC after serving since June 1969 as deputy commander.

Assigned to the AMC in April 1964 as deputy and later as director of Procurement and Production, GEN Miley continued in the latter capacity until August 1966. Then he became the assistant deputy chief of staff for Logistics (Programs and Budget) until 1969.

The Defense Department has announced that President Ford has nominated LTG John R. Deane Jr. for 4-star rank as successor to GEN Miley. Effective Dec. 30, 1974, LTG Deane became Deputy Chief of Staff for Research, Development and Acquisition, following approval by Congress.

When LTG William C. Gribble Jr. became Chief of Engineers August 1, 1973, LTG Deane succeeded him as Chief of Research and Development. The title was changed to Chief of RD and Acquisition May 20, 1974.

Myers Joins OASD (I&L) as Weapons Director

Frederick W. Myers Jr.

Newly appointed Director of Major Weapons Systems Acquisition in the Office of the Assistant Secretary of Defense (Installations and Logistics) is Frederick W. Myers Jr. His impressive career in R&D includes service as project manager for the Army Chinook helicopter.

In his new duties, Myers is the primary installations and logistics contact for the military services' aircraft, missiles and ships acquisition program. He serves as adviser to Jacques S. Gansler, Deputy Assistant Secretary of Defense (Materiel Acquisition, and Assistant Secretary of Defense (I&L) Arthur I. Mendolia.

With respect to his responsibilities for production aspects and interface problems throughout weapons systems acquisition, Myers will represent DoD Installations and Logistics relative to life cycle costing, design-to-cost, and logistic options during the Defense Systems Acquisition Review Council process.

Myers has served as a top manager in the Mobile Nuclear Program Office, U.S. Atomic Energy Commission; assistant to the president and senior transportation systems analyst, Research Analysis Corp.; chief, Plans and Programs, Transportation Research and Development, HQ DA; senior analyst, Aircraft and Missile Systems, Office of the Deputy Assistant Secretary of Defense (MA), OASD (I & L).

He has a BS degree in aero transportation from the University of Maryland and an MS in research management.

Webster, Wisman Appointed to Key DoD Posts

Secretary of Defense James R. Schlesinger recently announced the appointment of RAdm David A. Webster and MG William W. Wisman (USAF Ret.) to key positions.

RAdm David A. Webster

RAdm Webster was named Principal Assistant to the Deputy Assistant Secretary of Defense (Materiel Acquisition) and Director for Systems Acquisition, Office of the Assistant Secretary of Defense (Installations and Logistics). He formerly served as Director for Ships, Weapons, Electronics and Associated Systems, DASD (MA), OASD (I&L).

Listed among his previous assignments are director of Missile Weapons Control Division, Bureau of Naval Weapons; operational test and evaluation officer, Office, deputy director of the Ship Ordnance Systems Installation Directorate, Naval Ordnance Systems Command; program coordinator, Surface Ship Aviation Integration Program; and director, Surface Warfare Division, Office, Chief of Naval Operations.

MG William W. Wisman

RAdm Webster has a 1943 BS degree from the U.S. Naval Academy and a 1950 MS degree from the Massachusetts Institute of Technology, both in electrical engineering.

MG Wisman was appointed as deputy director for Telecommunications, Office, Director of Command and Control Systems. During 1972-73 he served with Supreme Headquarters Allied Powers Europe. Other key assignments include deputy chief of staff for Plans and Programs, North American Defense Command; and deputy director for Operations, National Command System, Office, Joint Chiefs of Staff.

Other assignments have included the China-Burma-India theater of operations; HQ Strategic Air Command; and commander, 819th Strategic Aerospace Division, Dyess AFB, TX.

Rogers Gets 4-Star Rank, Heads FORSCOM

GEN Bernard W. Rogers

Promotion to 4-star rank and reassignment as commander, U.S. Army Forces Command, Fort McPherson, GA, came recently for GEN Bernard W. Rogers, former Army Deputy Chief of Staff for Personnel, Washington, DC.

A graduate of the U.S. Military Academy, GEN Rogers has bachelor's and master's degrees in philosophy, politics and economics from Oxford University, England. He has also completed the Army Command and General Staff College, Army War College, and the Infantry School Advanced Course.

During 1971-72, GEN Rogers served as chief of Legislative Liaison, Office, Secretary of the Army, following an assignment as commander, 5th Infantry Division (Mechanized) and Fort Carson, CO. He was assistant division commander, 1st Infantry Division, Vietnam, from 1966-67.

Other key assignments have included military assistant and executive officer to the chairman, Joint Chiefs of Staff, Washington, DC; chief, Troop Operations Branch, Operations Division, HQ, U.S. Army Europe; and chief of staff, 24th Infantry Division, Germany.

Among his military awards and decorations are the Distinguished Service Cross, Silver Star, Legion of Merit with three Oak Leaf Clusters (OLC), Distinguished Flying Cross with OLC, Bronze Star Medal with "V" device and one OLC, and the Air Medal with "V" device and 35 OLC.

DDC Assigns Miles as Deputy Administrator

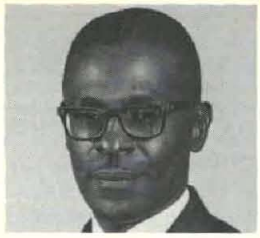
Herman W. Miles, former head of the Directorate of Development, Defense Documentation Center (DDC), was recently installed as DDC deputy administrator.

A DDC staff member since 1958, Miles has served as director, Directorate of Research and Engineering Management Information; digital computer systems administrator, and as a statistician. He has a BS degree in business administration from American University and a master's degree from George Washington University.

Miles has served on the Maritime Information Committee of the National Academy of Science's National Research Council; Executive Office of the President, Study of Environ-

mental Quality Information Programs in the Federal Government Committee; and the Committee of Transportation Research Information Systems, National Academy of Sciences.

A World War II veteran, Miles has served in the European and Pacific theaters with the Army cavalry, air corps, and engineer activities.



Herman W. Miles

Rachele Takes Over as ASL Deputy Director

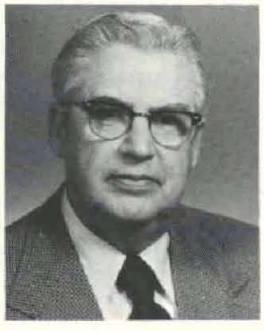
Henry Rachele

Henry Rachele assumed new duties recently as deputy director of the Atmospheric Sciences Laboratory, White Sands (NM) Missile Range after serving as chief of ASL's Meteorological Systems Technical Area.

A 1969 recipient of an Army R&D Achievement Award, Rachele has a BS degree in mathematics, physics and education from Utah State University. He is studying for his PhD degree in electrical engineering at New Mexico State University.

Rachele joined WSMR in 1956 as a mathematician supervisor with the White Sands Signal Corps Agency, forerunner of the ASL. He became chief of the Lower Atmosphere Technical Area in 1962 and later headed the Meteorological Satellite Technical Area.

Flynn Leaves Key Post in AMC RD&E Directorate



Walter W. Flynn

Walter W. Flynn ended seven years as chief of the Plans and Programs Division, Research, Development and Engineering Directorate, HQ U.S. Army Materiel Command, when he retired effective Dec. 31.

Twenty-three years of distinguished service earned him the respect of the Army R&D community. Flynn participated in initial planning for the establishment of the Army Materiel Command, and participated in study groups whose determinations influenced decisions to establish the U.S. Army Mobility Equipment Command and the U.S. Army Tank-Automotive Command.

Graduated with a BS degree in general engineering from Iowa State University in 1932, Flynn was employed as a field construction engineer in Iowa, Nebraska and Minnesota until 1941. Having received a commission as a Reserve officer in the U.S. Army Corps of Engineers upon graduation, he served 6 years on active duty including the World War II period, 37 months of which was a tour in the Canal Zone.

While he was director of Engineering, St. Martins College, Olympia, WA (1946-51), he coached tennis, track and football. In 1951 he began his Civil Service career with the R&D Directorate, Office, Chief of Engineers, serving until 1962.

For five years (1962-67), he was deputy chief of the Program Management Division, RD&E Directorate, HQ AMC. Later, as chief of the Plans and Programs Division, he was responsible for the management of programs representing about 90 percent of the Army research, development, test and evaluation appropriations.

Designated as an honorary faculty member of the U.S. Army Logistics Management Center (USALMC) in 1969, Flynn has been a frequent guest speaker to ALMC classes. He has served on many working groups and committees including the AMC RDT&E Review Board and the Production Engineering Measures Review Board.

Included among his honorary awards are a Meritorious Civilian Service Award, Sustained Superior Performance Award, 11 Outstanding Performance Awards, a Commandant's Medallion for Meritorious Service from the USALMC, and a Medallion from the Royal Finnish Army.

Roy D. Greene, former chief of the Programs Branch, Plans and Programs Division, RD&E Directorate, has been named to succeed Flynn in an acting capacity until a permanent replacement is selected. A former Air Force officer, he has a BS degree in agriculture from Western Kentucky University and a master's degree in public administration from American University. Greene is a 1974 graduate of the Industrial College of the Armed Forces.

Selected as an Army management intern in 1959, Greene served initially in the Office, Army Chief of Staff and then in the Office, Chief of Ordnance, Washington, DC. Later he was a budget analyst and program officer in the Army Research Office, Office of the Chief of Research and Development. Greene has been with HQ, AMC since Dec. 1967.

Vecchio Directs Picatinny Technical Support

Ralph Vecchio

Ralph Vecchio, former deputy director of the Technical Support Directorate (TSD), Picatinny Arsenal, Dover, NJ, recently became director, following the retirement of Karl Ottoson.

Employed at Picatinny since 1954, Vecchio has a BS degree in physics from Upsala College. He was initially assigned as a junior scientist and later as chief of the Ammunition Development and Engineering Directorate. During 1970-72, he served as chief of TSD's Technical Documentation Division.

Vecchio received a Department of the Army Research and Development Achievement Award in 1962 when 30 years old and a Picatinny Arsenal Research and Engineering Award in 1970. He is a member of Sigma Pi Sigma.

CE Selects Ellis as Louisville District Engineer

COL James N. Ellis, former executive officer, Office, Army Vice Chief of Staff, was recently named Louisville District engineer, U.S. Army Corps of Engineers.

A 1956 graduate of the U.S. Military Academy, COL Ellis has a master's degree in civil engineering from the University of Illinois. He is a graduate of the U.S. Army Command and General Staff College, the Army War College, and is a registered professional engineer in Vermont.

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

Hunter Assigned as New York District Engineer

COL Thomas C. Hunter, former commander, 24th Engineer Group, U.S. Army Europe, has succeeded COL Harry W. Lombard as New York District engineer.

Commissioned in the Army in 1951, COL Hunter has a bachelor's degree from Virginia Polytechnic Institute and State University and a master's degree from Texas A&M University, both in civil engineering. Additionally, he is a graduate of the Army Command and General Staff College, National War College, and is a registered professional engineer in Virginia.

Key assignments have included staff officer, Office, Deputy Chief of Staff for Personnel, Washington, DC; staff and faculty member, U.S. Military Academy, West Point, NY; chief of Operations, 18th Engineer Brigade, Vietnam; Commander, 36th Engineer Battalion, Fort Irwin, CA; and assistant to the Chief of Engineers, Washington, DC.

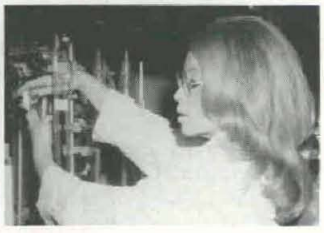
Included among his military awards and decorations are the Legion of Merit, Bronze Star Medal and the Army Commendation Medal with three Oak Leaf Clusters.

Women in Army Science...

Interesting Research

Edgewood Employes Earn Recognition

SP4 Linda K. Mulkey



Jacqueline M. Eskow

Career opportunities for women in Army science at Edgewood (MD) Arsenal are evidenced by the achievements of Jacqueline M. Eskow and SP4 Linda K. Mulkey.

A research chemist in the Environmental Research Division of the arsenal's Chemical Laboratory, British-born Ms. Eskow conducts research on the purification of air contaminated with trace quantities of toxic agents.

Results of her studies, published in conjunction with her supervisor and an associate chemist, are contained in "Kinetics of Trace Gas Sorption from Contaminated Air." This technical manuscript was presented at a recent American Chemical Society meeting and is scheduled for publication in proceedings of an "Advances in Chemistry" symposium.

Currently preparing for a return to full-time academic studies, Ms. Eskow has advanced her career by a series of self-development programs in chemistry, mathematics and physics. She has a 1969 bachelor's degree in chemistry from Mt. St. Agnes College and has attended courses in air pollution at Johns Hopkins University. She was a member of Sigma Phi Sigma honorary society and was elected to Sigma Xi honorary chemical society in 1974.

SP4 Linda Mulkey, a 23-year-old native of Boise, ID, is the only female lab specialist in the Toxicology Division of Edgewood's Biomedical Laboratory. She conducts blood chemistry tests with serum or plasma to determine if doses have reached a toxicity level.

SP4 Mulkey entered college to pursue her degree in registered nursing. However, her academic studies were sidelined a short time thereafter when she enlisted in the Army.

Although her ambition for nursing still remains, she is far from disappointed with her career in Army science. She was assigned to Edgewood last year after completing Army medical laboratory specialist training at Fort Sam Houston, TX.

SP4 Mulkey was recently named Edgewood's Soldier of the Month, accompanied by a Certificate of Achievement.

RIA Engineer Named to Illinois Examining Unit

Lorraine D. Wright, a mechanical engineer at Rock Island Arsenal (RIA), IL, recently became the first woman appointed to a 3-year term on the Illinois Professional Engineer Examining Committee in the Department of Registration and Education. Employed by the Federal Government for 10 years, Miss Wright is the third woman in the nation to be appointed to the committee. She works in the Advanced Concepts Division of the Artillery and Armored Weapons Systems Directorate at the arsenal.

She also serves as Army liaison representative on the American Defense Preparedness Association's Combat Vehicle System Section. A member of the National Society of Professional Engineers, she is a member of the National Society of Women Engineers, National Association of Women in Construction, American Association of University Women, National Federation of Business and Professional Women, and the Illinois Society of Professional Engineers.

Miss Wright earned a BA degree in business administration at Augustana College, Rock Island, IL, in 1973, and is enrolled in an advanced degree engineering program at Bradley University, Peoria, IL.

Army R&D—10 Years Ago

The Army R&D Newsmagazine reported on . . .

Committee Issues STI Report to Congress

Documentation and Dissemination of R&D Results, a 148-page report prepared by the House Select Committee on Government Research, was submitted to Congress, as the fourth of 10 comprehensive studies being made by the Committee on Federal R&D programs and problems.

Top Managers Study R&D Problems

"Federal Workforce Outlook Fiscal Years 1965-68," and "Personnel Management for Scientists and Engineers: Status, Critical Issues and Commission Leadership," two reports of interest to top-level management of R&D, were issued. Initial distribution was made at the Environment of the Federal Laboratory Symposium sponsored jointly by the U.S. Civil Service Commission (CSC) and the Federal Council for Science & Technology (FCST).

DoD Consolidates Contract Audit Activities

Secretary of Defense Robert S. McNamara announced creation of the Department of Defense Contract Audit Agency, designed to increase the efficiency and to lower cost of U.S. Government auditing of defense contracts. The agency was established to consolidate the activities and the 3,600 personnel of the various contract audit units in the Military Departments.

STI Functional Area Managers Established

Department of Defense Instruction 5010.13 was issued to all DoD agencies concerned. The instruction prescribed authority, responsibilities and relationships between the Scientific and Technical Information Program, the Technical Logistics Data and Information Program, and the Standardization Program. Positive lines of control were established in six functional areas, with over-all coordination responsibility vested in BG Allan T. Stanwix-Hay as director of Technical Data and Standardization Policy at the DoD level.

Army Leaders Brief Industry on Long-Range Needs

A team of Army officials, headed by Assistant Secretary of the Army (I&L) Daniel M. Luevano, discussed future Army needs with industry, small business and labor in a series of briefings sponsored by the National Security Industrial Association (NSIA) and supported by the Department of Defense.

Included on the team were GEN Frank S. Besson Jr., commanding the U.S. Army Materiel Command, plus four of his major commanders: MG Frank W. Moorman, U.S. Army Electronics Command; MG John G. Zierdt, U.S. Army Missile Command; MG William W. Lapsley, U.S. Army Mobility Command; BG Roland B. Anderson, Army Weapons Command.

Reader's Guide

ARI Reports on Officer Leadership Potential

Methods of determining leadership potential are reported in *Prediction of Officer Behavior in a Simulated Combat Situation*, one of five recently issued publications of the U.S. Army Research Institute for the Behavioral and Social Sciences.

Other newly published ARI technical research documents, available upon request, include: *Techniques for the Assessment of Worth; The Effect of Data Source Reliability on Intuitive Inference; Research on Tactical Decision Making: Application of a Decision Prediction Concept in a SIMTOS Environment;* and *Job Requirements of G2 Air and Image Interpretation Personnel.*

ASPA Issues on Industrial Relations Colleges List

Personnel and Industrial Relations Colleges: An ASPA Directory, is the title of a new publication recently issued by the American Society for Personnel Administration.

This document provides complete information on programs, faculties and training courses in human resource management. It also contains facts on more than 200 schools which offer instruction in this field.

Additional details may be obtained from: ASPA, P.O. Drawer A, Berea, OH 44017.

Fracture Characteristics of Boron Fiber-Reinforced Aluminium As Detected by Acoustic Emission

By Albert F. Grenis and Francis J. Rudy
U.S. Army Materials and Mechanics Research Center, Watertown, MA

Acoustic emission equipment is being used to study the structural integrity of fiber-reinforced, metal-matrix composites at the U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA.

When a solid material is deformed, sounds of low-level intensity, termed acoustic emission, are emitted. When the materials are relatively large, such as a plank of wood or even bars of some metals such as tin, and are subjected to stress, the intensity of acoustic emission becomes great enough before fracture to be audible to the human ear.

The high specific strength and modulus of fiber-reinforced aluminum make this metal extremely promising for use as a structural element in critical areas of military aircraft. One important consideration for improving such a composite involves the study of fiber distribution and of fiber fracture characteristics within the matrix material.

In an aluminum composite, for example, it would not be unusual for millions of fibers, such as boron or graphite fibers, to be contained throughout a cross-section of composite structural material.

New experimental and analytical studies of fiber fracture in aluminum composites are needed, other than conventional stress-strain studies, in order that structural composite elements having preferred or improved properties, as well as uniform properties, can be produced.

Early investigators decided that the phenomenon of acoustic emission could lend itself to the study of deformation of materials in the laboratory. All that was required was the proper instrumentation.

** An emission event is a rapid physical change in a material, such as the breaking of a fiber in a composite, that releases energy which appears as acoustic emission.[2]*

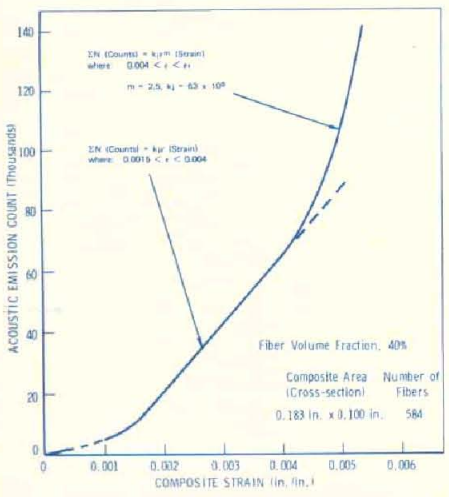


Fig. 1. Acoustic Emission Count as a Function of Composite Strain for Boron Fiber-Reinforced Aluminum.

Recent studies[1] with acoustic emission equipment in the Metals Research Division, AMMRC, show composite changes at different values of strain more dramatically than the standard tension test. Changes in composite integrity show along the entire stress-strain region.

Figure 1 shows the acoustic emission count, composed of events,* as a function of composite strain for one boron fiber reinforced aluminum specimen. One characteristic is that a linear relationship is present (after a strain value of 0.0015 in/in) for the acoustic emission count versus strain, indicating fiber fracture.

After a strain value of 0.004 in/in is exceeded, the acoustic emission count begins to rise very rapidly, now being of the power-law type. This indicates that multiple fiber fracture, as well as interface failure and matrix cracking, are taking place, and that the specimen is structurally ineffective.

Photomicrographs of the specimens, Figure 2, verify that multiple fiber fracture has taken place; a stress-strain curve for one of these specimens (Figure 3) tells us nothing about such effects.

Figure 3 also shows the acoustic emission rate and composite stress as a function of composite strain for this same boron fiber reinforced aluminum specimen. Here, the acoustic emission rate begins to increase slowly as the specimen of a known cross-sectional area is stressed. A sharp increase shows only near the facture, on the order of 3000 counts/sec. This is a relatively good specimen structurally; a poor specimen of the same cross-sectional area would have shown a much larger acoustic emission rate, at much lower values of applied stress and strain.

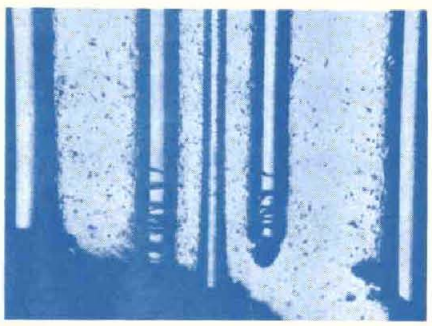


Fig. 2. Boron-Fiber-Reinforced Aluminum, Mag 200X.

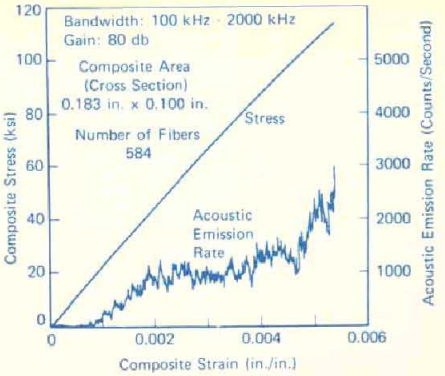


Figure 3. Acoustic Emission Rate and Composite Stress as Function of Strain for Boron-Fiber-Reinforced Aluminum.

In summary, the acoustic emission method is another useful tool for the study of the structural integrity of fiber-reinforced, metal-matrix composites. Large variations in acoustic emission, as well as in the stress-strain data, are possible for many fiber-reinforced materials due to deficiencies[3] that may be present in such specimens. These deficiencies could include variations in density due to uneven fiber distribution, fiber-fiber contact and some areas of poor metal-metal and metal-fiber bond.

Further acoustic emission studies are needed for understanding more about the deformation and fracture mechanisms in such composites and for the development of composites having improved and uniform properties.

[1] Grenis, A. F. and Ruby, F. J., Fracture Characteristics of Boron Fiber Reinforced Aluminum 2024, as Detected by Acoustic Emission. Army Materials and Mechanics Research Center, AMMRC TR 73-59, December 1973.
[2] Liptai, R. G., General Chairman. Acoustic Emission ASTM Special Technical Publication 505. (Acoustic Emission Working Group Subcommittee Report: Recommended Acoustic Terminology).
[3] DiCesare, E., Characterization of 2024 Aluminum Boron Fiber Composites. Army Materials and Mechanics Research Center, AMMRC TN 73-10, June 1973.

Advice to Readers: Submit DA Form 12-5!

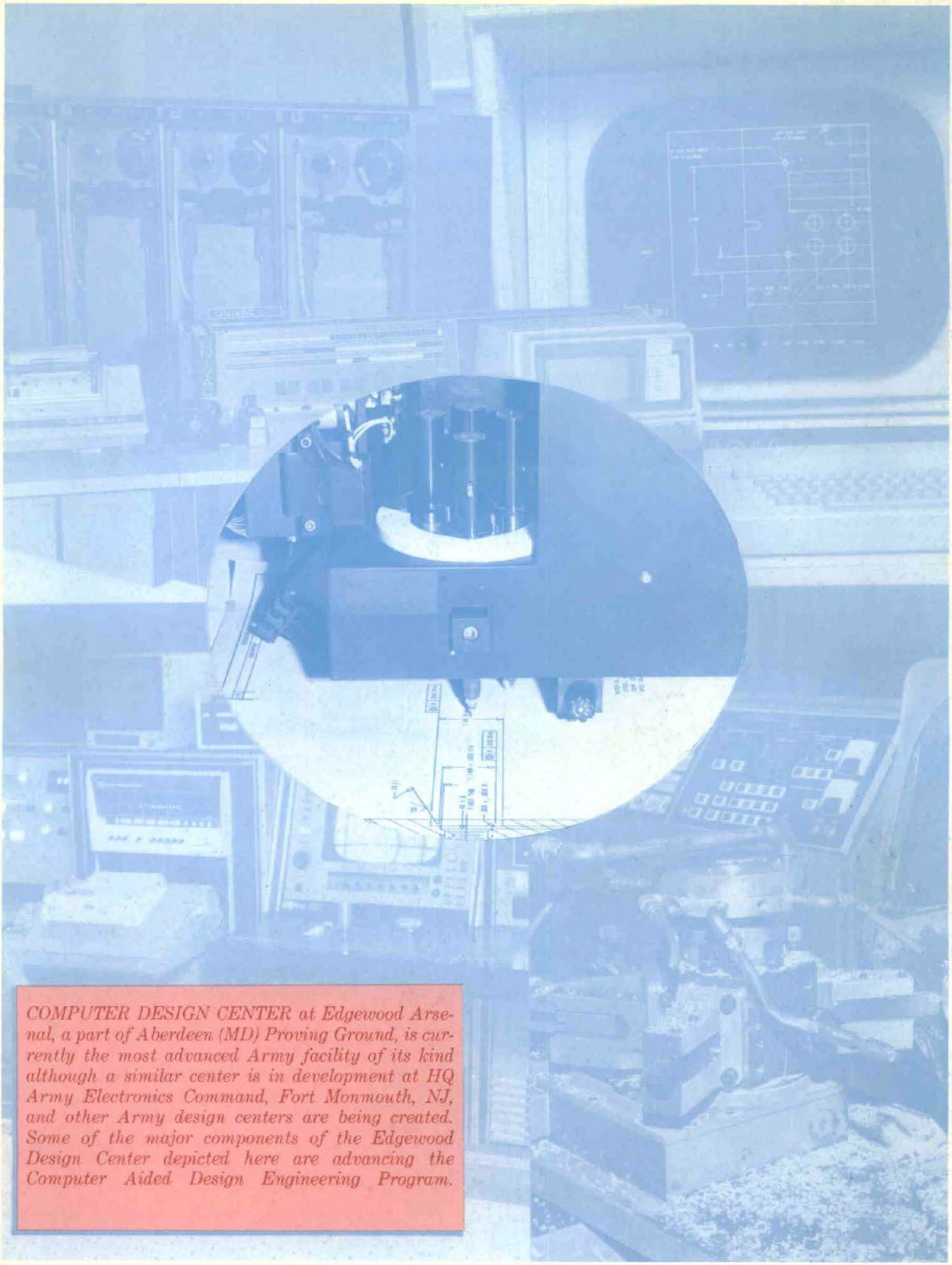
Some Army Research and Development Newsmagazine readers—in fact, a disturbing large percentage of them—may be chagrined in the near future when they find they have been dropped from distribution due to negligence.

If their requirements have not been certified by submission of the new DA Form 12–5 (successor to DA Form 12–4) to the Adjutant General Center, in accordance with Army Regulation 310–2, those accustomed to receiving the Army Research and Development Newsmagazine are due for a disappointment.

A recent check with the Office of The Adjutant General in the Forrestal Building, Washington, DC, showed that the submitted requirements under the new "Pinpoint Formula Distribution Plan" totaled only about 56 percent of DA 12–4 requirements that are now obsolete for the Newsmagazine print order.

Moreover, the Department of the Army periodicals review and authorization process is screening out about 25 to 33 percent (for some periodicals) of the requirements submitted on DA Form 12–5.

The Newsmagazine is directed primarily to Army R&D scientists, engineers, technicians and supervisors at laboratory and bench level, and top management personnel. The basis for distribution is one copy for each officer (LTC and above) directly involved in R&D activities, one copy for each civilian (GS-13 and above) directly involved in R&D activities, and one copy for each six officers or civilians in the lower grades.



COMPUTER DESIGN CENTER at Edgewood Arsenal, a part of Aberdeen (MD) Proving Ground, is currently the most advanced Army facility of its kind although a similar center is in development at HQ Army Electronics Command, Fort Monmouth, NJ, and other Army design centers are being created. Some of the major components of the Edgewood Design Center depicted here are advancing the Computer Aided Design Engineering Program.