ARMY
RESEARCH AND DEVELOPMENT
May - June 1975

ELECTRIC POWER

COUNTERMINE

MAJOR THRUSTS

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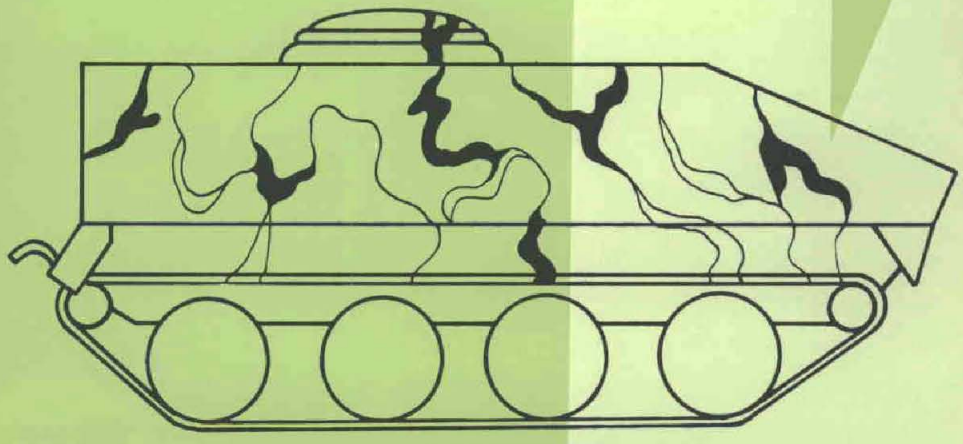


CAMOUFLAGE

MERDC PROGRAMS

SPEAKING ON...

Defense RDT&E Budget: Maintaining Technological Initiative

Director of Defense Research and Engineering Dr. Malcolm R. Currie's presentation to the House of Representatives Armed Services Committee, in justification of the Defense Research, Development, Test and Evaluation budget request for FY 1976, is a strong, comprehensive, massive statement. The Table of Contents alone takes up 11 pages. The Defense RDT&E Overview, which follows, is supplemented by detailed considerations of major areas of concern. Space available permits only the Overview coverage.

Dr. Malcolm R. Currie

The RDT&E program is an aggregate of thousands of individual items, each designed to meet a specific defense need. The proposed program for FY 1976 will cost $10.2 billion.

In my full presentation for the record, Mr. Chairman, I will explain each item, but I would like now to present a broad perspective which I believe is essential to your consideration of the complex details of the program. In short: This program is designed explicitly to maintain for our nation now and for the future one of its priceless assets—the technological initiative.

I will describe what I mean by the technological initiative. I will assert that we have the initiative today, but that it is increasingly perishable in the world environment which we foresee.

I will outline a philosophy of research and development management and describe a broad program that I am convinced can maintain this initiative for the years ahead. And I will ask this Committee—and the full Congress—to provide the vision, the wisdom and the investment decisions that will forge our future in the bold tradition of our successful past.

For decades we have based our security and economic vitality on technology. Today we find ourselves in an uncertain world. We view with concern a growing dependence on other nations for effective operation of our economy. We see a determined adversary led by people who understand well the role of technology, who have achieved apparent parity in raw power, and who insist they can and will create a position of military and economic strength favorable to their country.

Is technology, therefore, now proved for us to be a false god, best to be abandoned? Or, is this a time for new resolve and new effort to shape an assured future?

In this increasingly competitive, often hostile and rapidly changing world, Americans seem to have only one real choice. Clearly our national well-being cannot be based on unlimited raw materials or on unlimited manpower and cheap labor. Rather, it must be based on our ability to multiply and enhance the limited natural and human resources we do have. Technology thus appears to offer us our place in the sun—the means to insure our security and economic vitality.

Make no mistake about it: There will be continued rapid technology change in future decades throughout the world. This change will be a global fact of life, not a U.S. choice. Ready or not, technological advance will be pervasive and change the way we live.

Our nation's research and development community, including Defense R&D people, can and must respond to the rapid change. We can move with vision, as we traditionally have, and keep the leadership, or leave the initiative to others.

I am urging today the clear articulation of a national policy. We must maintain broad technological initiatives.

To do this, Defense-related research and development must be funded, led and managed so that it can continue to make its vital contribution.

Future Impact of Today's Decision. The FY 1976 RDT&E programs will have a profound effect on: The avoidance —that is, deterrence—of future wars of all kinds; the capabilities and costs of future U.S. weapons in competition with adversary weapons; the flexibility of the United States to meet crisis and wartime contingencies; the efficiency of our use of scarce and valuable military personnel and defense dollars; the perception of the rest of the world—hostile and friendly—of America's long-term commitment to maintain technological leadership in significant defense areas.

These are national security reasons for carrying out an effective Defense R&D program. The requested programs are proposed by the Department of Defense—and will be judged by the Congress—solely on their direct contribution to national security objectives. There is no other purpose for Defense R&D. There is no program in this request, no proposed spending, that is advanced for civil economic reasons.

But it is appropriate that the Congress and the public understand that there has been and will continue to be an enormous civil bonus from our national investment in Defense R&D. This bonus effect is much deeper than just the impetus for new industries such as jet engines, computers, and nuclear power.

Defense Department needs require the exploration and mastery of ever newer frontiers of technology, and this approach provides the necessary climate and foundation for industrial world leadership.

Therefore, while it is true that our decisions on FY 1976 Defense RDT&E are solely for our future national security, these decisions will also affect the broad economic health of our industry in an increasingly competitive world environment.

The Decision Environment

We cannot foresee exactly the needs of our children to the end of this century. Neither can we afford to fund enough R&D to cover every plausible future contingency. What we can do effectively is deliberately create options through a limited R&D program, thus permitting those who follow us to shape their own destinies based on conditions which will exist in their own times.

Our RDT&E budget is a constrained request—very much the product of today's difficult fiscal environment and of

(Continued on page 21)

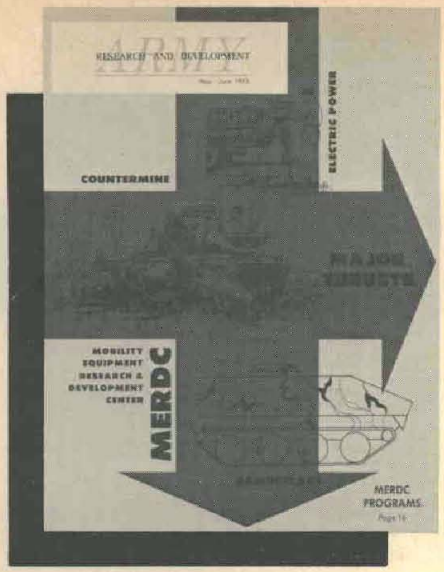
Army Research Office Moves To Research Triangle Park

Relocation of the U.S. Army Research Office, Durham, NC, from the campus of Duke University to the Research Triangle Park—a 6,200-acre industrial and U.S. Government complex considered one of the finest of its kind in the nation—was beginning as this edition went to press.

USARO had its origin when it was redesignated in January 1961 as an outgrowth of the Office of Ordnance Research, located on the university campus. Transfer to the Research Triangle Park will place USARO in a newly constructed one-story building that provides 22,500 square feet of usable space.

Expanded in staffing and mission when the U.S. Army Research Office in the Highland Building on Highland Street and Columbia Pike, Arlington, VA, was phased out in the spring of 1973, USARO is responsible for programing and monitoring basic research. The mission includes mathematics, and the physical, engineering, environmental, and life sciences.

THE NEW ADDRESS IS: U.S. Army Research Office, P.O. Box 12211, Research Triangle Park, NC, 27709. The telephone numbers are: Area Code 919-549-0641 or AUTOVON 935-3331/3332.



ARMY RESEARCH AND DEVELOPMENT

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ABOUT THE COVER:

Recently designated a separate AMC Development Center, the U.S. Army Mobility Equipment Research and Development Center (MERDC) is continuing its mission of research, development and engineering in support of the field soldier, with an added acquisition responsibility for the initial production buy of the equipment it develops. Its three Major Thrust areas of camouflage, countermine and electric power are illustrated on the front cover with a pattern-painted combat vehicle, mine-clearing plow, and missile power plant.

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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 Communications-Electronics, Computer Systems Command, and miscellaneous related activities. Use of funds for printing of this publication has been approved by Department of 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

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OTHER GOVERNMENT AGENCIES' requirements should be submitted directly to: AMCRD-PS-NM, 5001 Eisenhower Ave., Alexandria, VA 22333.

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Selective Scanner . . .

MASSTER Evaluating EQUATE, New Test Station

Six months of field evaluation of the Electronic Quality Assurance Test Equipment (EQUATE) system, a possible contender for satisfying the Army's automatic test equipment (ATE) requirements, and AN/USM-410 Electronic Equipment Test Station started in May at MASSTER, Fort Hood, TX.

The computer-controlled diagnostic, fault-isolation equipment was demonstrated recently on the AN/ARC-115 Aircraft Radio Transceiver at HQ U.S. Army Electronics Command (ECOM), HQ U.S. Army Material Command (AMC), and HQ Department of the Army in the Pentagon.

The EQUATE experimental model—intended to facilitiate cost-effective field maintenance—operates over the frequency range from DC to 18 GHz (zero to 18 billion cycles per second). Extension of its capability is planned to include electro-optical systems.

Consideration is being given to procuring additional models with programable interfacing before the end of FY 75 to provide maintenance support for Army Security Agency programs and the Army Advanced Attack Helicopter Program—if the EQUATE system is determined to be the most cost effective and technically feasible among the available ATE systems. Other possible applications include depot support of TACFIRE and the AN/TTC-39 Switching Central.

MASSTER will evaluate field maintenance support capability of EQUATE, using the AN/ARC-115, AN/PRC-77 and the AN/VRC-12 FM radios as a test bed.

Participating in the AN/USM-410 evaluation program is the Test Instrumentation Team of the U.S. Army Electronics Technology and Devices Laboratory, ECOM, Fort Monmouth, NJ. EQUATE was designed by RCA, Government and Aerospace Systems Division, under contract to ECOM.

First 'Complete' Stinger System Scores Direct Hit

Stinger, the Army's shoulder-fired weapon that incorporates the latest in infrared technology, scored a direct hit on a T-33 jet flying at 400 knots in its first countermeasures test firing.

During the recent engineering development test at White Sands Missile Range (WSMR), NM, the sixth successful guided test flight since February, a complete Stinger weapon system was fired for the first time. Project Manager COL David Souser explained that components, including separable gripstock and battery coolant unit, were mounted on a modified Chaparral launcher.

The Army plans two more Guided Test Vehicle firings. "After that," COL Souser said, "we will go into more advanced testing, including preconditioning of missiles and equipment in hot and cold environments prior to flight. We will conduct a few manned tests firing from the shoulder."

The 35-pound Stinger will have an IFF (Identification Friend or Foe) antenna. Army R&D personnel and General Dynamics, prime contractor, are designing, fabricating and testing a prototype system to provide an immediate air defense capability.

DoD Schedules 24th Annual NDT Conference

Potential solutions to problems of nondestructive testing (NDT) of Department of Defense agencies will be discussed at the 24th annual Defense Conference on NDT, Nov. 11-13 in San Diego, CA.

The conference is limited to military and civilian scientists, engineers, technicians and managers responsible for military NDT activities. Hosted on a rotational basis by the Military Departments and Defense Supply Agency, the meeting this year is under the aegis of the Navy.

Objectives are to present papers reporting on progress and problem areas, advance potential solutions, and encourage uniform practices in the application of NDT methods.

Technical paper proposals should be submitted by May 30 to Frank Gomex, chairman, Steering Committee, 24th Defense Conference on Nondestructive Testing, San Antonio ALC/MMEWA, Kelly AFB, TX 78241.

MDTS May Boost Digital Voice Transmissions

Successful demonstration of the Megabit Digital Troposcatter Subsystem, termed an R&D breakthrough that could provide an 8-fold increase in digital voice channel capacity of the Department of Defense strategic troposcatter communications systems, has been announced by the U.S. Army Electronics Command.

MDTS was developed under technical direction of the Communications-Automatic Data Processing Laboratory, U.S. Army Communications Systems Agency. It permits transmission of 192 digital voice channels over links up to 150 miles, and 92 channels over 250-mile links. ECOM believes MDTS could be operational in 1978 or 1979.

Present communications over these links have been limited to 24 voice channels because of fading and the multipath characteristics of troposcatter. MDTS uses a new adaptive equalization technique to combat the multipath effects of troposcatter.

Although MDTS is designed to upgrade the Defense Communications System, it also can be used in the Joint Tactical Communications (TRI-TAC) system of the Department of Defense. The MDTS prime contractor is GTE Sylvania, Inc., with Signatron, Inc., as major subcontractor.

U.S., FRG Schedule 8 Pershing Missile Firings

Eight Pershing missiles will be fired by United States and Federal Republic of Germany (FRG) troops during May and June at the Utah Launch Complex of White Sands (NM) Missile Range.

More than 300 Pershing missiles have been fired from sites in Florida, Utah and New Mexico since the test series began 15 years ago. Operational since 1963, Pershing is deployed with U.S. Army troops and North Atlantic Treaty Organization (NATO) defense forces in Western Europe.

FRG Air Force units will fire four operational rounds May 13 and May 28. U.S. Army troops from Europe will fire two rounds on June 11 and two rounds on June 25. Firing operations and new components of the automatic reference system/sequential launch adapter will be evaluated in the U.S. firings.

The firing units will be graded by the U.S. Army Field Artillery Missile Systems Evaluation Group from Fort Sill. Technical direction will be provided by a team from the Pershing Project Manager's Office, U.S. Army Missile Command (MICOM), Redstone Arsenal, AL.

Product Improvement of M551 Units Nears End

Product improvement of the motor-generator set and accessory box of the turret electrical drive system for the M551 Armored Reconnaissance Airborne Assault Vehicle (ARAAV) is nearing completion at HQ U.S. Army Armament Command, Rock Island, IL.

Circuit breakers were added to the accessory box to compensate for failure of the electro-mechanical relays. The circuit breakers are self-resetting and remain open until the cause of the current overload has been corrected.

A solid-state power inverter is being evaluated as a replacement for the motor-generator. The sealed unit has no moving parts, is extremely quiet during operation, and is not susceptible to damage by moisture or foreign materials.

Failures of the motor-generator were attributed to entry of water, mud or foreign material through the ventilation ports. The units also produce a noise level of 90-100 decibles and

require a 20-second warmup, degrading combat effectiveness of the vehicle.

Unit repair and maintenance of the turret electrical drive system will be simplified, since the product-improved units will consist only of replaceable plug-in components or printed-circuit cards. Weapon effectiveness of the ARAAV will be improved by the "instant-on" capability of the solid-state inverter.

New Water Quality Sets Going Into Production

Type-classified standard Water Quality Sets developed by the U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA, to test drinking water in the field are going into production.

Type classification means that the two sets are considered the most satisfactory units available to meet current military needs. One set, described as much more accurate than a World War II set it will replace, is designed for use by engineer teams in tactical situations to test water supply sources and to monitor equipment performance in drinking water production.

A second set developed for the Surgeon General is basically an improved engineer set for use by Preventive Medicine Teams in water quality surveillance programs. Additional equipment and reagents permit more extensive testing for bacteriological and chemical characteristics of sanitary significance.

Equipment and reagents for both sets are packaged in rugged, watertight cases weighing less than 65 pounds each.

MERDC Contract Calls for Truck Noise Reductions

Multiphase efforts to reduce operational noise levels of military forklift trucks are being made under contract with the U.S. Army Mobility Equipment Research and Development Center (MERDC), Fort Belvoir, VA, and Allis-Chalmers Industrial Truck Division, Matteson, IL.

Phase I work has been completed. It consisted of defining the levels and characteristics of noise emissions from 6,000-lb. capacity, gasoline-engine-driven Allis-Chalmers trucks that are in the Army inventory.

Current efforts are being directed toward development of techniques to abate noise sources. This will be followed by design and fabrication of noise reduction kits, and verification testing.

The performance goal is 85 decibels A-weighted (Standard Sound-level System), under any operating cycle. Baseline tests have revealed that, under certain operating conditions, noise levels can exceed 90 decibels A-weighted.

AMC Establishes West Coast Industrial Liaison Office

The U.S. Army Materiel Command has established a Technical Industrial Liaison Office collocated with a Navy TILO in California to provide industries in the western United States with planning information relative to future Army Research and Development requirements.

Scheduled for operational status by the end of May, the west coast TILO is located at 1030 East Green Street, Pasadena, and will be joined by a U.S. Air Force element in July, providing a centralized capability for tri-service R&D information required by existing or prospective defense contractors.

Responsibility for the TILO function was assumed by the Army Materiel Command in a transfer from the Deputy Chief of Staff for Research, Development and Acquisition. An East Coast TILO was established at HQ AMC in 1974. The new west coast office will be equipped similarly to provide industry with classified and unclassified documents, R&D summary sheets, and advanced planning information.

Technical Manual Aids Army MWIP Implementation

Implementation of the Army Weapons Management Improvement Program (MWIP) is being aided by Army-wide distribution of Technical Manual 38-214 (Test).

The manual outlines functional requirements and procedures for maintaining appropriate files and controls on all small arms weapons in the Army inventory.

The Army MWIP is designed to provide government investigative agencies with the identification of the last responsible Army activity possessing a specific serial-numbered small-arms weapon. Included are the 106mm recoilless rifle, all antitank weapons, all machineguns, all mortars and all types of rifles and pistols used by the Active and Reserve Army, and the National Guard.

Developed by the Army Logistics Management Center, Fort Lee, VA, the manual does not change existing physical security regulations or operations. The Army MWIP complies with the Department of Defense small arms serial number control system and interfaces with similar systems in other U.S. Armed Services and the Defense Supply Agency.

Army Grants $1.5 Million for Advanced Pershing II

Advanced development of the Pershing II surface-to-surface missile was initiated under a $1.5 million contract awarded recently by the U.S. Army Missile Command (MICOM), Redstone Arsenal, AL.

Martin Marietta Aerospace Corp., Orlando, FL, will demonstrate technology necessary to provide a major increase in Pershing accuracy. Use of smaller warheads and increased Army employment options are believed possible.

Deployed with troops in 1962, Pershing has a 400-mile range capacity and is now considered a major element in the North Atlantic Treaty Organizations' nuclear shield. COL Samuel C. Skemp Jr. is Pershing project manager at MICOM.

Dragon Weapon System Deployed to 509th Infantry

Dragon, the Army's 31-pound shoulder-fired weapon powerful enough to destroy any known enemy armor, has been deployed to the First Battalion (Airborne), 509th Infantry Combat Team in Germany, the first overseas unit to get it.

Dragon was issued earlier to Infantry training units at Fort Benning, GA, and Fort Polk, LA. The 509th Infantry Combat Team has a cadre of trained instructors and several gunners who were trained at these stations.

The Dragon is designed to complement the TOW weapon system and to replace the 90mm recoilless rifle.

COL Arthur L. Goodall, Dragon project manager at the U.S. Army Missile Command, Redstone Arsenal, AL, praised the Army-contractor team for "outstanding success" in meeting the Dragon's established deployment date.

2 Firms Developing Rotor Hub, Monitoring System

Exploratory development of a low-cost rotor hub concept for large helicopters, and manufacture of an associated 50-channel recording system to monitor testing strain, will be accomplished under two contracts awarded by the Eustis Directorate, U.S. Army Air Mobility R&D Laboratory.

Critical sections of the rotor hub will be designed and tested by Kaman Aerospace Corp., under a $245,000 contract. This effort reflects the Army's goal of low-cost rotor hubs with fail-safe design, improved ballistic tolerance, reduced radar reflectivity, and improved reliability and maintainability characteristics.

MTS Systems Corp., Minneapolis, MN, received a $99,435 contract to manufacture the "real-time" strain monitoring equipment, which will be used with the full-scale rotor blade fatigue test machine and other MTS test equipment at the Eustis Directorate, Fort Eustis, VA.

The system will automatically monitor and convert raw data to engineering data on a real-time basis. It will handle data obtained from strain gauges, thermocouples, load cells and associated monitoring equipment used in testing helicopter components in the Structures Laboratory.

R&D News . . .

NLABS Redesignated NDC, Assigned Additional Responsibilities

Effects of redesignation as the U.S. Army Natick Development Center were detailed, along with progress in priority effort areas of the former Natick Laboratories, when COL Rufus E. Lester, commander, addressed a meeting of R&D Associates for Military Food and Packaging, Inc.

Speaking in New York City to more than 200 members of the nonprofit organization that has cooperated with the Natick Laboratories for more than 20 years, COL Lester directed special attention to advances in radiation preservation of food, and to results of pilot plant operations to convert waste paper into numerous useful products.

One of the major responsibilities the NDC has inherited from Natick Laboratories is the management of the Department of Defense Food Research, Development, Test and Evaluation Program, assigned to NLABS since October 1969. R&D Associates for Military Food and Packaging, Inc., have had a collaborative role in implementing this program.

Two major recommendations made by the Army Materiel Acquisition Review Committee (AMARC), composed of six teams that submitted a 2-volume report in April 1974, will impact significantly upon the NDC mission, COL Lester stated.

First, President Ford signed into law on Dec. 26, 1974, a law establishing a single Department of the Army staff agency (Deputy Chief of Staff for Research, Development and Acquisition) to monitor the materiel procurement process.

Second, the AMARC recommended consolidation of the Army Materiel Command's RDT&E in-house capabilities into system development centers in major areas of RDT&E effort. The centers, eight in all as now planned, will be charged with accomplishing first production procurement and fielding of their assigned systems, components and items in the acquisition process.

Except for reporting directly to HQ Army Materiel Command, rather than the Troop Support Command, NLABS will be affected minimally by establishment as a development center—that is, little or no changes in personnel resources are anticipated, COL Lester said, adding:

"The basic mission . . . in research, development and engineering in food, clothing, airdrop and organizational equipment will remain the same, as will our continued support to satellite agencies. . . . Defense Supply Agency procured items such as food and clothing are not included under the concept."

Natick's role in the initial procurement of materiel items in its assigned areas of responsibility is to validate the technical data package. A logistics center will then assume responsibility for sustained supply. Natick, however, will provide engineering support to the logistic center throughout the life cycle of the commodities.

COL R. E. Lester

One of the NDC new functions is that of performing as the Army Materiel Command Lead Laboratory for coordinating development and standardization of tactical shelters for sea, air and ground transportation. The objective is to assure a higher degree of commonality for military requirements during the production process.

Turning to "two important programs which have great potential for American industry," COL Lester reported on pre-pilot plant operations at Natick in the conversion of cellulose by enzymatic hydrolsis into glucose products, including sugar as well as a clean-burning fuel (ethanol or ethyl alcohol for blending with gasoline).

The pre-pilot plant is capable of converting 1,000 pounds of newspaper into 500 pounds of glucose solution a month, he said, explaining that "techniques are available to refine it further to produce animal feed, vitamins, antibiotics, other drugs, and short-supply chemicals such as materials for plastics.

"Requests for information, processing data, or for the opportunity to visit our pre-pilot plant, are coming from all over the world. A multitude of U.S. chemical companies, pulp and paper mills, processors of agricultural products, and various state and municipal governments have shown interest in the potential application of this process.

"Many of these same firms and agencies will be represented among the more than 400 delegates expected to be in attendance at a symposium in Boston, Sept. 8–9, sponsored by the NDC and the National Research Council.

"The conferees will be apprised of the current state of the cellulase production and cellulose saccharification technology, and suggested potential applications of the process will be evaluated. At that time, we will determine what future steps should be taken."

Turning to "great improvements in the quality of irradiation sterilized foods processed at the Natick Development Center," COL Lester stated:

"We attribute these improvements to irradiation of the vacuum-sealed foods in the frozen state, better control of temperature and time for heating to inactivate autolytic enzymes, and addition of sodium tripolyphosphate and sodium chlorine to maintain juiciness.

"Technology is in the advanced stage for irradiation-sterilized beef, ham, poultry, pork, bacon, canned beef, pork sausage, lamb, cod fish cakes and shrimp. Astronauts on the Apollo 17 moon flight ate irradiated ham and praised it in their reports. Irradiated ham was a back-up item for Skylab.

"With the Apollo-Soyuz flight scheduled for lift-off in July 1975, the American astronauts have selected for their meals irradiation-sterilized turkey, beef steak, ham and corned beef."

COL Lester then explained that before radiation-processed foods can be produced and sold commercially, they must be approved in the United States by the Food and Drug Administration, and in other countries by officials in the appropriate health ministries. Department of Agriculture approval of irradiated meat and poultry items also is required in the United States.

Scientific evidence to convince those charged with approving food irradiation, he said, depends upon long and costly studies to prove safety for consumption —"wholesomeness." The major thrust of Army effort over the past four years has been to prove wholesomeness of irradiated beef sterilized in the dose range of 4.7 to 7.1 megarads.

No adverse findings caused by or attributed to irradiated beef have been reported, COL Lester said. If none occurs, the Army will submit a petition for approval for public use to the FDA and the USDA in 1977. He continued:

"When Army Secretary Howard Callaway visited the Natick Development Center in October 1974 (then designated the Natick Laboratories), he was pleased with the excellent quality of the irradiated foods which he examined.

"A month later, the Under Secretary of the Army, Honorable Herman R. Staudt, and later still the Assistant Secretary of the Army (R&D), Norman R. Augustine, visited the Natick Development Center and made their independent judgments."

Secretary Callaway requested an ad hoc group of the Army Scientific Advisory Panel to make a study of food irradiation and report to him on the potential of these foods for the Army and the world; also, what steps can be taken to shorten time required to obtain FDA and USDA approval.

Based on findings of the ad hoc group, COL Lester said, Secretary Callaway has decided to accelerate his planned program by starting wholesomeness testing as soon as possible—not later than the spring of 1976—of irradiation-sterilized chicken, pork and ham without waiting for completion of the ongoing wholesomeness study of irradiated beef.

Selection of these meat items, it was explained, is in line with the recommendation of the National Research Council's Committee on Food Irradiation and by its parent advisory board on military personnel supplies. Choice of beef, pork and chicken is based on the rationale that they are the three major warm-blooded animal foods in the diet of North Americans. Ham is a representative cured meat product.

Economic studies indicate that when the FDA and USDA approve irradiation-sterilized beef, chicken, pork and ham, the food industry should have a broad enough spectrum of foods that can be processed at a cost of five to nine cents a pound to make it attractive to produce and market them.

COL Lester said that these irradiation-sterilized foods "come very close in quality and sensory characteristics to unprocessed foods. The process also will make it possible to produce and market a variety of shelf-stable products not possible by the other established food preservation methods."

Among the unique characteristics of radiation sterilization he cited are dry-pack of the containers—no can purge during processing—use of a wide range in sizes of containers, portion control packaging, and assurance of safety from toxicity by clostridium botulinum and other food-borne pathogens.

The process should permit reduction or, in some instances, elimination of certain chemical food additives that are a source of increasing concern because of research indications that some may be contributive to cancer.

Experiments at the NDC have shown that irradiation destroys clostridia, thereby reducing the need for nitrite as an additive by "at least 83 percent." Some nitrite currently is essential for the cured meat flavor and fresh looking color.

In conclusion, COL Lester said: "We look to the private sector to bring the benefits of food irradiation not only to the military but to the civilian community as well. After the approvals have been obtained from FDA and USDA, the Army will provide its expertise and expedite technology transfer to those who plan to produce and sell irradiation-processed foods."

National Institute of Education Outlines Program Goals, Budget

Among key 1976 program goals of the National Institute of Education are: to disseminate and foster utilization of R&D products and practices in public schools; and to seek solutions to education and work problems involving basic skills development, finance, productivity and management, and educational equity.

The National Institute of Education will devote nearly one-quarter of its $80-million FY 76 budget to the dissemination of research results. This action is prompted by recent Congressional criticism of the NIE for failure to produce more dramatic improvements in U.S. education.

ECOM Realigns Communications/ADP Laboratory

COL D. R. Lasher

Functional realignments within one of the U.S. Army Electronic Command's two principal R&D units, the Communications / Automatic Data Processing Laboratory (CADPL), was announced as the *Army R&D Newsmagazine* staff was sending this edition to the printer.

The laboratory is now functioning within two substructures, a Center for Tactical Computer Sciences (CENTACS) and a Center for Communications Sciences (CENCOMS). The realignment separates the automatic data processing functions of the laboratory from its communications R&D activities.

Directed by the U.S. Army Materiel Command, ECOM's parent command, the changes are explained as a "decisive recognition of the growing role of computers in the defense arsenal."

CADPL Commander and Director COL Donald R. Lasher explained: "ADP systems in the Army are essential to the whole broad spectrum of combat operations and support, ranging from the handling of data pertinent to artillery control and intelligence functions—on through the filing, storing, sorting, summing and display of information incident to command decision." He also cited the "enormous quantities of information involved in personal administration and logistics."

Establishment of the Army Materiel Command Office of the Project Manager for Army Tactical Data Systems at Fort Monmouth in 1971 was an influencing factor in the activation of CENTACS. The PM for ARTADS has line authority for development, production and fielding of computer systems applicable to tactical situation requirements.

The new CENTACS organization directs attention to the ADP system concept, emphasizing computer software engineering and acquisition, along with expansion of services to AMC elements.

A Teleprocessing Design Center incorporated in CENTACS will serve as a "systems test bed" for tactical ADP experimentation and validation. An example is that of response to requirements for the tactical fire direction system known as TACFIRE, which is under the project manager for ARTADS.

Included in CENTACS' mission is the development of new and improved computer software and ADP system components—memories, displays, and input-output devices for tactical data systems, including TACFIRE.

CENTACS Director LTC Alan B. Salisbury is a 1958 graduate of the Military Academy and holder of a master's degree and doctorate in electrical engineering and computer sciences from Stanford University.

In addition to the broad Army tactical functions, he said that the number of combat disciplines made more effective by the use of computers is increasing.

"Systems of weaponry, surveillance, target acquisition, avionics and switching grow increasingly sophisticated and complex," he explained. "It would be hard now to name any function on the battlefield, technical or clerical, broad or single-purpose, that will not be computer-controlled in some way. And the surface has barely been scratched."

CENCOMS is headed by Rudolph C. Riehs. It combines remaining COMM/ADP Laboratory technical areas that conduct R&D related radio, telephonic, telegraphic and facsimile communications, security, electromagnetic compatibility, and processes. Serving also as deputy to COL Lasher, Riehs has a master's degree in electrical engineering from Rutgers and has worked in Army communications R&D at Fort Monmouth since 1940.

Riehs is a senior member of the Institute of Electrical and Electronics Engineers, and has served on IEEE professional groups and technical committees. His publications are numerous and include a chapter in *Miniaturization* (Reinhold Publishing, 1961) and a chapter on communications in *Handbook of Astronautical Engineering* (McGraw-Hill, 1961).

COL Lasher, head of the Communications/Automatic Data Processing Laboratory since last August, is a 1952 U.S. Military Academy graduate, has a master's degree in data processing from Stanford University, and since 1958 has had several command assignments involved with ADP developments.

3 APG Personnel Receive Annual Honorary Awards

Three personnel assigned to the Materiel Testing Directorate (MTD), U.S. Army Aberdeen (MD) Proving Ground, are recent recipients of annual honorary awards recognizing outstanding contributions to the MTD mission.

Cecil E. Martin, a mechanical engineer in the Armor Branch, Automotive and Armor Division, received the Director's Award for "an outstanding level of technical achievement in testing of the XM800 armored reconnaissance vehicle and manned target tanks."

MSG John Kaminky was presented with the Crozier Award, memorializing former Chief of Ordnance MG William Crozier. MSG Kaminky was credited for his work on the self-contained pressure gauge, gated television, digital theodolite system, and advanced data collection concepts.

Cornelius W. Wilson Jr., an artillery repairman with MTD's Weapons Processing Section, won the Groak Award for servicing, maintenance and overhauling industrial shop equipment.

Established in 1969, the Groak Award honors the late George Groak, former MTD employe credited with enhancing the reputation of APG's technicians.

Simulators Compare Armored Cavalry Capabilities

Two computer-operated electronic systems were used recently to compare firepower of a conceptual armored cavalry platoon with the standard AC platoon in a realistic combat situation at Modern Army Selected Systems Test, Evaluation and Review (MASSTER), Fort Hood, TX.

Test officers at MASSTER have long recognized realism in simulated combat as an elusive goal in Army exercises, because actions have been based primarily on human judgment.

"Now the computer-operated electronic systems will enable our test officers to assess relative firepower in the most realistic situation we can conceive," said LTC R. D. Kittelson, MASSTER project officer for the tests.

Designed to operate independently or in conjunction with each other, the two computer systems—the Positioning Reporting Recording System (PRRS) and the Automatic Data Collection System (ADCS)—have been used for a year in other tests at MASSTER.

The PRRS uses small transmitters that can be carried on a man's back or mounted on a vehicle. Towers around the Fort Hood reservation pick up signals from the transmitters and relay the information to the computer, pinpointing location of each transmitter to within a few meters.

The ADCS is used by an observer to enter specific information about a combat engagement. For example, an observer might enter on his ADCS keyboard, "Tank No. 43 fired at Tank No. 29 with a 105mm armor-piercing shell." As this information is received by the computer, it also notes the exact second of engagement.

The computer takes the PRRS report and the ADCS action and determines if the tank was hit or missed. This is done by determining the distance between the two tanks involved, and by using an established table of probabilities to determine what damage could be caused at that distance by a particular shell.

This phase of the computer program is part of another data system that has not yet been accepted by the Army—the Weapons Engagement Scoring System, designed to use smoke and flashing lights to indicate when a vehicle has been "hit" by a tank or other weapon using an eye-safe laser as part of the exercise.

Sophisticated computer programing also takes into account countermeasures that the target tank might employ. For example, some antitank guided missiles take several seconds to reach their target; if the target tank can locate his attacker and counterfire in time, it may be able to avoid being hit.

All this computer action, plus the final report of "hit" or "miss" can take as little as three seconds, which is about the time used on an actual battlefield when a tank fires at a target. Thus, test officers can evaluate actions with more accuracy than human judgment permits.

The conceptual AC platoon is based on years of study and recommendations by MASSTER, the U.S. Army Armor Center at Fort Knox, KY, and other Army research agencies. The standard AC platoon has a mixture of M–551 Sheridan armored reconnaissance vehicles and M–113A1 armored personnel carriers (APCs). The conceptual platoon is built around four M–60A1 tanks, five APCs and several motorbikes.

"In terms of combat capabilities, we expect and predict the conceptual platoon will have more firepower because of the main battle tanks, better protection against enemy tanks, and an additional capability in maneuverability and speed, because of the use of motorbikes as scouts and messengers," said LTC Kittelson.

Results of the test may serve as a basis for a decision by the Department of the Army to reorganize the existing AC platoons. AC tactics also are under study in MASSTER tests. LTC Kittelson said tactics have been refined to employ present U.S. technology and to take into account an enemy capability to use antitank guided missiles. Tests have been conducted in day and night operations to assess comparative effectiveness.

SPECIAL ANTENNA is mounted on armored personnel carrier for use in a test at Modern Army Selected Systems Test, Evaluation and Review (MASSTER), Fort Hood, TX. The antenna and related electronic gear will report the vehicle's exact location to a central computer to provide accurate data on the exercises. The MASSTER test was designed to examine armored cavalry organizations with men and equipment of the 1st Cavalry Division.

Joint Research Team Concludes Skin Disease Study

Development of new diagnostic culture techniques for fungus and bacterial skin diseases was the objective of a field study concluded recently by a joint U.S. Army/University of Miami (FL) research team.

The work was carried out in Colombia, South America, by five epidemiologists, three from the Letterman Army Institute of Research (LAIR), San Francisco, CA, and two from the University of Miami School of Medicine.

LAIR participants were COL Alfred M. Allen, MC, chief, Cutaneous Protection Division, Department of Dermatology Research, CPT Robert D. King, microbiologist, and Judith Ritchie, research assistant.

University of Miami researchers were David Taplin, associate professor, Departments of Epidemiology and Dermatology, and Patricia M. Mertz, research associate in dermatology. COL Allen and Prof. Taplin worked on similar field studies begun during the Vietnam conflict (reported in the July–August 1973 *Army R&D Newsmagazine*).

Colombia was selected for the recent research project because it contains a diverse composition of geographical and climatic conditions. Included are sea-level swamps, temperature highlands, and the towering Andes Mountains. Another favorable factor was that the Colombian Army had personnel staffed in all of these zones.

The conscriptive status of the troops provided the research team with an ideal sampling of the over-all Colombian population. Investigators were able to procure data on the relationship of environment to the health of men with widely divergent backgrounds.

Approximately 1,500 persons were examined and surveyed during the 6-week expedition. Data were gathered on the nature of infections, the environment from which the victims came, how long they had been at the present site, and ohter epidemiological factors. More than 10,000 bacterial cultures were processed by the research team.

One of the findings was among the troops stationed in Bogota (elevation 8,660 feet), there was less skin disease than among U.S. Army troops at Fort Benning, GA. However, in one hot, humid Colombian area, 67 percent of the men suffered from ringworm—more ringworm than had been seen anywhere by the researchers.

Part of the project was to reach areas where there were no diagnostic facilities. Ultimately, the team will attempt to provide a global profile of hazards—what diseases are where, who gets them and why they become endemic? This objective has been achieved partially in Ugunda, Nigeria, Venezuela, Panama.

This type of global reference system is of particular importance in Latin America because large areas of the hinterlands are now being opened to exploitation for the first time as the result of new road construction and use of air transportation. It is believed that large populations will inhabit areas where only Indian tribes now live.

R & D NEWS

AMC/TRADOC Assessing Contingency Operations Container Handling

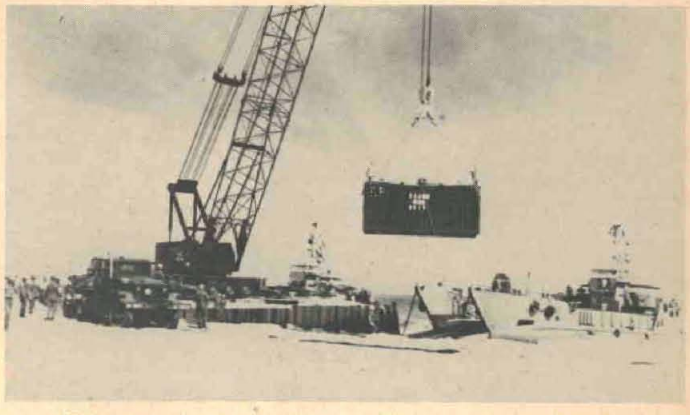
Intent upon meeting changing requirements of providing theater commanders with an effective capability to load and unload large shipping containers in contingency operations, the U.S. Army Training and Doctrine Command and the U.S. Army Materiel Command are evaluating CHITO.

CHITO denotes Container Handling in Terminal Operations, a study growing out of the commercial maritime industry's replacement of a relatively large number of break-bulk ships by a small number of large, fast container ships. The objective is to select, procure and test necessary equipment, and train a terminal company to use it.

Most of the new container ships do not have cranes aboard for loading/unloading. Therefore, the U.S. Army Transportation School, one of the U.S. Army Logistics Center's (LOGC) associated schools, has developed the Terminal Service Company (Container) to load and unload container ships at points that do not have shore-based container cranes for use in combat situations.

The Terminal Service Company must have its own handling equipment for these situations. This equipment is expensive and, with the current austere funding for the Army, it is uncertain whether equipment required for the Terminal Service Companies should be purchased in the near future.

LOGC has proposed that the minimum items required for successful training and evaluation of one Terminal Service Company be procured under the program, as soon as possible.



LCUs, beached on each side of jetty, are unloaded by crane

Required equipment includes a 250-ton capacity crane with a 70-foot boom and an 18-foot radius of operation (horizontal distance from the centerline of rotation to a vertical line through the center of gravity of the load).

This capacity may seem excessive when the heaviest container will weigh only about 33.6 tons, but as the radius of operation (and boom length) increases, the lift capacity of the crane decreases. When unloading container ships, the crane will be operating with a 150-foot boom at a radius of 100 feet.

The other required crane has a 140-ton capacity (34 tons at 40-foot operating radius), and will be used aboard container ships that do not have an integral crane. It will move from cell-to-cell and hatch-to-hatch under its own power, through the use of deck reinforcement matting and wooden bridging.

At least three sideloader container handlers are required as items of equipment for CHITO training and evaluation, and 12 are proposed for the Terminal Service Company when operating at a fixed port.

The sideloader, which can handle containers up to 40 feet in length and weighing up to 67,000 pounds, will be used to move containers away from the dock to a nearby marshalling area. When the area is far removed from the dock, the sideloader is used to load yard trailers, stack containers, and load containers on over-the-road trailers for delivery to using units.

The sideloader can be fitted with forks and used to handle items such as pipe, lumber, poles, structural steel, etc. It does not have a rough-terrain capability, and therefore is limited to operating on improved surfaces.

When the Terminal Service Company is involved in a Logistics-Over-The-Shore (LOTS) operation, under close-support combat situations, the sideloaders are replaced by 50,000-pound capacity rough-terrain forklift trucks equipped with a toplift container attachment.

Additional items of equipment required by the Terminal Service Company are 4,000- and 10,000-pound rough-terrain forklift trucks, mobile ramps, yard-type truck tractors, and 34-ton semitrailer container transporters.

Although CHITO is aimed primarily at training, it also will serve to evaluate various items of equipment and personnel in the Container Terminal Service Company. Some forklift trucks are now on hand at Fort Eustis, VA, where the company will train. The minimum items required should be available by January 1976.

The current Terminal Service Company for break-bulk operation consists of 325 personnel and a capability to handle 1,000 short-tons/day. The proposed TSC(C) will have 262 persons and a capability of unloading 720 containers/day in a fixed port.

Assuming that each container weighs 13 tons (a conservative estimate), this equates to 9,360 short-tons/day. This capability to unload large tonnages quickly accounts for the growth of the container industry, and its success is due to the special materials/container handling equipment used.

AMCLO Integrates RDT&E Efforts

Coordination and integration of U.S. Army and U.S. Navy research, development, test and evaluation activities regarding air warfare and missile systems technology is the function of the U.S. Army Materiel Command Liaison Office (AMCLO), Naval Weapons Center (NAVWPNCEN), China Lake, CA.

AMCLO operational responsibility, involving other U.S. Army agency requests for assistance, is assigned to LTC Richard F. Boyd who reported to China Lake in 1972 following a tour as commander of the 120th Aviation Co., Vietnam. Progress reports on evolving technologies are prepared quarterly.

Army agencies requesting information on Navy programs generally direct their inquiries to a specific technology rather than a total weapon system. The AMCLO is the focal point for information exchange among all AMC agencies interested in NAVWPNCEN programs.

Areas of mutual Army-Navy interest have included Helicopter Fire Control, IR Suppression Studies, Fuel Air Explosives, Chaparral (missile system) Improvements, Stinger (missile) Guidance Systems, Hellfire Missile Technology, Anti-Materiel Weapon (APAM), and Aircraft Survivability.

NAVWPNCEN "in-house" facilities advantageously located for achievement of the AMCLO mission are the Naval Air Facility, Guided Missile Ranges, Exterior Ballistics Range, Terminal Ballistics Range, Electronic Warfare Range, Fuze Test Range, Supersonic Test Tracks, Aircraft Weapon System Test Range, Explosive and Propulsion Research and Development Laboratories, Aircraft Survivability Facility, Solid State Physics Facility, and the Microwave Anechoic Facilities.

AMC Liaison Officer LTC R. F. Boyd (far right) with RAdm R. G. Freeman III (third from left), NAVWPNCEN commander, and staff members (l. to r.) Dr. G. L. Hollingsworth, technical director; LeRoy Riggs, head of the Resources/Technology Office; CPT R. D. Franke, deputy commander; and F. H. Knemeyer, head of the Systems Acquisition Office.

TACOM Demonstrates New Tracked/Wheeled Tactical Test Vehicle

Development and successful operation of a high-mobility test rig, convertible as a wheeled or tracked tactical vehicle to carry a ¾-ton cargo in a variety of terrains and climates, was announced recently by the U.S. Army Tank-Automotive Command, Warren, MI.

The TACOM Systems Division and Engineering Support Division, Research, Development and Engineering Directorate, reported that the vehicle is capable of cross-country travel at maximum speeds of 55 mph in the wheeled and 35 mph in the tracked mode.

Powered by a Ford 289-cubic-inch engine, the rig has a 3-speed automatic transmission, and is 126 inches long and 74 inches wide. It weighs 5,600 pounds with wheels and 6,700 pounds with tracks.

All eight wheels are gear-driven and the vehicle is controlled by "skid-steering," the method used for tracked vehicles. The driver turns by reducing speed of the wheels (or tracks) on one side of the vehicle.

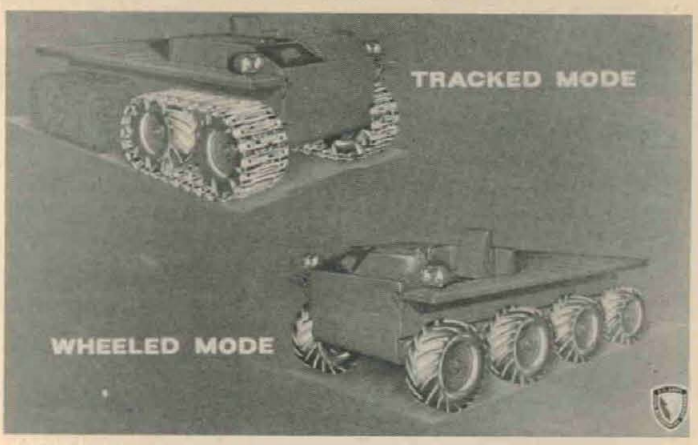
Converting the vehicle to the tracked mode is accomplished by installing four band-tracks, each fitted around two tires. Designed for soft soil and snow, the steel-reinforced rubber bands are bolted to all-steel track shoes. Two raised lugs on each shoe mesh with the tire tread to eliminate slippage. Three men can convert the test rig from wheels to tracks in less than an hour.

Assembly of the test rig was completed following more than six years of concept development work. The vehicle then underwent extensive performance tests at the Keweenaw Field Station, Houghton, MI, and the Waterways Experiment Station (WES), Vicksburg, MS.

Philip Meengs, project engineer, said test results showed that the concept is feasible, no slippage occurred between the tracks and tires, and that the integrated drive and suspension system "performed very well."

Observers were impressed by the skid-steer handling characteristics in both the wheeled and track modes. Investigators had no previous experience with skid-steering on a wheeled vehicle.

Meengs explained that although no formal Army requirement exists for such a convertible wheel-track vehicle, several needs have been expressed by segments of the Army and the Air Force. The U.S. Army, Alaska, for example, wants a squad-subsistence load-carrying vehicle capable of operating on wheels or tracks. The Air Force, he said, has expressed interest in the vehicle to provide perimeter security at remote airfields.



WHEEL/TRACK convertible test rig was developed at the U.S. Army Tank-Automotive Command, Warren, MI, to operate on soft soil, snow and hard-surfaced roads.

Meengs said that while performance requirements for a wheel-track vehicle operating in Alaska would be somewhat different than for an airport security role, the "over-all payload requirements would be quite similar. . . . We are attempting to come up with a vehicle that will provide varying degrees of mobility. . . ."

Meengs pointed out that although the vehicle is intended for use with either wheels or tracks, it is being designed to operate at a cost close to that of a conventional tactical wheeled vehicle of comparable size. Several modifications are being made at TACOM to improve the vehicle's handling, after which it will undergo a series of checkout tests for comparison with results observed during the 1973 tests.

Microwave Energy Aids Chemicals Purification

Microwave energy in the form of a discharge plasma is being considered as a new method of converting highly toxic chemicals into harmless substances, based on research at Aberdeen Proving Ground (APG), MD.

Dr. Leonard A. Jonas, a research scientist in the Chemical Laboratory, provided technical guidance and helped monitor a contract program with the Lockheed Corp. Palo Alto (CA) Research Laboratory. He coauthored a technical paper, "Microwave Decomposition of Toxic Vapor Simulants," with Lionel J. Barlin and Merle E. Sibert of Lockheed, and Alexis T. Bell of the University of California at Berkeley.

Results of the research are reported in a recent issue of *Environmental Science and Technology*, a publication of the American Chemical Society.

Plasmas are electrically charged energetic gases created when the microwaves break off electrons from simple substances like argon, helium, oxygen or nitrogen, which researchers place in a narrow quartz tube.

In the process under investigation, a toxic gas simulant is pumped through the tube. Free electrons in the plasma collide with gas molecules, breaking them apart. The particles are then reconstituted as molecules of a substance that experimentally has proved nontoxic.

Dr. Leonard A. Jonas

The research team plans to test the method on more toxic materials. Dr. Jonas says the use of microwave energy could prove easier and less costly than incineration of toxic substances, and could lead to new commercial equipment.

Department of Defense Revises Civilian Health Services Policy

Changes resulting from a 2-year management improvement study of the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) were announced recently by the Department of Defense.

Adjustments to bring expenditures under control include elimination of coverage for perceptual and visual training. Air ambulance service is limited to cases where a physician certifies that such service is necessary for preservation of life or limb.

Dental care is restricted to instances where clinical evidence establishes that an oral disease is significantly complicating a medical condition other than that associated with the teeth or supporting structures. Outpatient cost-sharing rules will apply to dental care adjunctive to pregnancy.

Services of therapists will require certification of need by an attending physician and recertification at least once every 30 days. Other changes include a fee for licensed or certified professional psychologist services, cost-sharing for surgery in ambulatory surgical centers, restrictions on long-term care and handicapped claims, and on care for which Veterans Administration benefits apply.

SAM-D Electronic Warfare Capabilities Assessed

Complete electronic warfare assessment of the Surface-to-Air Missile Development (SAM–D) is the objective of a new program at the Electronic Warfare Laboratory, U.S. Army Electronics Command, Fort Monmouth, NJ.

The SAM–D system employs state-of-the-art concepts in many of its components and the EWL, an element of the Office of Missile Electronic Warfare (MEW), has inventoried modern threat-oriented countermeasure devices to test capabilities of the system.

One of the test devices is a transmitter which is a full-threat-level jammer configured specifically to exercise the complete range of electronic counter-countermeasure capabilities of SAM–D. A central console enables the operator to "dial-in" jamming sequences as required by the test scenario.

The device is expected to be installed in a modified Air Force NKC–135A airborne platform, designed for precise experiments in electronic warfare R&D. Nicknamed "Big Crow," it is capable of creating electronic countermeasure environments for the susceptibility/vulnerability analysis of missile and missile support systems previously unavailable from a single platform. Five R&D stations can be configured with specialized EW units such as the countermeasure test transmitter.

Standard electronic countermeasure devices are carried routinely on board and may be interchanged with others to expand and/or concentrate capabilities according to mission requirements. A total of 10 of these systems may be utilized at one time. Two modified ANALE–32 chaff dispensers are available to aid in the evaluation of chaff rejection capabilities of SAM–D.

A data acquisition station permits tape recording the user's analog and digital data requirements, and correlation of his data on this system with on-board inertial navigation data and synchronized timing data as required.

A family of pod-mounted jammers designed for supersonic flight provides EW capability beyond that of Big Crow and the project-related electronic countermeasure devices on board. Operated as self-screening jammers in both barrage and deceptive modes, carried on either manned or drone aircraft, the devices exhibit flight and tactical characteristics like those hostile aircraft penetrating the defended zone for SAM–D.

ECOM researchers say the total EW capability developed in the MEW program for assessment of the SAM–D electronic counter-countermeasure capability represents the most severe electronic warfare threat yet employed in the development of air defense systems.

"BIG CROW" electronic warfare (EW) laboratory is being modified for use in the EW assessment program for the Army's SAM-D system. Antennas for the full complement of EW equipment aboard the plane are in the oblong radomes above and below the fuselage and the bulbous radome on the nose.

TACOM Aims at RDT&E Savings in Truck Purchase

What is believed the largest U.S. Government contract ever awarded for standard commercial vehicles intended for use in tactical applications was announced recently by the Army Tank-Automotive Command.

Based on recommendations of the Special Analysis of Wheeled Vehicles (WHEELS) Study established in February 1972 under chairmanship of the Assistant Vice Chief of Staff, to provide a more cost-effective means of meeting military vehicle requirements, Chrysler Corp. will receive $145.7 million for 33,759 Dodge 1¼-ton trucks.

Programed to replace the Army's current fleet of ¾-ton and 1¼-ton vehicles, the standard "off-the-shelf" models are expected to save a billion dollars—over the next few years during replacement of about 400,000 special vehicles—by minimizing the need for costly and time-consuming test and evaluation procedures.

The Army vehicle fleet of about 600,000 trucks and trailers consumes almost 6 percent of the Army's budget in terms of acquisition and support costs. Some 50,000 commercial vehicles are in the Army inventory, few have been used in tactical conditions. About 4,000 of the new vehicles will be ambulances.

Purchased at a unit price of $3,825.16 —about $1,400 less than the suggested retail price without some of the extras ordered by the Army—each vehicle will be equipped with 318-cubic-inch engines, automatic transmissions, steel-belted radial tires, maintenance-free batteries, rustproofing, and Army-green paint. The vehicles will have a 12,000-mile or 12-month warranty and most repairs are expected to be made by Dodge dealers.

Several options available for installation on the vehicles include 24-volt, 60-ampere and 100-ampere electrical and electronic kits, and arctic kits. The manufacturer's warranty will be extended an additional three months for each vehicle equipped with these kits.

Initial delivery of 20 trucks has been scheduled for the spring of 1975 with the remaining 33,739 to be provided during 1976 and 1977.

There were three other bidders: Chevrolet Division of General Motors, $150.5 million; AM General, $170.5 million, and Ford Motor Co., $188.7 million.

Army OKs Initial Production Of Missile Minder Systems

Production of the initial first four units of the AN/TSQ–73 Missile Minder, a new command and control system for coordinating fire power of the Hawk and Nike Hercules surface-to-air missile systems, was recently approved by the Army.

Scheduled for delivery beginning in August 1976, the highly automated Missile Minder will fulfill the Army requirement for a reliable control and coordination system, capable of interfacing with appropriate systems within the Army as well as systems of other services. It will replace the AN/MSG–4 Missile Monitor system currently deployed with the field Army.

Over-all acquisition of the new system is being managed by the project manager, Army Tactical Data Systems (ARTADS), Fort Monmouth, NJ. Development, production and logistical support responsibilities for the system have been delegated to the ARTADS field activity located at the Army Missile Command, Redstone Arsenal, AL.

Missile Minder is one of a family of computer-based, highly automated systems being developed to evaluate and present graphically the fluid battlefield situation to tactical commanders for immediate response to enemy threats.

ROTC Hall of Fame Inducts Former SASA Commander

Walter E. Rafert, commander of the Small Arms Systems Agency at Rock Island Arsenal, IL, until he retired as a colonel in 1970, was inducted recently into Purdue University's Army Reserve Officer Training Corps' Hall of Fame of Distinguished Alumni.

Serving currently as director of the Systems Application Engineering Division, Rodman Laboratories at Rock Island Arsenal, Rafert graduated from Purdue University in 1943. During a 28-year military career, he served a tour of duty as deputy director, Developments, Office of the Chief of Research and Development, now the Office of the Deputy Chief of Staff for Research, Development and Acquisition, Department of the Army.

Established in 1974, the Purdue University ROTC Hall of Fame honors alumni for achievements of particular distinction. This year's honorees were selected from alumni who graduated between 1921 and 1950.

M60A1 main battle tank, equipped with a deep-water fording kit, is shown during testing maneuvers by U.S. Army Armor Engineer Board, Fort Knox, KY.

AMC/Industry Meet . . .

Stresses Improved Independent R&D Cooperation

NATIONAL CAPITAL AREA Army/Industry Conference participants shown during coffee break are (left to right) BG Frank P. Clarke, TRADOC; BG Harry A. Griffith, HQ AMC host and presiding chairman; Robert E. Bell, General Electric Co.; COL W. B. Burdeshaw, TRADOC; and Francis A. Hinchion, Raytheon Co.

National Capital Area representatives of major industries convened Apr. 18 at HQ U.S. Army Materiel Command, Alexandria, VA, by invitation of AMC Director of Research, Development and Engineering BG Harry A. Griffith.

More than 80 industrial representatives focused attention on how they can —when kept continuously informed of changing Army requirements for new weapon systems or product improvement of existing materiel—engage in more cooperative, independent R&D programs related to military objectives.

In view of continuing inflation of R&D costs and materiel acquisition, along with austerity R&D funding, the Army is increasingly more dependent on industry to assume part of the burden of obtaining a better return on investment (ROI).

BG Griffith, in his opening remarks, emphasized the desire of AMC Commander GEN John R. Deane Jr. to improve Army/industry communications on matters of mutual interest. His topic was "Changes in R&D Management."

BG Griffith said one of the major problem areas in Army/industry relations is duplication of effort during the materiel development test phase. "Army adoption of a Single Integrated Development Test Cycle, and Test Integrated Working Groups," he said, "are the keys to elimination of much duplication."

Frequently he referred to recommendations of the Army Materiel Acquisition Review Committee (AMARC), and discussions of problem areas and corrective actions developed during the Atlanta I and Atlanta II Army/industry conferences.

TRADOC (Training and Doctrine Command) representatives included BG Frank P. Clarke, assistant deputy chief of staff for Combat Developments, and COL W. B. Burdeshaw, chief of the Combat Developments Planning Group, Fort Monroe, VA.

BG Clarke served on a panel that included BG Griffith (chairman), Roy D. Greene as acting chief of the AMC RD&E Plans and Programs Division, William A. Simcox of the Electronic Industries Association, Francis A. Hinchion of Raytheon Co., D. Max Heller of Martin Marietta Aerospace Co., and Elliott B. Harwood of Boeing Co. The panel responded to questions from industry representatives and AMC RD&E Division chiefs.

Speaking on "Development of Army Requirements," COL Burdeshaw related TRADOC's role to that of materiel using agencies and commands in the development cycle. His presentation covered improved training, doctrine and materiel objectives, ground suppression of enemy forces, a combined arms team concept, cost-effective ammunition, lessons learned from the Mideast conflict, and the Vietnam conflict aftermath.

COL Frank J. Palermo Jr., chairman of the Army Materiel Command Ad Hoc Study Group for Technical Assessment, made a presentation of "Systems Assessment of the RDT&E Program." He described R&D capabilities and shortcomings versus FY 1975-76 requirements.

In addition to serving on the Panel, Roy D. Greene, whose regular AMC assignment is chief of the Programs Branch, spoke on "The Research, Development, Test and Engineering Budget, Comparison/Trends."

Industrial representatives were given a questionnaire at the conclusion of the meeting that will enable them to submit their views on whether periodic Army-industry conferences should be continued, the worth of such discussions, topics for future meetings, utilization of the Defense Documentation Center, "Have you submitted Unsolicited Proposals to AMC?" and "What recommendations do you have to improve the flow of R&D information to industry?"

MICV Prototypes Undergo TACOM Development Tests

Mechanized Infantry Combat Vehicle prototypes accepted by the U.S. Army Materiel Command project manager for MICV are being evaluated in development tests at the contractor's plant in Warren, MI, near headquarters of the Army Tank-Automotive Command.

The MICV is programed as the eventual replacement for M113 Armored Personnel Carriers used in a combat role. Prior to manufacture of a preproduction model, 10 prototype MICVs will be provided on an incremental basis for the development tests. Production is scheduled to begin in 1978.

Capable of traveling over smooth terrain at speeds exceeding 45 miles an hour, MICV will permit an infantry squad to fight from six ballistic-proof windows and firing ports. Armed with a 20mm automatic cannon, the MICV has a stabilized weapon system that includes a 7.62mm machinegun and six 45-caliber submachineguns. A gunner can fire while on the move, a capability common to the M60A3 and M60A2 tanks and the M551 Sheridan tank.

MICV developmental efforts began in 1964, resulting in five pilot vehicles built by Pacific Car and Foundry Co. This design did not go into production but was used as a baseline for the MICV.

Following extended feasibility studies, the FMC Corp. was awarded an engineering development/producibility engineering planning contract in 1972.

Edgewood Arsenal Expands Interdisciplinary Board

Expansion of the Edgewood Arsenal Interdisciplinary Board from 7 to 11 members, announced recently, provides a broader cross-sectional representation of major R&D labs and directorates.

Established by Dr. B. L. Harris, Edgewood Arsenal technical director, the board functions to improve communications among scientists and engineers while opening a direct line of contact to the technical director's office.

Open communication has enabled the board to make recommendations for establishing a system of awards which are presented for the best technical papers at semiannual conferences.

Don Bowie, a researcher in the Chemical Laboratory, is board chairman. Other members are Walter Arbogast, secretary, Jacqueline M. Eskow, Foy E. Ferguson, Lawrence D. Whiting, Edward A. Coale, David P. LaBar, CPT John R. Lowe, Allen W. Shatto, Patricia Silsby and Eugene A. Martino.

Aircraft Identification Study

Visual proficiency in recognizing military aircraft will be examined by the Human Resources Research Organization (HumRRO)) under a 19-month contract awarded recently by the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI).

Code-named ALERT, the project will serve as the basis for a program of research on over-all air defense problems. Studies will focus on current Army training and test methods, and estimating the "saturation level" for learning recognition techniques.

Recognition accuracy will be measured in a static 2-dimensional-target test situation, and in a moving, 3-dimensional-test situation.

Achievements Cited at 11th USACC Anniversary Observance

Relatively few people in the world holding top executive positions are inclined to consider or classify 1974 as "a good year," but the commander of the U.S. Army Communications Command took the occasion of USACC's 11th anniversary to join that select group.

MG Jack A. Albright noted the progress of his command during 1974 in expanding and improving its global communications responsibilities and, without reservations, said "it was a good year." He cited achievements in communications planning, consolidation and automation, logistics support, air traffic control, and financial and resources management.

Organized into 13 subordinate commands, USACC has about 30,000 military and civilian personnel tasked with managing, engineering, testing, installing and operating worldwide communications systems.

The mission includes the Defense Communications System (DCS), and similar networks for the Defense Civil Preparedness Agency, U.S. Army forces above corps level in the Continental U.S. and abroad, the Military Traffic Management Command, and the U.S. Army Health Services Command.

Three major operations and maintenance commands are the USACC CONUS, Fort Ritchie, MD; the 5th Signal Command, Worms, Germany; and the 6th Signal Command, Fort Shafter, HI. CONUS communications serve the U.S., Hawaii, Alaska and the Panama Canal Zone.

Service areas of the 5th Signal Command include Europe and the Middle East. The 6th Command operates from Hawaii westward across the Pacific and throughout the Far East.

Collocated at HQ ACC are the Communications Electronics Engineering Installation; Safeguard Communications Agency; 11th Signal Group; Army Commercial Communications Office; Air Traffic Control Activity; Communications Management Systems; and HQ Fort Huachuca.

Additional support is provided by the U.S. Army Communications Systems Agency, Fort Monmouth, NJ; the U.S. Army Interagency Communications Agency, Winchester, VA; and the ACC Criminal Investigation Command Agency.

Among progressive activities during 1974 listed by MG Albright are:

Communications Planning. In August 1974, ACC published a non-DCS, nontactical system improvement plan which consolidates communications-electronics requirements and identifies desired resources.

The U.S. Army Commercial Communications Office was established as a headquarters field activity. It will manage on a worldwide scale all Army leased communications facilities and be responsible for 32 percent of ACC's O&M budget.

Consolidation and Automation. The command's 5-year Army Telecommunications Automation Program (ATCAP) is responsible for standardization of all automated telecommunications centers. One such approach is the Automated Multi Media Exchange (AMME). The first AMME was activated in October 1974 and installation of 23 additional AMMEs in CONUS and four abroad is planned.

Logistics Management Information System (LOGMIS) provides a data base for identifying and locating all command equipment assets worldwide. The system also reports on equipment support capabilities.

Air Traffic Control. Obsolete and nonstandard equipment is being phased out and replaced with current state-of-the-art systems. Typical is a new automated radar terminal at Fort Rucker, AL. Similar systems are being installed at Fort Hood, TX, and Fort Sill, OK.

Financial Management. A mathematical computer is being utilized to determine the most cost-effective approach to the Defense Satellite Communications System. More than $19 million cost avoidance was identified in one such application to on-site spare parts provisioning.

Personnel Resources. The USACC was cited by the Army Chief of Staff for having one of the highest reenlistment rates in the Army. During 1974 the command doubled its female enlisted force with opportunities extended into microwave system repair, dial central office repair, and technical controller.

MG Neel Traces Health Services Command Goals

Improved management of resources and organizational realignments were among topics MG Spurgeon Neel, commander, U.S. Army Health Services Command, discussed at recent ceremonies marking the HSC second anniversary.

Addressing about 150 retired Army Medical Corps officers, MG Neel highlighted HSC achievements. "Since HSC is not a deployable force," he said, "there is a constant need for planning and organizing to maintain its health care goals."

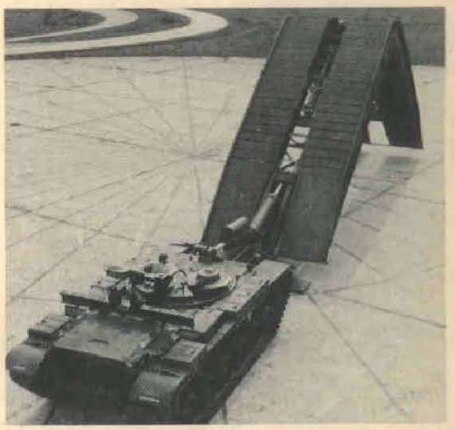
Successes cited by MG Neel included HSC's Ambulatory Patient Care Program, greater use of medical support personnel to relieve physician workloads, and mutual utilization and modular training support of Reserve Component medical health care personnel on a year-round basis.

MG Neel, who has headed HSC since its inception on Apr. 1, 1973, also noted expansion of health delivery systems which include Tripler Army Medical Center (MEDCEN), Hawaii, and U.S. Army Medical Department activities (MEDDAC) in Alaska and the Panama Canal Zone.

TACOM Commander Twice Cited For Outstanding Brotherhood

MG Joseph E. Pieklick, commander, U.S. Army Tank-Automotive Command (TACOM), Warren, MI, has been cited in two separate actions by the Michigan State Legislature and the City of Detroit for his efforts on behalf of brotherhood.

He was credited with pioneering TACOM's Upward Mobility Program which resulted in numerous promotions for minority personnel. Additionally, "he took an active role in encouraging worthwhile activities including Black History Week, Brotherhood Week, and the Martin Luther King Birthday Celebration."



AVLB (Armored Vehicle Launched Bridge) units have been released to worldwide Army combat forces, following evaluation testing at Aberdeen Proving Ground (APG), MD. Designed to facilitate movement of tactical maneuver units, the AVLB consists of a 60-foot retrievable bridge and launcher mounted on a modified M60A1 tank chassis.

Military Standard 1290 . . .

Climaxes 15 Years of Aircraft Crash Safety Research

By George T. Singley III

Chances of occupant survival in accidents of U.S. Army aircraft of the future will be enhanced substantially by requirements of Military Standard 1290, Light Fixed- and Rotary-Wing Aircraft Crashworthiness.

Published recently by the Department of the Army as the first document of its kind issued by a Department of Defense agency, MIL–STD 1290 establishes minimum acceptable total aircraft system crashworthiness design and test criteria.

The standard is the product of more than 15 years of aircraft crashworthiness research and development by aviation safety specialists of the Eustis (VA) Directorate of the U.S. Army Air Mobility R&D Lab, headquartered at Ames Research Center, Moffett Field, CA.

Efforts of the Eustis researchers have been conducted in coordination with other aviation organizations, including the U.S. Army Agency for Aviation Safety (USAAAVS) and the U.S. Army Aeromedical Research Laboratory (USA ARL) at Fort Rucker, AL.

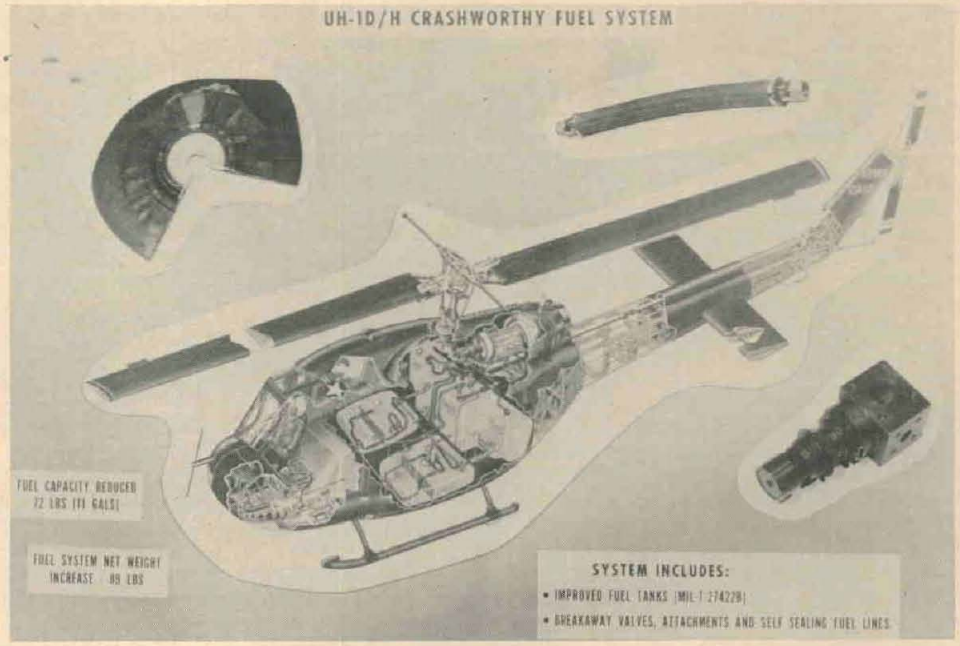
Due to the recent R&D efforts of the Department of Transportation to reduce the number and severity of injuries to people involved in automobile crashes, the public has become aware of the benefits which could accrue by designing to:

- Absorb the crash energy in a manner which minimizes the decelerative forces experienced by the occupants.
- Assure vehicle structural strength and integrity sufficient to provide a protective shell, i.e., an inhabitable volume, for occupants during the crash.
- Provide adequate occupant restraint systems, passive (air bag) or active (restraint harness).
- Minimize postcrash fires potential.

Much publicity has been given to automotive crashworthiness R&D and the favorable early data received on the reduction of injuries achieved by safety features in late-model cars.

Comparatively, however, relatively few people are aware that Army aviation has been a pioneer in the field of crashworthiness since the late 1950s; also, that the same engineering principles used to reduce injuries in automobile accidents can, in general, be applied to improving the crashworthiness of helicopters.

UH-1D/H, crashed in a drone mode during test of crashworthy fuel system.



UH-1D/ CWFS has not resulted in a thermal injury or fatality since 1970.

Prior to the recent advances in occupant crash protection, many automobile users had reconciled themselves to "when your number comes up . . ." philosophy toward accidents — in fact, many still have this attitude. Some aviators, employed in what has traditionally been perceived as an inherently hazardous occupation, seem to have adopted a similar attitude toward crash injuries.

Crashworthiness R&D advances, however, are making it possible to avoid some of these injuries. A review of past personnel losses due to Army aircraft crashes indicates the magnitude of the potential benefits of crashworthiness.

During 1967-1969, a total of 2,546 Army helicopter noncombat crashes involved 11,334 personnel, of whom 1,094 (9.6 percent) were killed and 2,699 (23.8 percent) were nonfatally injured.

Research showed 93.8 percent of these crashes and 41.3 percent of the fatalities were potentially survivable, that is, the crash decelerative forces imparted to the occupants of a portion of the aircraft did not exceed established human tolerance limits, and the structure surrounding the occupant remained intact.

Additional findings revealed 59 percent of the fatalities and 94 percent of the nonfatal injuries in the potentially survivable crashes were due to causes other than fire, such as impact–induced trauma, drowning, etc. A breakdown of noncombat, potentially survivable Army aircraft crash fatalities for the period July 1964 through June 1969 showed that 51 percent were passengers, 28 percent were pilots or copilots, and 21 percent were either crew chiefs or gunners.

Efforts of aviation safety specialists have been concentrated on preventing the crash, determining the cause of the crash and, to a lesser degree, determining the causes of crash injuries. Obviously there are technical, human, and resource limits on accident prevention— the inevitability of aircraft crashes.

In recognition of this fact, the Army began, in 1955, financial grant support of the Aviation Crash Injury Research (AvCIR) group of Cornell University. In 1959, the U.S. Army Transportation Research Command (now the Eustis Directorate, AMRDL) awarded a contract

FUTURE aircraft door-gunners will be provided with crashworthy seats and restraint systems similar to those shown above. Because the restraint system is attached by inertia reels, gunner can perform standup operations during combat.

to AvCIR, then a division of the Flight Safety Foundation, for aviation safety research with emphasis on crash injury and Army aircraft crashworthiness.

Since that original effort, the Eustis Directorate has pursued a comprehengive R&D program for development of design criteria and engineering data to improve crashworthiness through:

Investigation and analysis of aircraft accidents; dynamic crash testing of instrumented full-scale aircraft; component static and dynamic testing; crashworthiness evaluations of Army aircraft and aircraft mock-ups; design and evaluation of concepts for improved crashworthiness; preparation of crashworthiness technical reports, design guides, and military specifications.

Early phases of this program concentrated on identification and investigation of causes of crash injuries. This was followed by projects to develop design concepts and criteria to improve the crashworthiness of Army aircraft. Sufficient R&D had been performed by 1967 to allow the Eustis Directorate to publish USAAVLABS TR 67–22, "Crash Survival Design Guide."

This document has been periodically revised (the most recent edition being USAAMRDL TR 71–22) and has been accepted by both U.S. Government and industry agencies as the basic manual. Most of the Crash Survival Design Guide crashworthiness design criteria also have been stated as requirements for the UTTAS (Utility Tactical Transport Air System) and AAH (Advanced Attack Helicopter).

Criteria are included in the Crash Survival Design Guide relative to fixed- and rotary-wing aircraft data, airframe crashworthiness, seats and restraint system, emergency postcrash evacuation, and the elimination of postcrash fires.

MIL–STD–1290 was drafted by the Eustis Directorate and published by the U.S. Army Aviation Systems Command. It establishes the minimum acceptable crashworthiness design criteria which, when implemented in the initial stages of aircraft systems design, will provide the Army with aircraft possessing improved crash safety characteristics.

Requirements of MIL–STD–1290 are applicable to, and mandatory for, the design of all Army rotary- and lightwing aircraft. Future Army aircraft (i.e., those for which development contracts were not awarded before January 1974), must be designed to minimize occupant fatalities and the number and severity of injuries during crash impacts—as severe as the 95th percentile potentially survivable accident—while reducing, to the maximum extent practical, aircraft damage.

The aircraft must be designed for crashworthiness based on initial impact velocities as severe as 42 feet per second down, 50 feet per second forward, and 30 feet per second sideward—or any combination equaling a 50-feet per second resultant velocity vector.

The standard also contains detailed criteria for achieving this level of crashworthiness in potentially survivable accidents by insuring proper design consideration of the following factors:

- The airframe protective shell surrounding occupants must assure living space throughout the crash sequence.
- The tiedown strength must ensure that neither the structure nor the restraint systems which restrain occupants, cargo, and equipment will fail during the crash sequence.
- Occupant environment hazards such as barriers, projections and loose objects in the immediate vicinity of the occupant, which may cause contact injuries, must be avoided. Objects within occupant strike envelopes which cannot be moved must be padded.
- The occupant acceleration environment requirement is that airframes, seats and landing gear must be designed to absorb crash energy in a manner that limits the direction, rate of onset, magnitude, and duration of impact forces.
- Postcrash hazards must be minimized with respect to the threat to occupant survival posed by fire, smoke, toxic gases, exposure and drowning—primarily by providing adequate emergency egress provisions; use of nonflammable, fire-retardant, and nontoxic materials; minimization of postcrash fire ignition sources; and flammable fluid containment during the crash sequence.

Additionally, future Army aircraft will be equipped with crashworthy fuel systems (CWFS), in accordance with the CWFS technology developed by the Eustis Directorate during the 1960s.

The first UH–1D/H equipped with a CWFS was produced in June 1970. Since then the Army has been retrofitting and producing its UH–1, OH–58, AH–1G, and CH–47 aircraft with the CWFS. As of mid-August this year, 247 major accidents had involved CWFS–equipped aircraft, without any thermal injuries or fatalities.

This notable success was achieved by fabricating the fuel cells from a tough material laminated from rubber and nylon, and by judicious application of breakaway self-sealing couplings and fittings. A series of low-cost, stringent tests was developed for CWFS qualification. One is that the fuel cell(s) must not leak after dropping 65 feet.

In addition to minimizing postcrash fire hazards, MIL–STD–1290 reflects the significant advances achieved recently in crew and passenger seat and restraint system crashworthiness technology. Crew seats must comply with the design and test requirements of MIL–S–58095, "Seat System Crashworthy, Non-Ejection Aircrew, General Specification For."

MIL–STD–1290 requires that all seats be stronger than current seats, and that they be equipped with energy absorbers to lower the crash loads imparted to occupants. The goal is to reduce substantially the number of back injuries in future aircraft crashes.

Effectiveness of this standard will not be fully documented until aircraft designed to its requirements become operational. In comparison to past aircraft accident experience, designing Army aircraft to MIL–STD–1290 should reduce the number of fatalities in future Army aircraft crashes by at least one-half. The number and severity of injuries should also be reduced considerably.

GEORGE T. SINGLEY III has served since 1968 as an aerospace engineer in the Structures Technical Area of the Eustis Directorate, USA AMRDL, Fort Eustis, VA. He has been project engineer for several aircraft R&D projects, including crashworthy seats, troop restraint systems, crashworthy landing gear, and development of a computer model for simulating helicopter structural response to crashes.

Singley was the project engineer for preparation of MIL–S–58095(AV) "Seat System: Non-Ejection, Aircrew, General Specification For," and MIL–STD–1290 (AV) "Light Fixed- and Rotary-Wing Aircraft Crashworthiness."

Singley received a BS degree in mechanical engineering from the University of Delaware in 1968, an MBA from the College of William and Mary in 1971, and is taking graduate engineering at Old Dominion University.

Portable Alarm System Detects Potentially Hazardous Chemicals

Field capabilities of detecting potentially hazardous chemical agents are expected to be improved substantially with a new portable alarm system developed by the U.S. Army Edgewood Arsenal.

Scheduled for distribution to Army troops in Europe, the device has been under development since 1965 by EA's Detection and Alarms Branch, Defense Systems Division, Directorate of Development and Engineering. Components include a detector unit, remote alarm, power source refill kit, field test kit and vehicle mounting kit.

An electrochemical cell continuously monitors air content for chemical elements. The presence of nerve agents causes the cell to produce electric energy which activates a horn on the detector unit and a horn or light on the remote alarm. The unit can detect minute amounts of chemical vapors below lethal concentrations.

Normal pollutants such as smoke, dust or motor vehicle exhausts will not generally affect the alarm system.

The basic detector and battery measures about 26 inches high, 12 inches wide and 8 inches deep. Weighing less than 18 pounds, the system is capable of operating for a minimum of 12 hours.

The alarm may be carried by the individual soldier, vehicle mounted, or used in fixed emplacements in a wide variety of tactical and environmental applications. It has been tested successfully at temperatures from minus 40 degrees to plus 120 degrees Fahrenheit.

Soviet Computer-Aided Design of Microelectronics

By Lyman Hall, Gustave Schoone

For several years, the Soviets have been publishing articles and presenting papers at international meetings on computer-aided design (CAD).

The dearth of computers in the Soviet Union throughout the 1960s and into the early 1970s obviously delayed the advance into computer-controlled production and computer-aided design.

The 1975-80 period will yield a much greater availability of computers as well as accelerated research efforts to develop and field advanced technology and hardware. This is expected to result in establishment of a sophisticated CAD capability.

Among the salient reasons why computer-aided design is important to the Soviet Union and can be expected to receive a high priority are:

- Design efficiency can be improved by several orders of magnitude due to the greater speed and accuracy involved.
- Improved efficiency results in better allocation of resources, both money and manpower.
- Better control produces a high degree of uniformity and repeatability in design and production.
- Complex high-precision, low-volume designs can be realized, with significantly less time and cost than is possible by using manual techniques; this is especially significant in meeting rigid military requirements.
- Product quality is enhanced by automated design processes, including simulation, testing and data analysis.

Soviet interest in computer-aided design dates as far back as 1962, at which time publications appeared which were little more than a review of earlier Western literature. Articles by Viktor M. Glushkov showed that by 1967 the Soviets were undertaking the automated design of major systems, including the use of computers.

EQUIPMENT manufactured by Warsaw Pact countries is available to the Soviets. Shown here, and in the photo in column three, above, are the control panel and microscope subunits of the Polish KA-70 coordinatograph used for automated production of printed-circuit masks.

A high level of interest is indicated by support from officials like Glushkov, an academician who is director of the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences. He is vice president of the Academy of Sciences, deputy to the Council of Nationalities of the Supreme Soviet of the USSR, recipient of the Lenin prize (1964), and a hero of Socialist Labor.

Glushkov described the saving in manpower and time which accrued with his first automatically designed computer, the MIM. He indicated that automatic synthesis of digital circuits had been developed and, as a result, the design time for logic devices had been reduced to one-fifth of the previous time. He also claimed that design was optimized so that the quantity of required electronic circuit elements was reduced by 2 to 2½ times.

A 1967 article in Sovetskaya Rossiya described the use of the M–20 computer in the design of the small Aurora computer. M. I. Peskov, chief designer of the Ministry of Radio Industry, pointed out that circuit design calculations were carried out by computer, and that patterned glass photoplates of the logic circuits were also generated under computer control.

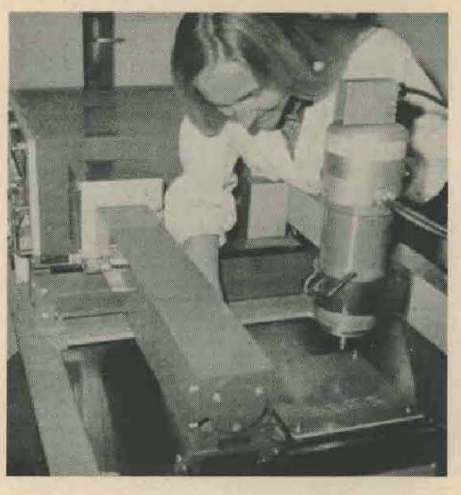
Another 1967 article, in Pravda Ukrainy, described a special computer built for controlling the technological processes of microcircuit manufacture. Other devices related to design process automation, such as the AChG–1, an automated drafting device developed at the Belorussian Cybernetics Institute, and the Itekan, an automated design tool, have also been described.

Other articles lead to the conclusion that the BESM–6 computer was partly designed by using another computer, probably the BESM–2. The late S. A. Lebedev, chief designer of the BESM–6 and past director of the Institute for Precision Mechanics and Computing Techniques, also wrote an article describing design and production problems of automation.

Nevertheless, most evidence indicates that manual techniques have dominated Soviet design of computers up to the present. The Soviets were still considered incapable of supporting very complex CAD systems as late as 1973, due to software and hardware limitations, and deficiencies in personnel and management.

Although CAD languages are well known to the Soviets, until recently there had been a notable lack of coordination between computer facilities, as well as a shortage of programers experienced in complex computer systems.

The Soviets have, however, developed at least two languages that have CAD application. One, LYAPAS, was developed specially for CAD by A. D. Yakrevskiy in 1969. The other, PROYEKT, is also reportedly very good for CAD systems. Concurrently, there has been a continued interest in appropriate Western-developed languages, such as PL/1, which could be used to prepare more sophisticated CAD software.



A recent assessment concluded that the Soviets are "progressing rapidly" with design automation, but "the lack of know-how to provide such items as automatic wiring for core memories or back panels of computers makes it very doubtful that they can achieve the sophisticated level of design automation carried out by the U.S. computer industry for at least 4 or 5 years."

The preponderance of Soviet literature on CAD indicates a heavy emphasis on topographical optimization of components on the supporting structure. A trend can be noted in the refinement of the location of discrete semiconductors on printed circuit boards, and of monolithic transistor cells and film components on integrated circuit (IC) substrates.

The major effort seems to be in the area of locating discrete components on printed circuit boards rather than in ICs. Although this observation reflects the typical level of CAD sophistication in the USSR, the reader should not conclude that every Soviet designer totally lacks state-of-the-art capability.

Precision coordinatographs, for example, are controlled by instructions stored on magnetic tape and used to generate good mask artwork. Automatically controlled design and processing equipment of this type is produced by Soviet manufacturers. Soviet integrated circuits available on the international market reflect probable use of some good CAD.

Soviet software support to CAD seems to be limited, with its development characterized by independent and uncoordinated efforts. Routines have been written in several languages, including Soviet versions of PL/1, ALGOL–60, and FORTRAN; both linear and nonlinear (operations research) programing has been noted.

The Soviets continue to keep generally

aware of Western state-of-the-art, but apparently employ modern CAD methods only in certain high-priority design facilities, such as those engaged in military R&D.

Current methods are described in Soviet literature as third generation CAD. (First generation is that level associated with programs like ECAP, NET–1, SCEPTRE, NASAP, and PREDICT; second generation with programs like ECAP–II, NET II, CIRCUS and SLIC; third generation is associated with programs like AEDNET, CIRCAL and GINA.)

Limitations of indigenous equipment, such as storage capacity and particularly input/output devices, are partly compensated through acquisition of foreign equipment. Although it is not considered to have had a high priority, the level of support is expected to show significant growth. This should result in a healthy expansion of CAD and a great improvement in the Soviets' previously tenuous IC production capability.

Evolution of IC fabrication from CAD to direct control of an ion beam (called elionics), such as the process claimed by Hitachi of Japan, most likely will mature from earlier projects like the KIEV 67 system.

If new computer equipment (such as the Ryad devices) becomes readily available, hardware restrictions should disappear and a totally independent CAD program could flourish from established software expertise.

Considerable progress is being made in Soviet CAD but much work remains to be done before the Soviets reach the Western level of development. The next five years, in particular, should produce many refinements in automated design, and a realization of new goals in related technologies such as large-scale integration (LSI).

For those interested in further information on this subject, the following bibliography is provided:

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LYMAN HALL, a 1959 graduate of the University of Kentucky, is currently engaged in an analysis of state-of-the-art aspects of worldwide electronics developments. Assigned to the Army Materiel Command's Foreign Science and Technology Center, Charlottesville, VA, he has worked in procurement and production, HQ Army Electronics Command and as a design engineer with the RCA. GUSTAVE SCHOONE is a staff member with the U.S. Army FSTC where he is engaged in analysis of worldwide developments in computer technology. Previously employed by NASA at the Wallops Island, VA, test station, he is a 1970 graduate of Cleveland State University and is a member of the Institute of Electrical and Electronics Engineers.

3 WSMR Employes Receive Grants For Advanced Missile Research

Assistant Secretary of the Army (R&D) Norman R. Augustine recently approved research grants totaling $58,650 to three employes of the Instrumentation Directorate, White Sands (NM) Missile Range.

The grants will fund continued work on Army projects of significant national interest in advanced missile technology. All of the recipients are employed in the Research Projects Office.

Dr. Alton L. Gilbert will receive $40,250 for efforts to develop "real-time" data processing methods by using live video systems to improve effectiveness of equipment operators. Employed at WSMR for two years, Gilbert is a New Mexico State University faculty member credited with invention of a TV processing system used by NASA on the Apollo and Skylab programs.

Charles R. Hayslett, a senior engineer specializing in optical systems, will receive $10,000 for a feasibility study of a wide-angle low-distortion lens design believed capable of improving visual tracking and photography of high-speed missiles.

Employed at WSMR for nine years following graduation from San Jose State University, Hayslett has a degree in optics from the University of Arizona. In 1972 he received a similar research grant for advanced studies.

William L. Shepherd, a WSMR research mathematician for 15 years will receive $8,400 for studies in applications of probability and approximation theories to WSMR instrumentation.

A former faculty member of the University of Texas at El Paso with BS and MS degrees in mathematics from Oklahoma State University, he serves as WSMR representative to the Mathematical Association of America.

SBAO Plays Key Role in ECOM Contract Awards

When the cliche, "Is This Any Way to Run a Business?" is directed to the Small Business Advisory Office at HQ U.S. Army Electronics Command, Fort Monmouth, NJ, results call for an automatic "Yes!"

The proof of success is in the $49 million let in 14,168 military contracts to small business firms all over the country during the first half of Fiscal Year 1975. This represents 54 percent, numerically, of all ECOM contracts during the 6-month period—or 16.1 percent of the $304.7 million total.

The SBAO functions to assure that small business, labor-surplus concerns and minority firms are afforded an equitable opportunity to compete for Electronics Command procurements.

Chief of the office is Gerald F. O'Connell, a supervisory procurement analyst who has on his staff as analysts John P. Meschler, transferred from the Philadelphia Small Business Office, and Robert J. Wright, along with Mrs. Diann Curry, technician.

The Small Business Office monitors all proposed acquisitions of more than $2,500 on every ECOM Procurement and Production Directorate solicitation of proposals to determine if they are applicable to small business participation before contracts were awarded. They are always on the lookout for new firms to be considered.

The Small Business Advisory Office also is doing big business with the minority businesses. Seven years ago, one minority firm was issued a contract for $73,065. In FY 1974, 13 SB minority contracts totaled $11,432,732—believed the best performance record, service-wide, in minority awards.

The ECOM Small Business Advisory Office is monitoring a $675 million FY 75 program, an increase of $110 million over 1974 awards.

These figures provide answers when personnel are asked, "How's Business?"

U.S. Army Electronics Command (ECOM) Commander MG Hugh F. Foster Jr. (right) checks over agenda of recent Advanced Planning Briefing for Industry (APBI) with COL Robert F. Feeley, chief of the Intelligence and Control Systems Division, HQ U.S. Army Training and Doctrine Command (TRADOC). ECOM and TRADOC were joint sponsors of the classified Electronics Systems Planning briefing for more than 500 industrial and military representatives at ECOM HQ, Fort Monmouth, NJ. Jack Mannix, ECOM Technical and Industrial Liaison Office, was project officer and program director for the briefing.

MERDC's New Status as Development Center . . .

Imposes Broadly Diversified Army Materiel Requirements Mission

Scientific, engineering and technology pathways to progress blazed by forerunners of the U.S. Army Mobility Equipment Research and Development Center, which recently became one of eight R&D Centers set up or planned for activation this year, cut across history and traditions dating to 1870.

Few if any of the select group of Army R&D installations whose root origins go back three or four generations can take pride in a record of achievements more solidly based than that of the MERDC. The "great, great, great granddaddy" of the MERDC might properly be considered the U.S. Army Engineer Board at Willets Point, NY, now Fort Totten. Its mission: test new items of equipment.

Consequently, when the staff of about 1,400 civilian and 60 military personnel of the MERDC at Fort Belvoir, VA, join with the nation in the pride of observing the Bicentennial Celebration this year, they understandably can justify "bursting their buttons" a bit.

MERDC physical boundaries are the same as they were 33 years ago when the Army Engineer Board, then a complement of about 450 with its support staff, moved into the nucleus of laboratory and test facilities that became the Engineer R&D Laboratories (ERDL), and later the MERDC.

Facilities occupy 240 acres on the South Post complemented by 840 acres in the North Area Annex. Over the years the number of buildings has increased to more than 100, with 65 percent in the laboratory category, comprises some of the nation's most advanced RD and Engineering facilities.

Indicative of the magnitude of MERDC operations is that the FY 1974 budget was the largest in its history, about $104 million plus $7 million carryover funds. Research, development, test and evaluation funds, including AMC mission plus customer, totaled $4 million; PEMA (Procurement of Equipment and Missiles, Army), $22 million; OMA (Operations and Maintenance, Army), $11 million; and Stock Fund, $27 million.

Approximately 71 percent of the obligations were for industrial and academic contracts, 27 percent in-house, and 2 percent to other government labs. HQ Army Materiel Command, AMC subcommands and agencies, and the Troop Support Command provided about 95 percent of these funds.

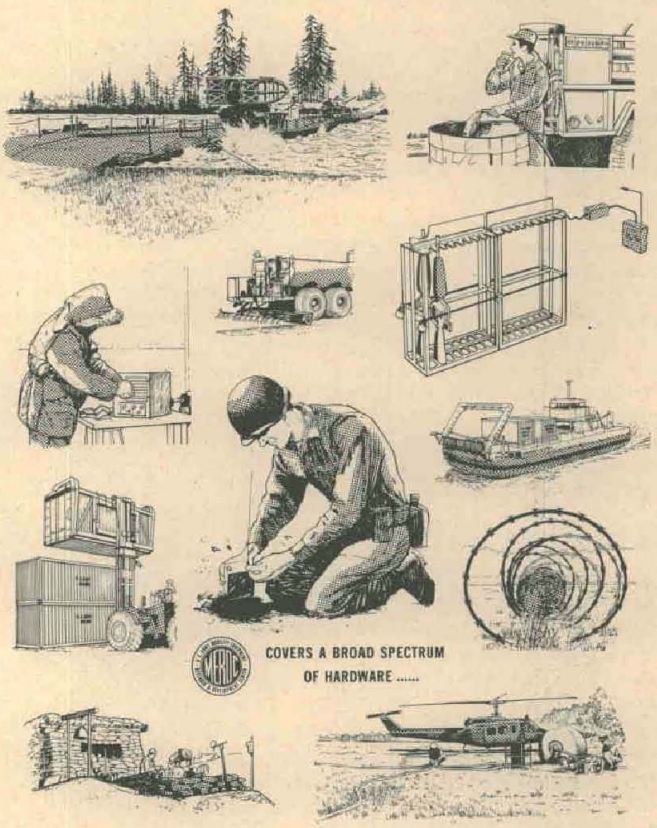
The remaining funds came from Army and non-Army customers including: MASSTER (Modern Army Selected Systems Test, Evaluation and Review); TRADOC (Training and Doctrine Command); DCSLOG (Deputy Chief of Staff for Logistics); Army Medical R&D Command, Office of the Surgeon General; Army Research Office, AMC; the Air Force, Navy, Marines and Coast Guard; Departments of Justice, State, and Commerce; Small Business Administration.

After 13 years as the R&D agency of the AMC subcommand known most recently as the Troop Support Command, the MERDC achieved independent status as a development center in March 1975. The change makes the MERDC directly responsible to MG George Sammet Jr., whose duties as AMC deputy commander for Materiel Acquisition were expanded recently to include technical supervision of AMC labs.

Establishment of the MERDC as a Development Center is in line with one of the major recommendations for creation of DCs made by AMARC (Army Materiel Acquisition Review Committee), consisting of six teams that intensively studied the Army acquisition process over a 4-month period. MERDC's status is part of an AMARC-promoted evolution toward consolidation of Army RDT&E facilities, selected user and command elements into mission-oriented DCs.

Expanded functions of the MERDC, including the "initial production buy" of equipment developed, are listed in a mission statement. Curently, RDT&E in assigned areas of responsibility involve some 200 major projects and related task areas.

The MERDC is charged with conducting a broad-based, multi-disciplinary program of scientific research, advanced technological development, and full-scale development directed toward new and improved materiel, equipment, systems and operational procedures for the Army.



REPRESENTATIVE ITEMS of Mobility Equipment R&D Center endeavor in combat, logistic and mobility support are (clockwise from upper left) the ribbon bridge, reverse osmosis water purification unit, joint services interior intrusion detection system, 30-ton air cushion vehicle lighter, barbed tape forward area refueling equipment, sandbag bunker, container stacker, and 15,000 BTUH heater. Center, top, is the universal liquid distributor, and bottom, the tactical intrusion detector.

Specific responsibilities include providing the principal technology base and managing system development and acquisition for: countermine, camouflage, barrier systems, and tactical sensors in combat support; fuels, lubricants and fuels handling equipment; marine and railway transportation equipment in mobility support; electric power generation and distribution; tactical environmental control equipment; supply distribution and materiel handling; water and waste management; physical security sensors; and engineer topographic systems (engineering only) in logistic support.

MERDC—like all the other seven Army development centers planned—is responsible for development and the acquisition of the materiel life cycle until a system has been fielded and the technical data procurement package has "matured." This includes negotiation, award, administration and reporting on development and initial production contracts. The process "may take longer than the first production buy."

In addition to its R&D mission, the MERDC is charged with "those tasks and functions directed toward engineering for timely, economical quantity production, as well as maintaining the centralized 'design memory bank' for its end items."

Many of the MERDC programs in these fields have important applications in the civilian sector. The MERDC staff maintains close coordination and exchange of information with

agencies involved with energy and environmental protection, transportation, water and waste management, oil pollution abatement, noise abatement, and petroleum products research and conservation activities.

Most functional areas assigned to MERDC as a development center have a long history of prideful achievement in its predecessor organizations. Major Thrust areas of camouflage, advanced electric power sources for combat equipment requirements, mines and countermines, have a deep background of professional expertise at the center. Currently, the MERDC is assigned by the Army Materiel Command as "Lead Laboratory" in areas of camouflage, and countermines.

Emphasis on improving mine detection and neutralization capabilities stems from combat experience in Southeast Asia. Studies showed less than 5 of every 10 mines emplaced by opposing forces were detected. Most of those found had to be neutralized by hand with a bayonet. Current effort is to develop countermines to reduce greatly personnel and vehicle losses.

Initially, two detectors in the Army inventory are being product-improved: the AN/PSS metallic mine detector to decrease weight and maintenance requirements, and the AN/PRS-7 metallic non-metallic detector to reduce both the weight and the false alarm rate.

For near future mine detection advances, the center is employing three scientific approaches: metal reradiation of radar pulses, thermal imaging, and microwave mine detection.

Development is nearing completion on the Metal Re-Radiation (METRRA) mine detection system, based on a novel technique pioneered at MERDC. It will fill a requirement for rapid detection of scatterable mines or booby traps located on or above the earth's surface, regardless of concealment.

METRRA is similar to conventional radar, except that its receiver is tuned to a frequency other than that transmitted, usually the third harmonic. Its detection application is based on the phenomenon that junctions of unwelded metal parts, such as those in mines and booby traps, convert the transmitted frequency into its third harmonic.

An evaluation of the potential of thermal imagers has been conducted, using both the truck-mounted Forward Looking InfraRed system (FLIR) and various hand-held devices.

Tests have shown that a buried mine acts as a thermal barrier, causing the surface soil to cool or warm faster than the soil surrounding it whenever the environment undergoes temperature changes. Under favorable conditions, this causes a temperature difference of several degrees which can be detected with the thermal-imaging equipment.

The third developmental item is the vehicle-mounted road mine detector. This microwave system features the rapid sweep detection of antitank/antivehicular mines buried in roads. It has an all-weather capability, will be self-steering, and is transportable on its attachable carrier.

Promising research is also in progress on a short-pulse radar expected to lead to an off-road mine detector in the early 1980s.

In seeking the ultimate in mine neutralization, MERDC researchers are working on a technique that would neutralize rapidly, without detonation, all the explosive devices on a broad front. In the meantime, four items are expected to offer vast improvements over the bayonet or the bulling technique of driving through a minefield and taking losses as they occur. They should also provide the commander with a family of neutralization equipment from which to select the item or combination that best meets his requirements.

The first of these is FAESHED (Fuel Air Explosive System, Helicopter Delivered), which provides the capability of breaching minefields well ahead of advancing troops. It is a bomb-like munition carrying ethylene oxide.

Ground contact by a probe extending from the bomb fuze detonates the bomb burster charge and disperses the fuel to form an aerosol cloud above ground. The cloud is detonated; overpressure activates mine fuzes or otherwise neutralizes the mines.

A Surface Launched Unit (SLUFAE) is also under development. It will launch FAE rounds from a 30-tube launcher mounted on a cargo carrier to clear an 8-meter breach through a 100 to 200-meter minefield at a standoff range of 300 to 1,000 meters. Its all-weather capability and reduced vulnerability to enemy action will eliminate the restrictions helicopter delivery places on FAESHED.

HUMAN FACTORS engineering instrument and lie detector are used at MERDC to determine how various types of camouflage affect an individual's search patterns. It records eye movements and fields of view, and fixation point.

To complete the Army's near-future mine neutralization capability, MERDC has entered full-scale development of a Track Width Mine Plow and is investigating mine-clearing rollers. Designed for cross-country or unimproved roads, the plow casts antitank mines aside from the track width area in front of a combat vehicle. Its uses would include the hasty breach of minefields under combat assault conditions and possible follow-on use to proof fuel-air explosive breach.

Mine neutralization of the future may be accomplished by attacking the main explosive charge, the only element common to all land mines. MERDC is studying delivery of highly reactive materials to the main charge to induce ignition and subsequent burning. Another approach seeks to desensitize the mine by reacting the explosive to a nonsensitive compound.

Detection effort is also concentrating on the explosive and several approaches offer possible solutions. Biosensor approaches include the use of animals, particularly dogs, with considerable success to detect the presence of explosive vapors.

Additional effort is concerned with the development of trace-gas detection equipment to locate the explosive as well as the use of specific enzymes which are sensitive to the explosive. Investigation of nuclear interactions has also proved effective in detecting the explosive.

CAMOUFLAGE, also given Major Thrust Area Lead Laboratory preeminence as an MERDC advanced technology program, involves concealment and disguise to minimize detection or identification of troops, equipment and installations.

The recent increased emphasis on camouflage at highest Army levels resulted from recognition of worldwide improvements in surveillance capabilities. A contributing influence is increasing employment by U.S. forces of sophisticated equipment with distinctive and detectable signatures.

MERDC scientists work to establish and maintain a technology base by combining in-house/contract effort, and maximum use of talent within all AMC subcommands. An AMC-wide technology survey was accomplished through an ad hoc study examining night vision, ground target signatures, battlefield illumination and camouflage.

One outgrowth of the study was establishment of a camouflage point of contact in each subcommand and laboratory. These personnel are trained in camouflage appreciation; they assist in identifying camouflage opportunities and problem areas within their agencies.

(*Continued on page 18*)

MERDC's Status as DC Imposes Materiel Requirements Mission

(*Continued from page 17*)

In addtion, the center has accomplished a detailed threat summary and identified, by "Target Worth" analysis, AMC materiel to be designated camouflage critical (CC); also many items and systems considered camouflage-sensitive (CS).

Lists of equipment in 19 CC/CS categories have been distributed to commanders and developers, with instructions that current development plans be revised to place emphasis on camouflage, in addition to other system requirements.

The first major item developed in this program is the Lightweight Camouflage Screen System. This will replace the burlap and twine camouflage nets which entered the Army supply system in 1928. A woodland version type classified in 1972 and a desert version TCd this year are to be followed by a snow camouflage net.

The new screens are of polyester netting, garnished with polyvinyl chloride-coated spun-boned nylon. Each screen is reversible to an alternative, related color blend to accommodate seasonal changes.

The screens are designed to provide concealment from visual, radar, photographic and near-infrared detection. Modular construction makes them adaptable to a variety of situations formerly requiring special-purpose nets. Each module has one hexagon and one diamond-shaped net and a support assembly.

In connection with the woodland version of the camouflage screening system, MERDC sponsored the successful development of a Manufacturing Methods and Technology (MM&T) Program. The automated process produces the 900-square-foot modules at rates of 15 per hour.

The screen system has been used also with a dual-surface attenuation canopy in what may be the first version of a multi-capable camouflage system. The canopy suppresses heat emitted by equipment to reduce vulnerability to thermal or far infrared detection and destruction by heat-seeking weapons.

A new program of camouflage painting of major items of tactical equipment, including removing the white stars which now appear on the hood and sides, also is proving effective.

Tactical wheeled vehicles and trailers, combat vehicles, field artillery and air defense weapon systems, and engineer combat and construction equipment will be painted in camouflage patterns by commodity commands under MERDC guidance.

The 4-color patterns disrupt the identifying characteristics of the vehicles, reduce contrasts with soil and vegetation, and distort internal shadows. The value of pattern painting was initially demonstrated during testing by MASSTER at Fort Hood, TX, where accelerated evaluation of camouflage material, techniques and procedures is continuing.

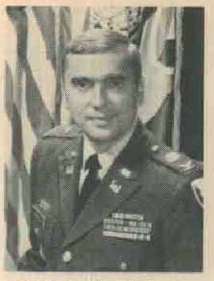
The major programs in camouflage screens and pattern painting are beginning to take effect in Army units worldwide. Meanwhile, MERDC's camouflage R&D program continues with such hardware projects as disruptors to alter item shapes, redesign of vehicle exhaust systems to reduce infrared signatures, efforts to develop radio antennas in other than the common whip shape, and design and development of decoys.

A radar diagnostic facility is helping to determine what elements of a military item generate radar reflection. Computer programs are used in infrared studies. Other testing programs are investigating what camouflage techniques work best under what circumstances. Some of the programs are conducted in-house at MERDC, and others at subordinate AMC commands with MERDC guidance and input.

An MERDC agency related to, but not part of, the camouflage R&D effort, is the Camouflage Effectiveness Assessment Office (CEAO), which prepared the original threat study and CC/CS lists as a basis for the updated camouflage program.

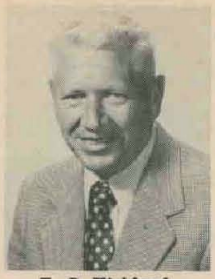
CEAO is now engaged in studies of item signatures and related camouflage measures in a concerted effort with TRADOC to answer developing agency questions such as: "How much camouflage is needed? Is this measure doing its job properly?"

The CEAO and MERDC Camouflage R&D teams will combine forces in the coming year to develop a complete system camouflage of an M60 tank. Existing material and innovative ideas will serve to model application to other systems.



COL T. R. Hukkala
MERDC Commander

LTC D. R. Anderson
Executive Officer



T. G. Kirkland
Technical Director

To insure wide availability of camouflage information, involving input from field units, MERDC's camouflage experts have instituted a Camouflage Action Line telephone system.

Any member of the military community with a question or comment on camouflage may call Autovon 354-2654 and be guaranteed a response within 72 hours. Objectively, CAL will improve contact with field troops who eventually will use the equipment under development.

ELECTRIC POWER. The intrinsic importance to the Army of Electric Power Generation and Distribution in the field—the third AMC Major Thrust area for which MERDC is responsible—is readily apparent. In modern military forces, virtually no weapon, communication or support system, ranging from the most complex and sophisticated missile to the most mundane heater, can operate without it.

The center's prime mission in this technology area is the development of equipment to convert the energy of logistic fuels into reliable, controlled electric power at electrical voltages and frequencies suitable for special- and general-purpose military needs.

Naturally, the energy crisis has had a profound impact, directing even more emphasis toward increased efficiency, multifuel capability, efficient mix of power source types, and balance between fuel conservation and mission effectiveness.

Mobile electric power, generally considered in the 0.5 to 200 kw range, is a Department of Defense standardized commodity, making it necessary that plants follow suitable configurations. MERDC recently completed development of the first DoD family of standard diesel-engine-driven generator sets, an inter-service, project-managed effort begun in 1967.

Members of the family in the 5, 10, 15, 30, 60, 100 and 200 kilowatt rating, now in initial production, offer cost savings based on a high degree of component standardization, minimal number of generator sets, and consolidation of requirements of all services in a single family procurement.

Increased emphasis has been placed on gas turbine engine technology because of its high potential for low maintenance, plus existing compactness and light weight, reliability, long life and multifuel capability. Development of a first-generation DoD family to replace the diesel generator sets in the 10 to 100 kw range is under way. Gas turbine engine drive 10 kw and 30 kw sets are in engineering development.

MERDC also is developing the fuel cell and Rankine-cycle engine generator sets as quiet/silent replacements for the standard family of gasoline-engine-driven generator sets in the 0.5 to 10 kw range generally used in tactical field operations.

In the meantime, researchers have acoustically enclosed a military standard 1.5 kw GED set to provide a high degree of noise attenuation. The set appears to have overcome the overheating tendency of previously enclosed power sources.

In special-purpose ratings, generally above 500 kw, the center's R&D activities are aimed at matching output to the requirement of new high-energy devices, in equipment with a high degree of mobility. Two 750 kw gas-turbine generator sets have been designed and built for the Army Missile Command mobile test unit.

Prototype Prime Power Group units for the SAM-D Missile System also have been produced in coordination with

the SAM-D Project Office and the prime system contractor.

In a peripheral electric technology program, an experimental electric-drive tractor trailer has been constructed at the center. It is proposed as a second-generation combination of transporter and power source for the radar group on the SAM-D missile system.

New methods of improving the transmission and distribution of tactical power sources are being investigated to reduce excessive movement and the number of generators in forward areas. Development of a modularized distribution system is proposed to provide the link between the generator and its load or loads. High-voltage DC cable, guided wave, and line-of-sight systems are being considered for transmission over distances up to 10 miles.

OTHER FIELDS. While these three Major Thrust areas, associated with the center since its earliest days, have received the most attention of late, developments are continuing in its other fields of endeavor that may replace countermine, camouflage or electric power as top priority endeavors.

Important developments are continuing in other materiel fields. For example, in combat support, progress is being made in barriers, directed toward the goal of providing the Army with a series of obstacles to canalize, delay or stop the movement of opposing forces.

Two existing types of barrier elements, improved by the center to reduce the logistical burden, are now in production. They are the General Purpose Barbed Tape Obstacle (GPBTO) and the M57 Antitank Mine Dispenser. A new hand-emplaced minefield marking system is in engineering development.

Working toward a tactical controllable barrier for the 1980s, the center is concentrating on perfecting command and control systems. Included are unattended sensors capable of determining what the targets are—whether personnel, wheeled vehicles or tracked vehicles. Work is under way also to determine what the barrier element is to be.

Research efforts are currently concentrating on delaying or impeding the progress of armored vehicles by using obstacles which cause engine interference, visual obstruction, or tractive interference. The objective of the barrier is to increase the vulnerability of the enemy to weapons fire; the ultimate is a controllable barrier meeting this objective at minimal cost, weight and installation time.

The high incidence of van- or shelter-mounted electronic equipment, which makes heating and air conditioning a necessity in a mobile Army, accounts for another R&D program.

The aim is to provide this environmental control with equipment that, in addition to heating and cooling effectively, meets military requirements of size, weight, interchangeability of parts, shock, vibration and corrosion resistance, and low radio interference and operational power surges.

MERDC test facility is used to determine stroking properties of motor vehicle hydraulic brake fluids and parts at 3 to 20 strokes a minute. First developed by MERDC about 20 years ago, the system has been product improved. Still the only one of its kind, it has served as a model for adaptation by industry.

A Total Environmental Control System (*TECS*) is under development to replace up to 19 different air conditioners in vertical and horizontal configurations now used in the Army. Utilizing solid-state technology, TECS is expected to eliminate surges and operate with multiple types of current input.

RD&E in supply distribution and material handling is another MERDC logistic support field. This effort strives to provide the materiel required for a fast, efficient and highly responsive system for the worldwide distribution of military supplies, including ammunition.

Programs in this field interface with the intermodal containerized system rapidly becoming the Army's primary means of supply distribution. They include equipment to lift, transfer and transport MILVAN and TRICON containers; smaller materials handling equipment to stuff and strip containers; and container control and identification to monitor container movement in transit.

WATER AND WASTE MANAGEMENT includes RD&E of water supply systems for production of potable water from fresh, brackish, sea and CBR (chemical, bacteriological, radiological) contaminated water sources. The program calls for technology advances for storage and distribution of water to support a field Army; collection and treatment of wastes for reuse and/or disposal; sewage treatment systems for Army watercraft; fire suppression; portable incinerators and well-drilling equipment.

In response to Department of Defense and Department of the Army abatement policies, the center participates in development of basic technology for pollution control. This involves a comprehensive pilot-plant study of wastes treatment for Army ammunition plants; also, treatment and renovation of wastewater from field laundries, showers and kitchen units.

Mathematical modeling and simulation is used extensively in these R&D efforts. Coupled with data from physical models, simulation has resulted in increased methodology predictability and reliability of developmental systems.

In addition to the development sensors for combat support, MERDC is working on systems to provide reliable and versatile physical security protection. The Joint-Service Interior Intrusion Detection System (J–SIIDS) is in production and is planned primarily to satisfy the urgent need for arms room protection. Additional J–SIIDS items in development are intended to offer extended security protection for other areas.

The Facility Intrusion Detection System (FIDS), a second-generation system, is in full-scale development. FIDS will provide worldwide physical security protection for any structure controlled by the Department of Defense. The system is designed to provide a much higher degree of security and flexibility than the J-SIIDS through centralized signal processing. Two redundant microprocessors will meet more stringent environmental specifications, and assure a greater degree of sensor interface flexibility.

MOBILITY SUPPORT, the third major division of MERDC programing, embraces at least three activities long associated with the Corps of Engineers: bridges, construction equipment, and fuels handling equipment.

The Army standard Armored Vehicle Launched Bridge (AVLB), Mobile Floating Assault Bridge (MAB), and Ribbon Bridge, all were developed by MERDC and are being product improved through support to multi-million dollar contracts.

A Technical Data Package (TDP) provides for procurement of the British Medium Girder Bridge to supplement the Bailey in the U.S. Army inventory.

The center also is working with the United Kingdom and the Federal Republic of Germany in an International Concepts Study aimed at cooperative development and standardization of bridging for the 1980s. The program is designed to conserve financial and human resources by using the special expertise in each of the cooperating countries.

Mobility Support work also is performed as requested and funded by the AMC product manager on the Family of Military Engineer Construction Equipment/Universal Engineer Tractor (FAMECE/UET) being assessed for quantity procurement. A liquid distributor for dust control is nearing type classification

(*Continued on page 20*)

MERDC Status as DC Imposes Materiel Requirements Mission

(*Continued from page 19*)

following successful prototype testing.

Work is continuing on the Commercial Construction Equipment (CCE) program, directed to replacing high-cost military design and commercial modified equipment with proven off-the-shelf commercial equipment, and providing for its support.

FUELS HANDLING equipment responsibilities of the MERDC include development of tank ship mooring and off-loading equipment; pipeline, storage, and distribution systems; and fuel decontamination devices.

Development of a tactical mooring and off-loading system, nearing completion, will give the Army the capability to unload products from tankers where port facilities are unavailable.

Research is under way to improve materials used in self-supporting collapsible tanks for quick storage of fuels in remote areas. Field fabrication of plastic tanks from premanufactured large open-end cylinders also is being investigated.

Forward-area refueling equipment, capable of rapidly refueling combat helicopters simultaneously has been developed. Fuels are flown to pumping equipment in 500-gallon rubber drums.

Fuels and lubricants R&D became an MERDC responsibility when the Coating and Chemical Laboratory was transferred to the center from Aberdeen Proving Ground, MD. MERDC is now the Department of Defense lead element for fuels and lubricants for ground equipment.

Due to the national energy conservation program, this may become a Major Thrust area. Accordingly, planning includes improving conventional fuel availability, short-term development of means to utilize existing unconventional fuels, long-term development to provide substitutes, aiding more economical future engine design.

Three general commodity areas comprise the MERDC transportation effort. Shifting of United States and foreign-flag maritime shipping to the use of containerized cargo, and the Army's dependency on commercial shipping in a resupply operation, influenced the military to examine current resources.

The Trans-Hydro study provided guidance for future MERDC transportation development efforts including ship-to-shore lighters, amphibious lighters, coastal, harbor and inland water craft, and on-beach handling of large commercial containers. Aerostatic tethered balloon systems are among unloading units being considered for use in undeveloped port areas.

The greatest emphasis has been placed on the amphibious lighters and a contract has been placed for Army use adaption of a commercial air-cushion vehicle. Known as the LACV–30, the vehicle will carry 30 tons of containerized cargo at speeds exceeding 50 mph. MERDC will test and evaluate this vehicle.

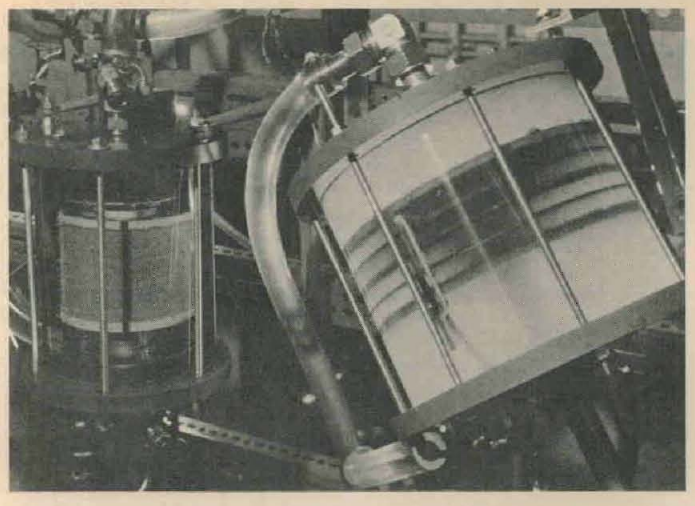
Methodology tools being employed in MERDC continuous effort to minimize costs include design-to-cost, value engineering, product improvement, and manufacturing methods and technology. Liaison with other Defense activities, the civilian sector, and the international scientific and engineering community, serves to minimize duplication of effort, shorten R&D and production lead time, and reduce costs.

An active In-House Laboratory Independent Research (ILIR) program is making significant contributions in support of MERDC's broad-based materiel functions. Scientists and engineers are thus encouraged to pursue R&D of innovative ideas that may have potential for military requirements.

Two new laboratory office buildings for the countermine/counter intrusion effort are the most recent additions to MERDC facilities. One includes a shielded radio frequency anechoic chamber for measuring far and near field radiation patterns of special-purpose antennae in the countermine effort.

Mine detection field testing and mine neutralization explosives research facilities are provided in the other building. A valuable tool in developing sensors and target classifiers is a Vehicle Automatic Classification Identification Simulator.

A simulated service brake testing unit is the only one of its kind in the Defense Department. It is used for brake fluid development and brake system component evaluation not only by DoD agencies but by the U.S. Department of Transportation, Bureau of Standards, and the Postal Service.



ELECTROKINETIC PROCESS in use at MERDC may provide a method of removing water and other contaminants from fuels.

Another MERDC facility believed unique is the new Combustion Laboratory at San Antonio, TX. A high-pressure turbine combustor, it provides the Army with the first research system designed to assess the fuel and materials requirements of current and future turbine engines.

The fuels handling equipment test facility includes a laboratory and a small port on the Potomac and indoor-outdoor areas for year-round tests.

Bridge test facilities include an instrumented, hydraulically actuated test frame capable of applying loads up to 350 tons, a variety of test sites, and a full complement of the latest instrumentation to evaluate bridge concepts and design.

A rail hump test system to simulate impact shocks on equipment during rail transport is another unusual facility.

Equipment is available to test power generating equipment reliability, audio-noise, electromagnetic interference; high-energy and high-power batteries; and hybrid power sources.

An air conditioner laboratory is equipped to evaluate conditioners and compressors under simulated extremes of temperature and humidity.

System support facilities is the inclusive term applied at MERDC to those which may have application in any field of endeavor. Prominent among them are the Computer Center, the Computer-Aided Design and Engineering (CAD-E) Facility, Materials Research, Climatic Test, Calibration, Developmental Fabrication, Noise Measurement and Analysis, Exhaust Emission Measurement, and Human Factors Laboratory.

Facilities in materials research run the gamut of analytical and test equipment necessary in determining the application of lightweight metals and rubber, paper and coated fabrics to design of military equipment, and in developing inorganic coatings for metals and biodegradation prevention methods.

The Climatic Test Facility, one of the largest on the east coast, can test the ability of large items to operate in various climatic conditions. It has a temperature range from plus 165 degrees F. to minus 85; humidity from 20 to 100 percent; altitudes to 35,000 feet; and wind velocities up to 40 knots.

Another MERDC facility in the Washington area is an acoustical test pad constructed as part of an Environmental Protection Agency project.

These represent but a sampling of the facilities that make MERDC one of the best equipped in the Army Materiel Command. Plans for future construction include laboratories for camouflage, system concepts and simulation, coating and chemicals, environmental control, energy conversion, mechanical equipment, and water and waste programs.

MERDC's civilian and military staff is proud of its long history of outstanding achievements responsive to Army needs, with many notable R&D "spin-off" benefits to the nation's civilian population. As one of the Army's eight new Development Centers, MERDC views the future with confidence it will add significantly to the heritage from predecessor organizations.

Speaking On...

(*Continued from inside front cover*)

the disturbing trends in world affairs—but it is sufficient to create a spectrum of options for the future.

Here are some of the forces which shaped this request:

• *A strained national economy.* This is not an ideal Defense R&D program. It was deliberately limited by today's fiscal realities, and it may be substantially diminished by inflation beyond the levels projected in budget calculations.

• *Detente.* As short-term tensions between the super powers may be eased, long-range technological and economic competition will persist and intensify. Renewed emphasis must be given to resources we apply to long-term security.

• *An increasingly complex and uncertain world.* Events of the last year portend further shifts in the complex interrelationships of a world of changing leadership, power status and access to raw materials. This requires that Defense R&D be broadly based and flexible so that it can produce options for unpredictable contingencies.

• *The rising cost of Defense manpower, maintenance and operations.* Added R&D emphasis is needed to reduce manpower, maintenance and operations costs. These categories have grown to 60 percent of the total Defense budget while "modernization investment"—the sum of R&D and procurement — has been squeezed to about 30 percent.

There is a paradox for us here: manpower costs rise and curtail R&D—which has the potential to reduce manpower costs, as well as preserve military lives. The Soviet military modernization investment is estimated at more than 50 percent of their military budget.

We are clearly caught up in a fateful trade-off between the costs of near-term readiness, which is heavily manpower dependent, and investment for long-range security.

• *Vladivostok.* Because it limits total numbers of weapons and weapon carriers, the accord on strategic nuclear weapons at Vladivostok reenforces our need for technological progress. Evolution in performance of strategic systems will now be the decisive motivator on both sides as we seek agreements.

R&D clearly has the potential to change the nature of strategic deterrence. The Soviet Union is now investing massively in strategic R&D and is prepared for unprecedented deployment of modernized new systems.

Technological Initiative as a National Goal. I want to state emphatically that right now, at this point in our history, we still *do* have the technological initiative in most areas important to our security. This is, however, a dynamic balance capable of rapid change.

The technological initiative is the product of a broad base both of research and of leadership in translating science into practical use. It requires pioneering and aggressive innovation over the spectrum of research, engineering, production and management—all of which are necessary for improved performance, higher productivity and affordable cost in the solution of complex problems.

The findings of modern science are available to all advanced countries. Almost all of the basic work is published in the open literature and widely circulated. Soviet scientists—who are generally on a par with our own—understand thoroughly the status of science throughout the world. There is no scientific limitation to what the Soviet military establishment can do.

But good science is only the first requisite for technological initiative. The American edge lies in an ability to apply science to the development of devices and techniques for which there is a real need, which are a substantial advance over existing applications, which can be produced in quantity, and which can be afforded by the ultimate user—military or civil.

Traditionally, the United States has excelled in the practical uses of science. The reasons for this leadership are several:

• *National Style.* Modern America evolved from a frontier society. The frontier today lies in science and technology, and Americans remain anxious to reach out and explore. We have a competitive society, and science and technology are highly competitive. Individual initiative is our hallmark. There is a boldness, a willingness to set high goals, to risk, and to be conspicuous—in a loss or a win—that has been part of our heritage and part of our education. There has evolved a basic confidence that investment in research and development, coupled to real needs in a competitive environment, will provide the edge—and it has.

• *Incentives.* The American society offers effective incentives for technological excellence. A successful individual receives pay and prestige. A corporation—the source of most of the technical applications—gets a profit. The Department of Defense gets a battlefield edge which pays in deterrence in lives and in security. The nation receives value-added payments—in business—for effective applications of technology.

• *Institutions.* This country has evolved institutions for R&D in government and the private sector which, I believe, work better than those in any other country. Defense Department people understand the value and the limitations of applied technology. They have available both in-house laboratories and Federal Contract Research Centers to act as links between the military users and the universities and industry where science and technology largely originate.

The Defense R&D establishment is closely linked to the civil R&D establishment. So the Department of Defense benefits substantially from national R&D that it does not fund, just as the civil sector reaps its bonus from the defense innovations and technological thrusts. Industry is encouraged to take substantial but practical steps forward. This approach has paid off historically despite the risks and inevitable failures.

We have indeed failed in some instances to maintain the technological initiative. In some industries—steel and coal, for instance—technical innovations are rare in this country, and much of the initiative has passed to other industrialized countries. We must learn from these experiences.

There are few defense technology areas where the Soviets have been permitted to take the initiative although the gap is closing in many areas. In some areas, which have critical military as well as civil applications, determined Soviet efforts to buy Western technology confirm significant Soviet lags behind the United States.

The Soviet R&D Approach. I would broadly characterize the U.S. approach to Defense R&D as a search for new technology or "quantum jumps." We seek to push back frontiers of technology, attain substantially higher plateaus of capability, and find revolutionary solutions. We foster a competitive environment which stresses innovation and is receptive to new technology and keyed for rapid change.

By contrast, the Soviet approach could be broadly characterized as "conservative incrementalism." Soviet R&D institutions and the requirements generation process that underlies them have in the past been committed essentially to step improvements of existing systems and components. When incrementalism is the dominant development strategy, risks are fewer and personal cost of failure less.

On the civil side, Soviet R&D is severely handicapped by the national style, incentives and institutions. Civil laboratories lack quality control and modern instruments and facilities. Industry often produces shoddy and unwanted consumer goods. The managerial and technical skills of mass production are scarce. The civil sector receives little bonus from work done in the military R&D establishment.

In Soviet military R&D, no such difficulties exist. There, Soviet resources are applied with considerable effectiveness. The defense sector has its own built-in organizational handicaps, but the atmosphere is markedly different from that endured by civil scientists, engineers and managers.

The military sector enjoys high priorities for instruments and facilities; success is rewarded in a most unsocialistic way—with money and privileges! Standards are rigidly enforced. Funding, judging from the scale and breadth of military R&D, is no limitation. Massive application of resources makes up for any lack of efficiency.

The weapons produced are the real test of the effectiveness of the Soviet approach to Defense R&D. I have seen some Soviet deployed systems, and their quality is good by our standards, even though they often require more manpower and give less protection to their soldiers.

Soviet workmanship is high quality; the engineering is generally excellent; the systems are well conceived; and the over-all effectiveness of the weapons is impressive. The doctrine of military R&D conservatism and massive investment fits the Soviet style and has returned solid dividends.

Over the past 20 years, the Soviet government has poured immense resources into an effort to achieve military parity and go on to superiority. The effort continues to grow and the products continue to improve. We now see evidence even of some flexibility in their conservative incrementalism policy. They are moving resolutely down independent and innovative new paths.

Soviet actions and products give credence to a recent Communist Party Cen-

(*Continued on page 22*)

Speaking On...

(*Continued from page 21*)

tral Committee Resolution statement: ". . . The development of Soviet science has special significance (today) when the scientific-technological revolution has become the most important area in the competition of the two opposed world systems."

I do not doubt that the Soviet Union —if uncontested—can in time gain the broad technological initiative but only if we decide, whether by conscious national intent or by default, to slacken our efforts.

I believe that the American "new technical plateau" approach to Defense R&D is superior to an approach dominated by conservative incrementalism. Our approach is an expression of our national character. We should understand it and not denigrate it. It has provided us—so far—with the broad technological initiative.

Conceptual and Management Framework. I would like to describe briefly the concepts which underlie our planning and management of Defense RDT&E. These concepts can provide a framework in which to understand the thousands of individual projects making up the over-all Defense R&D program.

Defense R&D programs fall essentially into two groups having different objectives: Group One—*Creation and demonstration of options* which may be useful for future military capabilities. Group Two—*Full-scale system development* for potential deployment.

It is important that these activities and objectives be distinguished, and that the programs in each group be reviewed with the different objectives in mind. *Group One* includes the thousands of projects in the "technology base" plus creation and demonstration of subsystem and system options (in general, the Defense R&D Budget categories 6.1-6.3).

In this group, we fund work in the sciences that relates directly to our needs, and we fund the development of new techniques and devices which could form the basis for future weapons. We foster feasibility demonstrations and competitive approaches to military problems so that we can pick and choose the best of the available technologies.

In this general category, we also build prototype test platforms for proving out new technology—whether in electronics, propulsion, materials, aerodynamics, guidance or elsewhere.

In some cases (for example, the Lightweight Fighter), these prototypes represent concepts for whole systems, brought into being in a competitive industrial environment in order to extract from industry its most creative solutions to cost-performance trade-offs. *I strongly endorse hardware rather than paper competition wherever possible.*

Group One programs are often risky but payoffs from success are great. There will be, and should be, failures, but these failures come at a relatively inexpensive stage of the weapons acquisition and ownership process. These programs are highly leveraged because the potential return from success is so large compared to the investment.

These programs reduce risk. They make innovative use of technology to reduce costs and make more efficient use of manpower. They also provide valid cost data. In the aggregate, the Group One programs create and preserve a broad base of *technological options* from which we can select with confidence those that can then be carried forward for full development and deployment.

We draw a sharp management line between Group One programs, creation and testing of technology options, and Group Two, development of full systems for potential deployment. Group Two programs embrace generally the R&D budget Category 6.4. They are characterized by the terms full-scale system development, operational system development, and engineering development.

In Group Two, we build full-scale engineering models suitable for the combat environment and for test and evaluation by the military men who will use them. Each program usually involves much greater cost than the prototype and demonstration programs in Group One.

This cost accrues from the much greater engineering detail, the design for conformance to full military specifications, the controlled and complete documentation necessary for eventual possible procurement and production, the design of support equipment, training requirements, and extensive test and evaluation.

Obviously, it is at the point of transition of a program from Group One to Group Two that a crucial commitment begins. We need to be demanding and thorough in our review of programs at this decision point. And we are.

For the full system development programs in Group Two, such as B-1 (bomber), AEGIS (Navy antiair warfare missile), Air Combat Fighter, UTTAS (Utility Tactical Transport Aircraft Systems), TRIDENT (advanced nuclear submarine), etc., we ask these hard questions: What is the projected military need for this program? What are the alternative solutions? Is this system cost-effective? What are the production and life-cycle costs? What are the cost-performance trade-offs? Is the program well-managed? Is the test program adequate? Are the cost and schedule realistic?

The decision to put a program into Group Two is made by the highest officials in the Department of Defense, meeting as the Defense Systems Acquisition Review Council. This is the so-called DSARC II milestone decision. Seventy-nine major programs are under this DSARC management review process, and 66 lesser programs are similarly approved through Program Memoranda which rigorously record the need, technical cost and schedule objectives of these programs.

I believe that the DSARC process is working and has evolved into an increasingly powerful management tool in DoD. This process is reflecting itself in the Services (e.g., the Army's ASARC). It provides a mechanism for critical examination and review which has improved considerably the quality of management and the results.

Of these two broad categories of R&D programs, Group One represents a FY 1976 investment of roughly $4 billion, supporting literally thousands of individual projects for technological options. Group Two, with only a few hundred programs, represents an investment of about $6 billion, developing systems for potential deployment as our deterrent and war fighting forces.

I invite the Congress to review the Defense RDT&E program from this 2-group perspective so that we can better address together the details of the many projects and their contributions to our defense objectives.

The programs in Group One need to be reviewed in a broad sense, assessing the general level of funding, the over-all quality and adequacy of the technology efforts and competitive approaches—rather than in an element-by-element sense.

The programs in Group Two—few in numbers, high-priced and with a potentially large follow-on commitment—merit detailed consideration, especially at that crucial decision point when the commitment of a program to Group Two is made. And, of course, to go on from this decision point we need Congressional approval.

Additional Comments on Management. I believe that this approach to R&D—creating many options and then selecting only a few for full development—will provide the continued technological leadership that we seek. I recognize, however, that its success depends upon rigorous management discipline. I believe that we have both the management tools and strength to make this approach work.

The management tools I speak of are those I outlined in last year's testimony. These *management initiatives* included: Planning by mission area; measurement of potential *Return-on Investment;* nurturing *competition* at early stages of development; adopting *Design-to-Cost* goals; doing *test and evaluation* early and rigorously; emphasis on improved *program management.*

We are working hard to make these thrusts work and I believe they are proving effective. The Service Assistant Secretaries for R&D and I have published—and distributed widely—a Statement of Principles of Defense RDT&E Management which contained these initiatives. The Statement is attached as an Appendix and I invite your attention to it. It is a brief of my philosophy, embodying the whole approach we have been discussing.

In the enormously complex weapons systems acquisition process, many tough decisions are made. We make mistakes. But I believe our decisions are improving. Problems are being anticipated and averted, and we have many outstanding successes which often are not recognized.

During the past year I have initiated—with the cooperation of the Services—a number of specific activities aimed at eliminating duplication and proliferation. Among others, this effort is looking at precision weapons, missiles, navigation and communication systems, surveillance and target location systems, and night vision equipment. They are discussed in Section III.

Formation of the Intelligence R&D Council has also contributed to the effective coordination of programs across both the Services and the intelligence community.

MAJOR R&D PROGRAM EMPHASIS. With this conceptual and man-

agement framework as background, I would like now to describe some Major Thrusts which shaped this RDT&E request in the broad areas of strategic forces, general-purpose forces, and the technology base.

Strategic Programs. Our R&D programs for strategic systems continue to be guided by the fundamental objective of strategic forces—the prevention or deterrence of war. We want always to provide visible evidence to any would-be attacker that losses to him will far outweigh any possible gain. Our efforts are modified and focused by the fact that strategic capabilities are eroded, not only by increased adversary capabilities, but also by political change and technological advancement.

There has been speculation that the Department of Defense would accelerate programs and increase spending as a result of the Vladivostok (U.S.-Soviet summit conference) ceilings. Such is not the case. In view of over-all fiscal constraints and the urgent need to modernize our general-purpose forces, we made a conscious decision to reduce strategic R&D programs from the previously planned funding levels for FY 1976.

I am not saying that we made these reductions *because* of Vladivostok or that those agreements will permit us to relax. On the contrary, the support of a vigorous strategic R&D program is fundamental for our continued security. What I am saying is that when we sat down to assess our request and assign priorities, strategic R&D was not spared.

Of about $2.5 billion requested for R&D in this area for FY 1976, about 60 percent is concentrated in two full-scale system development programs—TRIDENT and B-1.

The remaining 40 percent of our efforts are focused in advanced development of technological options to permit us to project equivalence—both actual and perceived—in the face of a Soviet throwweight advantage, in active defense technological enhancements, and in space applications for warning, guidance and communications.

Offensive System. The military capabilities of our offensive forces in being constitute the central ingredient of deterrence, and assure us that the risk of nuclear war today is at a low level. To sustain this level of deterrence into the future requires that we maintain a strong R&D program encompassing a broad spectrum of technology options.

These options will provide us not only with improved, competitive performance for new systems, if they are required, but also serve as signals to any adversary that we have the resolve and ability to foreclose possible opportunities to change the military balance against us.

Last year, with the concurrence of Congress, we embarked on a program of "strategic R&D initiatives" to provide these options for the future. These initiatives involved improved accuracy and higher yield-to-weight rations for ICBMs (intercontinental ballistic missiles) and SLBMs (submarine-launched), advanced ICBM technologies and basing modes, advanced tankers, cruise missiles and less expensive submarines.

Today, the need for continuation of these initiatives is even more evident than it was then. We will emphasize improved yield and accuracy for our ballistic missile forces, within the letter and spirit of the Vladivostok agreement, for superior Soviet throwweight will inevitably be accompanied by accuracy improvements.

As the Secretary of Defense has pointed out, we should continue with our accuracy improvement programs, and improve the yield-to-weight ratio of our warheads to acquire a more efficient hard-target kill capability or to improve our over-all effectiveness against soft, point targets.

This effort is pivotal to the maintenance of parity with the growing strategic offensive capabilities of the Soviet Union. Yield and accuracy improvement programs are applicable to both ICBMs and SLBMs, but, because SLBM accuracy is a more difficult problem, our efforts there have been reduced somewhat from our earlier plans.

In other efforts aimed at providing strategic options, an advanced ICBM program, Missile-X, will develop technologies applicable to a follow-on to Minuteman, having larger throwweight and adaptable to a variety of basing modes. We will continue the development of a cruise missile through coordinated Navy and Air Force programs using the same guidance, warhead and propulsion. This represents a deferral of a decision for full-scale systems development pending competitive demonstrations and evaluations of prototype systems.

TRIDENT and B-1 are the two major full-scale systems development programs in the strategic area. FY 1976 represents the peak R&D funding year for each of them.

The TRIDENT system, consisting of a new, much quieter submarine and a long-range missile, will constitute the future backbone of our sea-based deterrent forces. The importance of this part of our strategic TRIAD is enhanced by Vladivostok.

The TRIDENT I missile will be capable of backfitting into POSEIDON submarines and will give us a range at least approaching that of the Soviet SS-N-8. The system can also accommodate a larger and longer-range TRIDENT II missile now in the planning stage.

The B-1, because of its high cost and past technical problems, has been a controversial program. On several occasions we have subjected the B-1 to rigorous study, comparing its cost effectiveness with that of various alternatives at different threat levels. Our most recent such effort was the Joint Strategic Bomber Study—a year-long analysis conducted under my jurisdiction and completed last fall. . . .

The study shows that the cost-effectiveness of the B-1 is directly dependent on the level of the developing Soviet threat. If that threat evolves into the late 1980s, as currently projected, the inherent capabilities designed into the B-1 for survivability in an SLBM attack on bomber bases, and for penetration against sophisticated air defenses, make it cost-effective. At current threat levels—and levels projected at least through the early 1980s—the B-52s, with improvements, are adequate.

I conclude that the B-1—as costly as it appears—should be continued in development and in an extensive program of test and evaluation. This course of action will maintain an option for a future production decision based on demonstrated performance, cost and updated threat assessment.

Defensive Systems. There are no development programs under way for defensive systems. All the effort here is in advanced technology development (Group One of the previous section). The preponderance of funding is devoted to Ballistic Missile Defense. BMD is at the same level as FY 1975 ($245 million) and about $100 million below FY 1974.

We have restructured the Site Defense program, as requested by the Congress, and revitalized our BMD technology program to enhance deterrence—by providing the capability to actively defend a portion of the MINUTEMAN force should that be required—in case follow-on strategic arms limitation negotiations fail, and to preserve the technological initiative in BMD—thereby helping to maintain the penetrativity of our own missile forces, preserve the U.S. lead in BMD technology, and have confidence that we will not be technologically surprised.

Strategic Command, Control and Communications. It is of paramount importance that we have a command and control capability that can survive massive nuclear attack and still insure that our nuclear forces will be responsive to the National Command Authorities. The attainment of this capability is an essential to credible nuclear deterrence as is the capability of the nuclear forces themselves, and this objective has the highest priority in the Department of Defense.

This is why we are stressing, in addition to improvements in the existing communications network, the continued development and deployment of the Air Force Satellite Communications System (AFSATCOM), the Advanced Airborne Command Post (AABNCP) aircraft, and the SANGUINE extremely low-frequency radio relay site.

Space Systems. Space systems are playing an increasingly important role by providing us with highly reliable and relatively inexpensive worldwide surveillance, communications, meteorology, geodesy, and navigation. We will continue to emphasize R&D to improve these capabilities.

In some cases, space systems are, in fact, so much cheaper and so much more effective than surface-based systems that we are phasing out our ground-based back-up systems. Of special significance is the NAVSTAR Global Positioning System development, which I believe has the potential for revolutionary impact on both strategic and tactical warfare.

The system will provide for unprecedented precision in measurement of platform position and velocity in three dimensions. It could revolutionize world navigation and weapon delivery.

Programs for General Purpose Forces. Last year I stated that the technology of conventional warfare is undergoing a transformation. We are on the threshold of a new era in which evolving new capabilities will profoundly influence the nature of such wars and the way they are deterred.

The United States holds the initiative in such potentially revolutionary areas as first-shot target destruction with precision-guided ordnance, stand-off control of battlefield weapons, powerful new forms of surveillance, command and control, night vision and remotely piloted vehicles.

(*Continued on page 30*)

Women in Army Science...

First Among 30,000 . . .

Materiel Command Female Employe Selected for ICAF

Mary Ellen Harvey

Two types of distinction came to Mary Ellen Harvey, a GS–14 grade Army Materiel Command deputy director of the Equipment Authorizations Review Activity, when she was selected to attend the 1975–76 course at the Industrial College of the Armed Forces in Washington, DC.

First, her youth required a waiver because at 32 she was three years under the minimal age to qualify for selection to attend the prestigious 51-year-old ICAF; second, she became the first selectee from about 30,000 AMC female civilian employes. When she enters a class of 198 students in August, she will be among less than five women selected from all U.S. Government agencies.

An explanation for her selection based solidly on merit comes from MG Chester M. McKeen, who headed the AMC Directorate for Requirements and Procurement when he nominated Miss Harvey for career development through the advanced management training given by ICAF. BG McKeen stated:

"Based on the aggressive and professional management Miss Harvey demonstrated in her position in my organization, I was convinced she had the potential for greater responsibility and deserved the opportunity to develop that potential."

Following graduation from Immaculata College, PA, in 1963 with a BA degree in chemistry, she began her Civil Service career as a GS–5 supply management intern at AMC's Red River Army Depot in Texas. Nine years later she was a GS-14 employe—which serves as a strong attestation to career development opportunities for women employes of AMC.

A natural question in the minds of other ambitious women is: How did she do it? Some factors are: She broadened her education by attending the graduate school of the University of Maryland, European Division, for two years. Now she is enrolled at George Washington University working toward a master of science degree in administration.

In addition, she spent 3½ years in Europe as a branch chief at the U.S. Army Supply and Maintenance Agency, followed by 27 months in Vietnam as deputy chief of the Coordination and Control Office, U.S. Army Inventory Control Center.

She recently completed a 3-week Civil Service "New Managers" course at the Federal Executive Institute at King's Point, NY. ICAF training is specifically directed to prepare graduates to assume positions of greater responsibility in the Federal Government.

In her present position, Miss Harvey is responsible for technical review of all Army equipment authorization documents. She is the top authority in this area at the U.S. Army Equipment Authorizations Review Activity, which consists of four divisions and has an annual budget of $1 million.

Awards Evidence EPG Employe's Performance

When Adele M. Caputo was honored with the Decoration for Meritorious Civilian Service during a recent ceremony at the Electronic Proving Ground, the U.S. Army's second highest award for a Civil Service employe climaxed a long succession of work performance awards.

During nearly a quarter century of Federal Civil Service, Mrs. Caputo has received five Quality Step Increases in salary, four Sustained Superior Performance Awards and seven Outstanding Performance Ratings.

Achievements "in the field of human goals" with the Federal Women's Program, since 1969 as FWP coordinator at EPG and since 1973 as chairman of the FWP Committee, contributed to selection for her latest distinction.

Adele M. Caputo

As chief of the EPG Technical Publications Branch, Mrs. Caputo is responsible for issuance of test reports used as the basis for determining the suitability of equipment for Army adoption and procurement.

She is credited with developing "the first plan format" used by the U.S. Army Communications Command, headquartered at Fort Huachuca, AZ, and for developing the first test plans and report guides used by EPG engineers, technicians and publications personnel.

Mrs. Caputo has supervised the writers and editorial staff in her division since 1970 and has served as secretary, administrative vice president and president of the local Toastmaster's Club. Additionally, she organized EPG's massive 20th anniversary reunion.

International Women's Year Committee Established

Secretary of Defense James R. Schlesinger has authorized establishment of a Department of Defense (DoD) Committee and set objectives for observance of International Women's Year 1975. His stated objectives are:

- To continue striving to provide to men and women alike an equal opportunity for patriotic service in the all-volunteer military forces of the United States, and in the civilian rolls of the Department of Defense.
- To encourage recognition of the concept that the common defense is a common and equal responsibility of all citizens, and, through innovative and aggressive initiatives, encourage the active role of women in the mission of the Department of Defense.
- To acknowledge and emphasize the sacrifices of women in building the American nation, and in particular, recognize the accomplishments of women in the Department of Defense, both military and civilian.

The DoD committee is cochaired by Deputy Director Georgiana Sheldon of the Defense Civil Preparedness Agency and Deputy Assistant Secretary of Defense (Public Affairs) MG Winant Sidle.

NDC Applies Computer Controlled Technology For Standardized Clothing Design Production

Computerized control for standardization of clothing design to produce a full range of sizes to outfit the Volunteer Army—believed the only system of its kind used in the Armed Forces and one of the few in industry—is an answer to "What's new?" at the Natick (MA) Development Center.

Designers in the NDC Clothing Equipment and Materials Engineering Laboratory can use an established grading system to prepare an original pattern of a new or improved garment. Fed into the computer through a digital plotter, the pattern serves to precisely control production of a desired size.

What NDC design engineers have done is to apply technology developed by the Hughes Aircraft Co. to put together their own software technology for the computer-controlled grading of the various sizes required. Stored in the computer's memory bank, the information can be recalled as necessary.

NDC clothing designers are now able to spend more time in the designing stage rather than copying and resizing accepted patterns. This is particularly significant because of the rapidly changing state-of-the-art relating to styling uniforms for women in the Army.

John V. E. Hansen, director of the Clothing, Equipment and Materials Engineering Laboratory, states: "This pattern-making apparatus undoubtedly permits us to be more flexible in our operations, increases our productivity and, most importantly, enables us to keep in step with industry—thereby reducing the cost of military clothing to the taxpayer."

Personnel Actions . . .

Heilmeier Succeeds Lukasik as DARPA Director

Dr. George H. Heilmeier, assistant director, Defense Research and Engineering for Electronics and Physical Sciences since 1971, recently succeeded Dr. Stephan J. Lukasik as director of the Defense Advanced Research Projects Agency.

Dr. Heilmeier was head of Device Concepts Research at the RCA Laboratories, Princeton, NJ (1968–70). He joined RCA in 1958 and later became head of Solid State Device Research.

Selected as a White House Fellow in 1970, he served as special assistant to the Secretary of Defense, and in 1974 was a winner of an Arthur Fleming Award as one of the 10 Outstanding Young Personnel in government service.

Graduated with distinction and a BS degree from the University of Pennsylvania, he went to Princeton University for graduate studies and was awarded MSE, MA and PhD degrees.

The Defense Advanced Research Projects Agency executes research projects stemming from promising ideas which are not yet identifiable with specific military requirements or relate to the function of more than one of the Military Services.

Murray Assigned to ASD (M&R Affairs) Office

Secretary of Defense James R. Schlesinger recently appointed Robert J. Murray as Deputy Assistant Secretary of Defense for Policy, Planning and Management, Office, Assistant Secretary of Defense (Manpower, Reserve Affairs).

Murray had served as the assistant to the Secretary and Deputy Secretary of Defense since 1973. During 1962–69 he was assigned to the OASD (International Security Affairs), where he served as deputy director for the European Region, Near East and South Asia Region.

A graduate of Suffolk College and Harvard University, Murray is a Fellow of the National Institute of Public Affairs, and a member of International Institute of Strategic Studies, American Society for Public Administration, and the American Political Science Administration.

Hitz Takes Over as DASD for Legislative Affairs

Frederick P. Hitz, former congressional relations officer, U.S. Department of State, was recently appointed Deputy Assistant Secretary of Defense for Legislative Affairs (House Affairs), succeeding H. Hollister Cantus.

During 1967–73, Hitz was with the U.S. Foreign Service, including an assignment to the U.S. Embassy in Abidjan, Ivory Coast. He has a bachelor's degree (cum laude) from Princeton and an LLD degree from Harvard Law School.

CE Announces District Engineer Reassignments

U.S. Army Corps of Engineers key personnel changes include four district engineer reassignments effective in July.

COL Charles E. Edgar III succeeded COL Donald G. Weinert as Little Rock (AR) District engineer. COL Edgar is now executive officer, Army Engineer School, Fort Belvoir, VA.

COL Donald A. Wisdom will succeed COL Emmett C. Lee as Jacksonville (FL) District engineer. COL Wisdom is now assistant director of Military Construction for Environment and Energy, Office of the Chief of Engineers, Washington, D.C.

COL Daniel L. Lycan will succeed COL Walter H. Johnson as Rock Island (IL) District engineer. COL Lycan is serving as commander, Army Comptroller Systems Command Support Group, San Francisco, CA.

COL Anthony A. Smith, a student at the Industrial College of the Armed Forces, Fort McNair, Washington, DC, will take over from COL J. G. Driskill as Tulsa District engineer.

Call for Conference Papers

A call for papers proposed for the Seventh Annual Precise Time and Time Interval (PTTI) Planning Meeting, Dec. 2-4, has been issued. It is scheduled at the National Aeronautics and Space Administration's Goddard Space Flight Center (GSFC), Greenbelt, MD.

Sponsors are GSFC, the U.S. Naval Electronic Systems Command, and the U.S. Naval Observatory. Twenty copies of each proposal should be submitted no later than Aug. 1 to: Technical Program Committee Chairman, Dr. F. H. Reder, U.S. Army Electronics Command, AMSEL-NL-RH (EVANS), Fort Monmouth, NJ 07703.

Bennett Named Acting ASD (Installations & Logistics)

Resignation of Assistant Secretary of Defense (Installations and Logistics) Arthur I. Mendolia set the stage for Dr. John J. Bennett to succeeed him recently in an acting capacity. The March–April *Army Research and Development Newsmagazine* announced Dr. Bennett's appointment as Mendolia's principal deputy.

Dr. Bennett, retired from the Air Force since 1969, served his final Active Duty assignment as an assistant to the Assistant Secretary of the AF (Manpower). His biography and picture were carried in our March–April edition.

Looft Assumes Duties as DARPA Deputy Director

Donald J. Looft

Donald J. Looft, under whose leadership the Electronics Command's Night Vision Laboratory at Fort Belvoir, VA, was selected and recently honored as the U.S. Army "Laboratory of the Year," has departed as director to become deputy director, Defense Advanced Research Projects Agency.

DARPA is a separate agency but the director serves the staff of, and reports to, the Director of Defense Research and Engineering.

Associated in a succession of key assignments extending over 30 years as a military and civilian scientist with predecessor organizations of what recently was redesignated the U.S. Army Mobility Equipment Research and Development Center, Looft has been honored with numerous achievement awards. He was presented with the commanding officer's Leadership Award in 1959.

Edward J. Sheehan

Upon his discharge from World War II service in 1946, including a terminal assignment with what was then the U.S. Army Engineer R&D Laboratories, Looft accepted a Federal Civil Service appointment at the ERDL.

Known as one of the Army's top experts in the field of advanced electric power requirements, he authored, in the fifth anniversary edition of the *Army Research and Development Newsmagazine* (Dec–Jan 66), a comprehensive 7-page R&D progress report, "Electric Power Needs Reviewed for Advances in Weaponry."

EDWARD J. SHEEHAN has moved up from associate director to succeed Donald J. Looft as acting director of the Night Vision Laboratory. Sheehan has an MS degree in science and management from Massachusetts Institute of Technology, gained in 1972 under the Sloan Fellowship Program, and was graduated in 1959 from St. Francis College, PA, with a BS degree in physics.

Soon after graduating from St. Francis, Sheehan joined the professional staff of the ERDL Night Vision Laboratory, serving initially as an assistant project engineer. In 1960 he became a project engineer, and 19 months later was advanced to group leader in the Systems Development Technical Area of the NVL. After serving two years as a team leader in the same area, he became the director in 1965. In August 1974, he was advanced to associate director of the NVL.

Lee Joins Human Resources Research Organization

Gus C. Lee, former special assistant for the "All-Volunteer Force," U.S. Department of Defense, retired recently and joined the staff of the Human Resources Research Organization (HumRRO).

Assigned to HumRRO's Eastern Division, Lee had served for more than 27 years as a member of the Secretary of Defense staff, including positions as director of Organization and Methods; director of Manpower Utilization, Requirements, and Civilian Personnel; and director of Procurement Policy.

Awarded a DoD Medal for Distinguished Civilian Service in 1973, Lee has BA, MA and LLB degrees from the University of Texas.

People in Perspective . . .

Secretary Earns Auto Mechanic Certification

Diane Cooley

Complaints about auto mechanics' performance and prices are a matter of mounting concern to federal and state officials, as well as Congress, now that millions of Americans are trying to keep old cars running to avoid costly investments in 1975 new cars.

Few male motorists, however, might be inclined to direct indignation at Diane Cooley. Employed as a secretary in the Office of the Project Manager for the M60 tank at the U.S. Army Tank-Automotive Command, Warren, MI, Miss Cooley is properly accredited as an apprentice mechanic—and a pretty one, too!

Graduated recently from an Oakland Community College course in auto mechanics, Diane was the only female in a class of 35 students. She learned all about balancing tires, changing oil, replacing spark plugs, ball joints and shocks, relining brakes, and other essential maintenance and repairs.

Diane's objective, however, was not to learn how to compete with male mechanics on a professional basis. She owns a 1973 car and she wanted to learn all she could about how to keep it in good running condition.

Her biggest problem was in being accepted as an enrollee for what had been, up to that time, a course for men only. The instructor did not believe she would complete the 11-week course, and she concedes the training was not easy.

The attractive readhead also admits that she had a few very willing helpful hands along the way to her Certificate of Completion—the males in the class. The Sawyer Business College graduate plans a career in personnel management.

FRG Liaison Officer at HQAMC . . .
Bases Future Value of Tank on Long Experience

COL Helmut Ritgen

Skeptical questions pertaining to the future of the tank as an effective weapon of modern warfare do not merit much doubt in the mind of COL Helmut Ritgen, chief of the Federal Republic of Germany military liaison staff at HQ U.S. Army Materiel Command.

COL Ritgen was born in 1916, the year that tanks were introduced to the battlefield during World War I. His experience with tanks began 20 years later as an enlisted man with the German 6th Tank Regiment.

Much of his military career since then has been involved in tank warfare—World War II assignments during the invasion of France, the D-Day assault, along the Russian front in the Leningrad-Stalingrad-Moscow sector, and in 1944 on the Western Front again, including the Battle of the Bulge.

After more than a 10-year interval as a civilian, he returned to the German Army in 1956 and was one of the first German officers to attend the U.S. Army Armor Associate Advanced Course at Fort Knox, KY. Later he lectured at the German Armor School and for seven years worked in research and development at the German Federal Office for Defense Technology and Procurement, and the Ministry of Defense in Bonn.

During this period he worked on development of the Leopard I, successor to the famed Panther tank, and then became involved in the U.S.-German Main Battle Tank joint development program. He represented the FRG as chief of the German Element, Technical Coordination Group, Warren, MI.

When the joint MBT program was phased out, he represented the German Federal Government in the U.S. development of the XM803, which evolved into the current U.S. XM–1 main battle tank concept. Effective Aug. 1, 1972, he was assigned to his present liaison duty with HQ AMC.

This mission is concerned with use of standardized weapon systems including tank design, engineering and development of components. That serves to explain why COL Ritgen is optimistic regarding the essential role of tanks in future warfare, despite the high attrition rate during the intense tank battles that highlighted the 1973 Mideast War.

NAS Honors Army R&D Achievement Award Winner

National Academy of Sciences selection of a U.S. Army Research and Development Achievement Award winner in 1973 to be a visiting scientist and guest lecturer at the Bulgarian Academy of Sciences was announced in April.

In recognition of outstanding achievement in soil mechanics research, Dr. Ellis L. Krinitzsky, a geologist with the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS, was selected to report on his discoveries.

Dr. Krinitzsky has developed an X-radiographic technique that provides a new insight into engineering properties such as the strength, density, swelling characteristics and liquidification potential of soils. He wrote a book on this subject, published in 1970, and has authored about 35 technical papers. The book is an accepted reference work on soils research technology.

Graduated from Virginia Polytechnic Institute with a BS degree, from the University of North Carolina with an MS degree and from Louisiana State University with a PhD, all in mining geology, Dr. Krinitzsky is a Fellow of the Geological Society of America. He is a member of the Seismological Society of America, the American Society of Civil Engineers, the Earthquake Engineering Research Institute, and the American Association of Petroleum Geologists.

POWDER BLENDER, circa 1885, and operated through World War II to mix tetryl and black powder to make booster pellets, is demonstrated by Dick Chambers, proof technician in Picatinny Arsenal's Industrial Operations Directorate (IOD). When found recently by Chambers in a brook at the Dover, NJ, installation, the blender was rusty and mud covered. Looking on are Harry Bullock (left), Arsenal Museum curator, and Sam Zarra, chief of IOD's loading division.

Natick Leaders Cite 11 for 1974 Achievements

Gold and silver pins recognizing achievements in research, engineering and administration were among awards presented recently to 11 employes of the U.S. Army Natick (MA) Development Center.

John C. Perry received the Technical Director's Gold Pin for Engineering, in recognition of performance as project officer in the development of the Army Mobile Field Kitchen Trailer.

Dr. John M. Nystrom and *Dr. Robert K. Andren* shared the TD's Silver Pin for Engineering. They were honored for processes for combating water pollutants from Army munition plants, and design of a pilot plant for conversion of cellulosic wastes into useful products.

Dr. Howard R. Moskowitz, head of the Sensory Psychology and Methodology Group, Behavioral Sciences Division, won the TD's Gold Pin for Research. He was recognized for systematic application of food preservation research to improve taste, and for design of food preference surveys and mathematical evaluation models.

John E. Rogozenski Jr. gained the TD's Silver Pin for Research for his role in developing systems analysis and computer techniques used in the design of ration cost systems, menu analysis and planning and food service evaluations.

Henry Weisgold was awarded the Commander's Gold Pin for leadership in administration. He was credited with managerial expertise in reducing NLABS' energy consumption by almost 50 percent during the final quarter of FY 1974.

William Flynn's implementation plan, guidance and execution of an Army Materiel Command records clean-out campaign led to his selection for the Commander's Silver Pin Award for leadership in administration.

CPT James R. Siebold, Food Services Laboratory, won the CO's Quarterly Military Award for Engineering while serving as project officer in surveying customer opinions of cash foods and menu combinations.

MSG David E. Dexter received the CO's annual Military Award for Engineering. He was cited for demonstrating the military use feasibility of an automatic bakery system to reduce labor costs and improve over-all quality of baked goods.

1LT Stephen J. Wallner was presented with the CO's annual Military Award for Science . . . "for research on the extraction and isolation of pectinase inhibitors" used to retard the degradation of cell walls and thereby the spoilage of tomatoes.

Morris Campbell, Clothing and Equipment Materials Engineering Laboratory, received a Special Act/Service Award for achievements involving useful conversion of surplus and obsolete materials.

Yuma Proving Ground Commander Honors Employes

Yuma Proving Ground Commander COL Hugh H. Patillo honored achievements of 33 YPG employes when he recently presented monetary and nonmonetary awards.

A Special Act or Service Award of $500 was presented to Norma "Jean" McHenry. Monetary awards for suggestions were made to Michele R. Watts, $115; Robert N. White, $110; Torbio T. Bachicha, $105; SP6 Peter J. Haywood, $100; Anthony G. Bottone, $70; Eugene E. Frey, $55; CPT Lawrence L. Stetson, $50; Walter H. Robinson, $50; John Y. Guerrero, $40; Harry Christensen, $40; and Robert H. Perrine, $25.

Mary A. Hazier and Raul J. Ilizaliturri received Outstanding Performance Ratings (OPR), accompanied by Quality Step Increases (QSI). Kendrick E. Miller, Ida M. Ford and Kenneth R. Price also received QSI awards. An OPR with a Sustained Superior Performance Award and $200 each went to Charles A. Tawzer, Roger E. Walden and Maurice Evans. Loye E. Campbell received an SSPA and $150.

OPRs were also presented to Jack F. Osborn; Ralph S. Cabrales; Lynnes L. Sparks; Effie O. Van Lanen; Nancy J. Wahl; Arvie D. Johnson; Joan H. Willhite; Sandra E. Lopez; Nancy L. Phillips; Helen G. Ketchum; and John C. Klick.

2 BRL Employes Named Fellows for Achievements

William Mermagen

Dr. Ingo May

Two employes at the U.S. Army Ballistic Research Loboratories, Aberdeen (MD) Proving Ground, were recently named BRL Fellows in recognition of scientific and engineering excellence.

Dr. Ingo May and William Mermagen were inducted at ceremonies observing the fifth anniversary of the formation of the BRL Fellows. Norman L. Klein, deputy for Science and Technology, Office of the Deputy Commander for Materiel Acquisition, U.S. Army Materiel Command, was a guest speaker.

Dr. May, chief of the Ballistic Chemistry Branch, Interior Ballistics Lab, was cited for developing methods of designing charges and igniters for large-caliber weapons. The citation credits him with a key role in the Army Fundamentals of Ignition in Propellants Program, including propellant evaluation for the SMAWT (Short-wave, Man-portable, Antitank Weapon Technology) program. Dr. May has a BS degree in chemistry from Gannon College and a PhD in physical chemistry from Case Western Reserve University.

Mermagen is credited with developing telemetry systems for withstanding high-g loads, and for analysis of high-g telemetry applications in Army launchings of projectiles up to 60,000g. He also researched observable radiation phenomena occurring with ablating hypervelocity projectiles.

Mermagen is assigned to the Physical Measurements Section of BRL's Exterior Ballistics Lab. He has a BS degree from Fordham University and an MS degree in physics from the University of Delaware.

WSMR Suggestions Save Army $9,000 Annually

Estimated annual Army savings of $9,000 justified suggestion awards totaling $660 presented recently to four civilian employes at the U.S. Army White Sands (NM) Missile Range.

Raul M. Ramos, assigned to Transportation and Maintenance, modified scanner assemblies which reduce breakdowns, saving $5,500. *John A. Womer*, Range Control, suggested use of computers and terminal units for faster transmission of evacuation notices and road-block information.

Genevieve E. Schure, Range Programs, devised a new system for processing a master schedule, thus eliminating extraneous data and reducing required printed copies. *Nicolas Y. Ramirez*, Equipment Management, contributed to WSMR conservation with a suggestion for recycling fuel.

Cost Reductions Earn $410 for WSMR Employe

Two suggestions credited with saving the U.S. Army more than $3,058 annually have gained awards totaling $410 for Earl P. O'Brien, a mathematician at White Sands (NM) Missile Range (WSMR).

O'Brien received $295 for improving data reduction procedures and reducing the quantity of instruments required to support each test, saving more than $1,800 annually in programing and labor costs. He received a $115 award for a modification to a frequency-analysis program used to improve the management information system with a credited cost reduction of more than $1,240 annually.

Mathematician Receives $100 Special Act Award

A $100 Special Act or Service Award was presented recently to Robert E. Green, a mathematician in the Instrumentation Directorate at White Sands (NM) Missile Range.

The award citation recognized Green's work as coauthor of a technical paper on filtering of high-dynamic trajectory data. The findings are reported to be of special value to researchers in estimation and control theories and atmospheric perturbation studies.

A native of Texas, Green has a BA degree from Hardin-Simmons University and an MS degree from New Mexico State University, both in mathematics. The award-winning paper was coauthored by Dr. Wiley Thompson of the Electrical Engineering Department, NMSU.

DARPA Investment Yields . . .

Electrons From Cold Emitters

By Ralph L. Norman, Jerry W. Hagood and Joe Shelton

The director of Materials Sciences, Advanced Research Projects Agency, elected in March 1970 to fund The Department of Ceramics Engineering, Georgia Institute of Technology, in a program for the development of melt-grown oxide-metal composites for electron emission applications at a cost of $120,000. It was a good investment.

These electron emission applications are better known in the scientific vernacular as field effect emission. The basic idea was to find a way to eliminate the heated emitter in the vacuum tube, with its many associated problems, by replacing it with a cold emitter. A new material had to be developed to do this.

Background. The vacuum electronic tube began with Edison's invention of the incandescent light in 1883. Although not immediately known, the same hot filament which gave off light also emitted electrons from its surface under certain conditions—a process that came to be known as thermionic emission.

A device known as the Fleming electric valve was patented in England in 1904. Containing two elements, a heated filament or emitter and a conducting plate called a collector, all in a vacuum, the valve could be used to detect radio signals.

De Forest added a third element, called a grid, to the tube in 1906. The grid is a mesh or open-weave screen placed between the emitter and the collector; when elctrically charged, this screen controls the flow of the electrons in the space between the emitter and the collector.

This 3-element device, which is capable of radio signal amplification, formed the foundation of all modern radio equipmen until the invention of the transistor in 1948. The transistor is a solid-material device utilizing no vacum cavity or low-pressure gases for its operation.

The transistor, like the vacuum tube, is a practical electronic amplifier and in the past 20 years it has replaced the vacuum tube in many electronic applications. Nonetheless, vacuum tubes are still used in many applications from home TV sets to extremely high-power military electronic devices.

Thermionic Emission. Since vacuum electronic tubes obtain the electrons required for their operation from some material which gives off electrons when heated, this material is either formed directly into a filament or is indirectly heated by a filament.

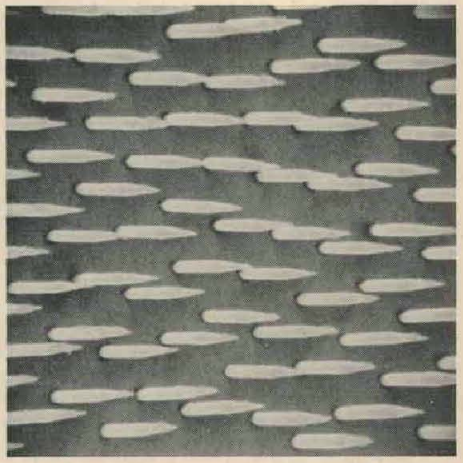


Fig. 2. Oxide has been etched away to leave chemically sharpened extended metal fibers. The magnification is 6,000.

The heated emitter appears, at first glance, rather satisfactory as a source of electrons for the vacuum electronic tube but in actual devices is associated with many problems.

Emitter heaters operate at rather high temperatures and are very inefficient since most of the input energy is given off as heat energy instead of emitted electrons. Results are somewhat comparable to those of the incandescent light bulb where the input energy is mostly given off as heat instead of light.

Since the incandescent light bulb is filled with an inert gas, the excess filament heat is rapidly carried away by convection. In vacuum tubes, elaborate emitter and/or filament cooling techniques are often necessary, especially in high-power applications.

This excess heat consumes extra space both inside the tube and in the electronics device in which it operates. Care must be exercised in the design and manufacturing processes of the tube to prevent later warpage, electrical shorting, destruction of vacuum, and other effects by the high temperatures during tube operation.

Problems here mentioned are just a few of the reasons why it is desirable to eliminate the heated emitters from the vacuum tube since they are the primary reason for its ultimate failure.

Cold Emission. The idea of obtaining electrons from a cold (ambient temperature) emitter has been considered for a long time. Theoretically, the idea works and is known as field-effect emission.

The most promising approach involves use of a few million ultrafine metallic fibers, perhaps made from tungsten, projecting from a few square centimeters of a conducting plate which serves as the source of the electrons in the circuit. The electrons will be emitted from the metal fibers when a voltage source is connected, as shown in Figure 1.

Experimentally, electrons have been emitted from single tungsten wires after appropriate pointing by chemical means; however, the area of the individual tip is very small. Consequently, the current per wire is also small (less than a microampere) and many millions of pins or fibers are required to provide the necessary electrons for a useful device.

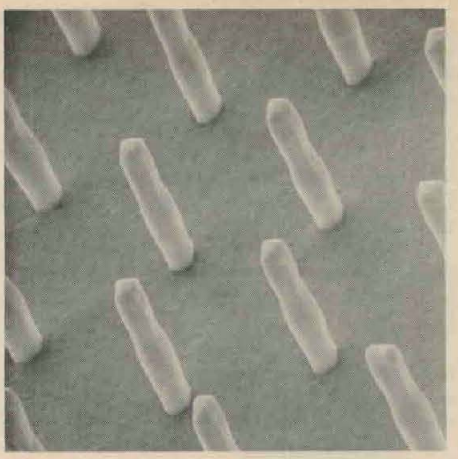


Fig. 3. This 19,400 magnification illustrates some shapes that are available. Fibers also may be etched below oxide surface and sharpened.

Photos illustrating this article were furnished by Dr. A. T. Chapman, professor of Ceramics Engineering, Georgia Institute of Technology.

Fig. 1. Photomicrograph Zero$_2$-W oxide-metal composite, magnified 600 times.

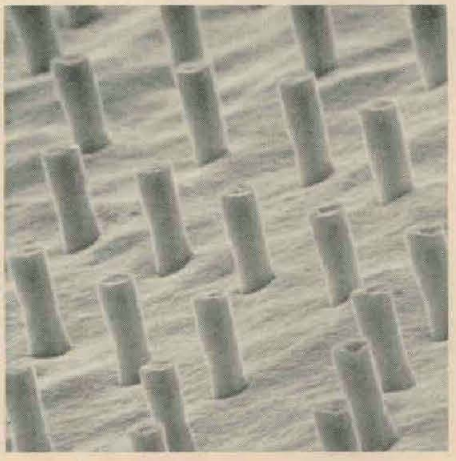


Fig. 4. Unsharpened fibers extend above surface at 20,800 magnification.

Further, these fibers must be spaced such that approximately a million or more are available per square centimeter of the emitting surface. These minute fibers must be structurally stable under the stresses encountered by the tube in use—the high accelerative forces of a missile, for instance — and under the electric field forces which are rather high.

Electrically, each fiber must be conductive and continuous, and a manufacturing process must be available to weld the fibers to the plate which is the source of the electrons.

The final emitter must be designed to ensure that all fibers project the same distance to subject each of them to the same electric field forces.

The Ideal Material. Ideally, one would like a material similar to that illustrated in Figure 2. Each fiber would be approximately the same distance from all its next nearest neighbors, with each fiber structurally supported by a high-resistance insulating material, perhaps a ceramic or glass of high strength.

The density of the fibers should be one million to a few million fibers per square centimeter surface area. Size of the individual fibers should be variable in a controllable manner. The over-all matrix of fibers and the surrounding insulating material should permit shaping by common manufacturing processes such as cutting, grinding, polishing, etc.

Further, one could magically hope that in the ideal material the metallic fibers and the insulating material would differ sufficiently chemically to enable chemical processing as well as machine processing.

The Real Material. The program at GIT (Georgia Institute of Technology), directed by Dr. A. T. Chapman, has recently produced materials with almost exactly these demanding requirements. Containing many very small metallic fibers uniformly aligned in an insulating ceramic matrix, the composites are produced by radio frequency induction melting the oxide-metal mixtures. A technique called "unidirectional solidification" is used to achieve the aligned structures.

Performance. Early experimental results at GIT and elsewhere indicate these new materials perform well as cold field effect emitters. Currents of 100 milliamperes per square centimeter have been obtained for over 2,000 hours. No noted decrease with time and currents of 0.5 amperes per square centimeter have been routinely observed.

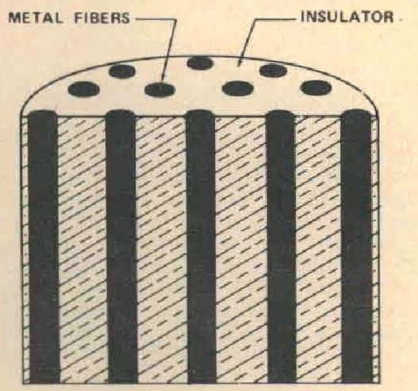


Fig. 5. Oxide-metal composite for field-effect emission.

RALPH L. NORMAN, JERRY W. HAGOOD and JOE SHELTON are project managers in the Advanced Research Projects Support Office, U.S. Army Misile Research, Development and Engineering Laboratory, U.S. Army Missile Command, Redstone Arsenal, AL. Respectively, they hold the following degrees: JD, MAPA, LLB, and BS in engineering physics; BS in electrical engineering; BS and MS in physics. The authors have been active in high-technology areas for several years.

Another characteristic extremely valuable in many electronic applications is that cold field emitter devices are truly "instant-on." Several TV manufacturers advertise that their sets are "instant-on"; however, they achieve rapid activation of the set after it is turned on by keeping its vacuum tube emitter filaments activated to approximately 40 percent power.

This lower power level enables the emitters to produce electrons very rapidly after the set is turned on. Since this new emitter operates at room temperature, it will give both picture and sound instantly. It will not require electric power during the time the set is not in use, as some present sets do, just to keep them warmed up to be ready to be "instant-on."

Future. These results predict the appearance of a whole family of new vacuum electronic devices. With the elimination of the emitter heater, circuitry and manufacturing complexity decrease. The total absence of the excess heat eliminates cooling equipment and allows device packaging in a smaller envelope.

Predictors believe that this new device will replace many present vacuum electronic tubes, especially tubes utilized in high-power equipment; also, that the lifetime will be longer than that of heated emitter tubes, and that it will result in an over-all cost reduction for consumers.

Military Applications. Extensive military applications for this new material are anticipated because of reduction of the size of components, weight, power requirements, and heat output. These factors are critical in aircraft and missiles. Several patents have been issued on lasers and electronics. Applications are being considered in optics and relativistic electron devices.

Pinpoint Delivery

A 155mm towed howitzer is extracted from a U.S. Air Force C-130 aircraft during a Low Altitude Parachute Extraction System (LAPES) test at Fort Bragg, NC. The test was conducted to develop LAPES procedures that reduce delivery time and threat to aircraft by enemy fire while operating in forward combat areas. In addition, use of the system lowers rigging time and provides a controllable means of pinpoint delivery.

Speaking On...

(*Continued from page 23*)

The R&D program for our general-purpose forces is designed to build on these advances and to bring them to full fruition. At $3.6 billion, this program is the largest mission element in our over-all RDT&E request.

In this period of intensive competition and change, I believe that this high level of investment is necessary. We need to maintain our technological lead where it already favors us and will close the gap in selected areas where we cannot allow ourselves to be behind.

Recent experience has demonstrated that our military technology—the result of past investment in R&D—can be decisive where it is skillfully employed against current Soviet technology, but that new Soviet weapons which are both innovative and advanced are very effective.

No single development is likely to dominate the battlefields of the foreseeable future, however. We will require an intricate orchestration of many of the emerging new developments to remain competitive with an adversary who is relatively unconstrained in numbers of weapons and manpower.

Each tactical warfare R&D program—whether it is designed to establish new options, or whether it is a full-scale system development intended for deployment—has been reviewed rigorously from a number of viewpoints:

- Military mission deficiencies have been examined and prioritized.
- The demonstrated state of technology has been examined.
- Alternatives have been established, many as competitive efforts.
- Improvements to existing systems have been initiated where they may offer the most cost-effective approach.
- Clear milestones in cost and performance have been established.
- Multi-Service reviews have been made to eliminate needless duplication. Foreign designs have been considered.
- Rigorous test and evaluation criteria have been established. The final scrubbed program of R&D for our general-purpose forces is described in Section VI of this Statement. I will here highlight the major objectives in several areas.

Ground Forces. Ground warfare in the future will be characterized by highly mobile and densely deployed armor and air defenses. Concentration of firepower will reach new levels of intensity. Electronic warfare will be robust and sophisticated. Precision weapons and new techniques for target acquisition and control of firepower will change the way the battle is fought and the way it can be won.

Our ground forces will be successful in this difficult new environment only if the program of R&D produces required new weapons and support systems which are superior, which work reliably in the field, and which we can afford in the quantities needed. Our R&D program is designed to do just that. I believe that it is a well-planned program and that it will be successful.

The new main battle tank (XM-1) prototypes will demonstrate in 1976 whether they can achieve a new magnitude of effectiveness and survivability within the stringent cost objectives established for them. Meanwhile, the M60 series will continue to be improved.

Similarly, existing attack helicopters will be improved and modified for TOW while the Advanced Attack Helicopter (AAH) demonstrates in competitive prototypes whether it can achieve its goals in cost and performance. Development of the A-10 attack aircraft is virtually complete. A new dimension in air-delivered antiarmor firepower will be achieved by these developments.

Night vision based on infrared thermal imaging is being developed for a variety of systems. Much work remains to produce this capability at reasonable cost, but I foresee the day when it will be ubiquitous on the battlefield and will change warfare.

The feasibility of a variety of precision weapons is being established by prototype efforts. Notable last year was progress on the Cannon Launched Guided Projectile which is fired from existing 155mm guns and can hit a moving tank with pinpoint accuracy at a range measured in miles.

HELLFIRE is another. Like other candidates, it will only be developed beyond the option stage if its operational and cost effectiveness can be firmly established. Mini-RPVs (remotely piloted vehicles) will institute a radically new capability for location of targets and guidance of weapons.

Our present air defense systems lack the mobility, firepower and all-weather capability needed in the European environment. The choice of the ROLAND II short-range air defense system for final development will correct this deficiency and will help achieve NATO standardization through a new kind of cooperative effort with our allies.

For the future, SAM-D technology still remains the most attractive possibility for eventual replacement of HAWK and Nike Hercules (missiles). It will undergo rigorous testing and will be carried forward only as the tests are successful and as costs can be controlled.

Finally, we initiated new efforts last year on comprehensive improvements of our electronic warfare capability in the field Army. I request support for continuation and enhancement of this cohesive overall program; it is important and urgent.

Tactical Air Forces. Our over-all investment in tactical air is very large, both in terms of initial acquisition and in terms of operational costs. It is imperative that we learn to apply constrained investment dollars and to use our assets more efficiently; it is equally imperative that we maintain the superiority in capability that we enjoy today.

One Major Thrust towards these ends is the F-16 Air Combat Fighter program, which has evolved from the competitive lightweight fighter prototype effort. It represents a departure from the trend towards heavier and increasingly costly and complex fighters. It is an opportunity to strengthen our over-all force structure within affordable bounds.

But the success of this program has yet to be demonstrated—it will rest on our collective management determination to hold down the cost. Whether the Navy can effectively build on a similar opportunity remains to be seen.

A second Major Thrust is to be more effective in our use of existing aircraft. More efficient command and control can achieve this. A system such as AWACS, although expensive in itself, can be cost-effective because it enhances significantly the effectiveness and therefore the value of billions of dollars of assets.

A third major avenue for reaching the above goals is focused on precision delivery of air-to-ground weapons through terminal guidance. A remarkable set of capabilities has been brought into being in the last several years—such as WALLEYE, MAVERICK, CONDOR, and laser-guided weapons.

These are being expanded to provide all-weather and night-time precision delivery at extended ranges. With cost as a driving criterion, the many technology demonstration programs currently being supported will narrow down to a few approaches which will comprise our needed future operational capability.

Because of the proliferation and sophistication of ground-based air defense, the broad area of defense suppression is receiving continued emphasis; it will be the key to effective use of tactical air over enemy territory. In addition to stand-off precision weapons, we are initiating and deliberately pacing programs for improved anti-radiation missiles, precision location and strike systems using TOA/DME guidance, advanced airborne electronic warfare capability and remotely piloted vehicles (RPVs).

Naval Forces. Our tactical naval forces must be able to maintain our sea lines of communication, project power across oceans and, in peacetime, provide presence in support of U.S. interests and policy throughout the world. These capabilities are severely challenged by aggressive Soviet naval developments in submarines, surface ships and long-range, land-based naval aircraft, all armed with an expanding sophisticated antiship missile capability.

I believe that the greatest danger to our sea lines of communication is from the growing Soviet nuclear attack submarine force. A coordinated long-range plan is well under way in response to this threat.

We are emphasizing a spectrum of approaches which will greatly enhance our ability to detect, localize and attack submarines. New concepts for towed array and deployable surveillance systems are in development. Complementary ship-based and airborne ASW systems and promising sensor developments are moving forward.

Ship defense against Soviet antiship missiles has been a thorny problem for years and still is. For over-all fleet defense we need a system such as AEGIS, with its associated SM-2 missile and its ability to control the firepower of other ships, in order to counter sophisticated and intense attacks.

For self-defense of individual ships, we require missile and gun systems having significantly better capability than those which exist. We must progress more rapidly not only in these areas, but also in the integration of these systems in ship platforms. This process is too slow at present.

For offensive capabilities, the HARPOON antiship missile has almost completed development and will give the fleet a powerful new punch. Our nuclear attack submarines provide a formidable

offensive capability and R&D in this area is being encouraged.

Newer ship types, such as the Patrol Hydrofoil Missile Ship, powerfully armed with HARPOON, have higher speeds, tactical flexibility and relatively low cost. Of the other new possibilities, the Surface Effect Ship program has been slowed down to provide a stronger supporting base of technology and of operational studies before proceeding with an investment of this magnitude.

Technology Base Program. Our technological initiative rests ultimately on the basic and exploratory research which make up our defense-related technology base. This effort is a critical part of the Group One, "creation of technology options," programs discussed earlier. It gives rise to the fundamental new opportunities which have been the hallmark of our post leadership—achievements such as jet engines, lasers, precision weapons, satellites, billion-bit-per-second computers and communications systems.

I have been seriously concerned over the decline and erosion of our technology base effort. With the level funding it has received, real effort has decreased 40 percent over the last decade. Many members of Congress have shared my concern and recognize its debilitating implications for the future.

In last year's testimony, I stated that I would defer a request for a substantial increase in technology base funding until I strengthened the framework in which such an increase would be used.

During the last year we have: Enlarged and strengthened the ongoing tri-Service topical reviews of technology to increase inter-Service coordination and reduce unnecessary duplication and overlap; strengthened our relationships with the university research community; and further evolved and emphasized the Technology Coordination Paper process to allow downward or upward adjustments in appropriate areas.

I am now satisfied that our technology base efforts are organized properly, are managed well, and that they have renewed and cohesive direction.

We have also completed a year-long DoD *Laboratory Utilization Study*, which has better defined the role of in-house laboratories and paved the way for achieving my objective of providing them with block-funding and greater management autonomy and responsibility.

This Study also confirmed my concern —shared by many—that the Defense Department may have become excessively inward-oriented in terms of the balance between in-house and contract research in industries and universities. We have established a broad action plan, including drawdown of laboratories' manpower, for redressing this balance.

I am convinced that now is the time to act. I am asking for an increase in real funding for the technology base effort. These increases are to be accomplished without increases in the RDT&E performed by in-house organizations. I earnestly solicit your support for this action.

Finally, I want to recognize explicitly the important role of Defense Advanced Research Projects Agency (DARPA) as part of our technology base. A unique research organization, it has been a catalyst in responding rapidly to needs and opportunities and has established the lead in speculative new areas of great national importance. A set of DARPA's new thrusts will be discussed later in this Statement.

TABLE I ($ Millions)

CATEGORY	FY 1974	FY 1975	FY 1976	FY 7T	FY 1977
Research	304.1	308.3	340.1	86.8	354.4
Exploratory Dev	1,062.4	1,080.5	1,228.8	314.4	1,321.0
Advanced Dev	1,416.1	1,697.8	2,129.9	664.6	2,962.0
Engineering Dev	2,540.0	2,929.1	3,783.4	912.0	3,516.0
Mgt & Support	1,118.7	1,179.4	1,343.3	354.1	1,417.7
Oper Systs Dev	1,753.5	1,420.4	1,411.1	351.0	1,436.4
TOTAL RDT&E	8,194.8	8,615.5	10,236.6	2,682.9	11,007.5

TABLE II ($ Millions)

MISSION AREA	FY 1974	FY 1975	FY 1976	FY 7T	FY 1977
Tactical	2,878.4	2,949.3	3,674.7	961.5	4,090.3
Stratgeic	1,924.4	2,141.0	2,534.7	674.4	2,453.1
Defensive Systems	682.6	659.2	744.5	181.8	841.9
Technology Base	1,386.5	1,415.5	1,610.5	413.2	1,731.8
Adv Tech Dev	200.4	255.2	315.2	91.4	435.1
Mgt & Support	1,122.5	1,195.3	1,357.0	360.6	1,455.3
TOTAL RDT&E	8,194.8	8,615.5	10,236.6	2,682.9	11,007.5

TABLE III ($ Millions)

DEPARTMENT	FY 1974	FY 1975	FY 1976	FY 7T	FY 1977
Army	1,942.3	1,749.4	2,189.4	585.6	2,405.9
Navy	2,704.5	3,051.6	3,517.7	903.8	3,798.1
Air Force	3,061.9	3,298.9	3,903.2	1,034.0	4,110.9
Defense Agencies	486.1	515.6	626.3	159.5	692.6
TOTAL RDT&E	8,194.8	8,615.5	10,236.6	2,682.9	11,007.5

RDT&E REQUEST IN SUMMARY. The FY 1975 funding is $8,616 million ($8,557 million in FY 1975 Appropriations Bill and $59 million in the FY 1975 Supplemental request). The following factors contribute to the FY 1976 request of $10,236 million:

- Approximately $200 million is comprised of items appearing in other accounts in FY 1975. These items, generally in accord with Congressional direction, have been moved to RDT&E for FY 1976. The list of items is available for the record.
- Inflation accounts for something between $700 million and $1,000 million, depending upon the exact inflation factors used. I believe that something approaching the higher number is more probable.
- The remainder of the difference between the FY 1975 appropriation and the FY 1976 request represents an increase of real effort of $400–$800 million. This increase would reverse the trend of the last decade and establish an over-all RDT&E program for the long haul.

The budget itself is presented in terms of budget activities, and detailed line-item information by budget subactivity is contained in the justification books made available to the Committee.

RDT&E Categories: The request in RDT&E categories is given in Table I.

As discussed previously, the Group One program (comprising the budget categories of Research, Exploratory Development and Advanced Development) has been increased purposefully to enhance and revitalize our base of technology options for the future.

The Group Two programs (Engineering Development, Operational Systems Development) show an increase mainly because of the peaking of B-1 and TRIDENT and the initiation of several programs such as the Air Combat Fighter. These increases are not entirely offset by decreases in systems whose development is essentially complete—such as the F-15, A-10 and HARPOON.

The Management and Support Category is being maintained at about a constant effort level. The dollar increase reflects mainly civilian salary raises. An analysis of our request shows that, overall, about 42 percent will be used for the technological base and the creation of options; the other 58 percent will be used in support of development of military hardware for production and deployment.

Broad Mission Areas: My detailed statement discusses the program in terms of mission areas; another way of analyzing the entire RDT&E program is in terms of these broad mission areas (see Table II).

Military Departments: To complete this summary of funding, the distribution by military departments is provided in Table III.

CONCLUDING REMARKS. Mr. Chairman, on the eve of our Bicentennial Year, we as a nation face difficult decisions in building for ourselves an enduring future. In a changing and uncertain world, we must have the perception and resolve to build on our strengths. One of those strengths is technological initiative.

But the technological competition is very real. Both friendly and adversary nations—particularly the Soviet Union—are competing. The Soviets seek to wrest the initiative from us. The stakes in this competition are high. They involve national survival.

I have stated my belief that the U.S. has the initiative now—we lead in most areas of technology. I believe that maintaining that lead should be an essential element of our national policy. But, more than declaration is required. We must be prepared to invest accordingly.

The choices to be made are difficult ones. Social demands are pressing and are growing. The outlays for our military manpower dominate the Defense Budget. It is always tempting to fulfill near-term needs at the expense of the future. And RDT&E is our investment in the future.

Whatever these choices are, they should be made consciously by us as a nation. I am confident we will choose well.

Maximum Performance Takeoffs of Heavily Loaded Helicopters

By Dr. F. H. Schmitz & C. Rande Vause

Under standard atmospheric conditions, the helicopter is, by design, capable of hovering out-of-ground effect with its normal operating payload. Geographical factors and mission requirements in many operational situations, however, force the helicopter to operate far from these design conditions.

Hot days, high altitudes and heavy payloads often degrade the performance of the helicopter to the point where hovering out-of-ground effect and, hence, a normal takeoff are not possible. The pilot must then perform a STOL takeoff, manipulating the small amount of excess available power due to ground effect, to accelerate the helicopter to sufficient translational velocity where climbing out-of-ground effect can be maintained.

If the horizontal takeoff distance is constrained by the operating environment, it is necessary to maximize pilot-vehicle performance to clear obstacles in the departure path. This situation was encountered frequently in Vietnam.

For example, rescue helicopters often were dispatched to remote, hostile landing areas to evacaute troops. The tropical climate and high operating altitude limited the rescue helicopter's performance; "payloads" were frequently increased to the point where the helicopter became heavily loaded. Taking off under these conditions, from a confined area, quickly identified the "good pilot."

Although some pilots were able to fly these takeoffs much better than most other pilots, they were unable to indicate what it was they were doing differently. The program described in this article was initiated to identify and quantify parameters significantly influencing takeoff performance, and to develop a control technique the average Army pilot could use to improve heavy-load takeoff.

Sophisticated theorems of optimal control theory were first applied to an experimentally verified mathematical model of a heavily loaded takeoff. Results showed how efficiently the maneuver could be flown, but the procedure was difficult. Introducing additional constraints to the mathematical model, and reapplying optimal control theory, resulted in the development of a simple, 2-segment, near-optimal takeoff procedure consisting of a level acceleration segment followed by a constant-velocity climb-out. Application of this technique resulted in only a slight degradation in performance from the optimal procedure.

Two problems persisted. The distance required to clear an obstacle varies considerably with the velocity at which the pilot switches from the acceleration to the climb segment, and the "best" speed varies with weight and ambient effects.

The first question was: "Is there a best switching speed that will nearly maximize performance for all heavily loaded conditions?" It was observed that as the ship approached maximum gross weight, the best rotation speed asymptotically approached a "critical" rotation speed.

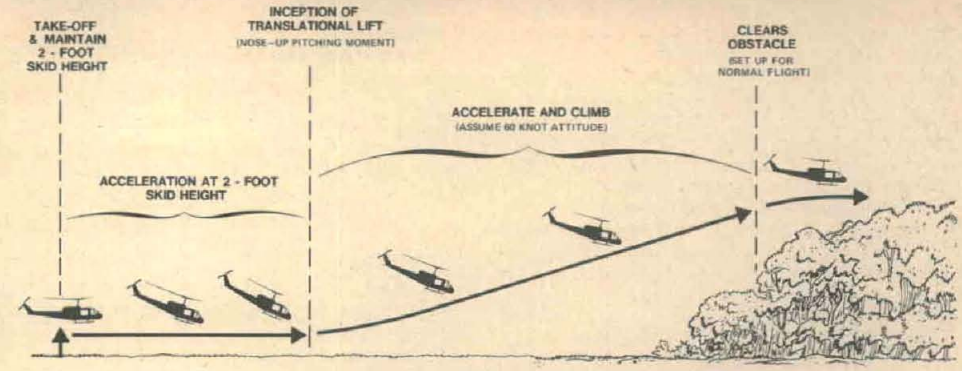


Fig. 1. Coordinated Climb Take-off Technique

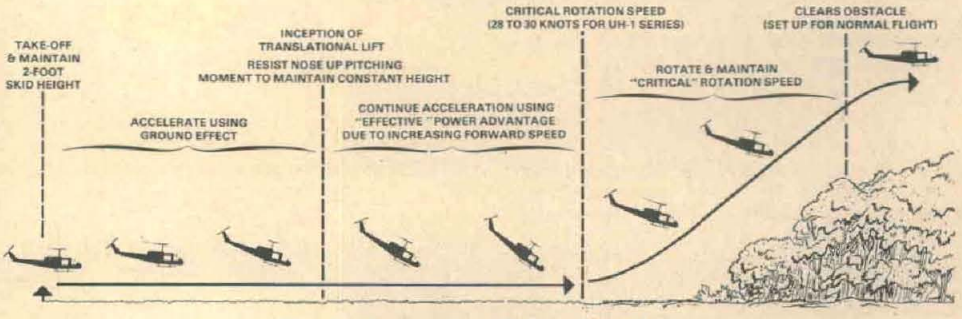


Fig. 2. Near-optimal Take-off Technique

Use of the critical rotation speed at all heavily loaded conditions results in only a slight increase in the takeoff distance. This penalty is more than outweighed by the operational simplicity of using a fixed critical switching velocity.

The second question was: "Is the best I can do going to be good enough?" i.e., "How much takeoff distance do I need to clear the obstacle in front of me?" To help the pilot resolve this question, a simple curve has been developed to relate the distance required to clear a 50-foot obstacle to the maximum hover height and the ambient temperature.

After checking the outside ambient temperature and maximum hover height, a pilot can read off a standardized placard the minimum distance required to clear a 50-foot obstacle. This knowledge significantly enhances the pilot's ability to judge whether or not a safe takeoff can be achieved.

Theoretical results obtained from the model have been correlated with existing data, and with a series of flight tests. Excellent correlation has been achieved, demonstrating that takeoff distances can be accurately predicted with the existing performance model, and that near-optimal performance can be achieved. During the flight tests, a number of Army pilots were instructed briefly on the near-optimal technique, and performance was dramatically improved.

As a result of this research, the 2-segment or "level acceleration" takeoff has been modified in the Army's latest "Standardized Aircraft Maneuver Guide": for the UH–1 series helicopters.

Figure 1 (Coordinated Climb Takeoff Technique) and Figure 2 (Near-Optimal Takeoff Technique) summarize the control policies for heavily loaded takeoffs as previously recommended and as currecently recommended by the Army.

This article summarizes several related, but somewhat independent, research efforts since the heavily loaded takeoff problem was first identified during combat operations in Vietnam. Each accomplishment is a notable technical contribution, including:

- Development of practical algorithms for solution of helicopter optimal control problems. Application of algorithms to yield optimum trajectories.
- Development and experimental verification of the heavily loaded dynamic performance model. Identification of the near-optimal takeoff trajectory. Analysis demonstrating the sensitivity of the near-optimal profile to parametric variations.

The major significance of this research, however, lies in the ability to apply results to solve conclusively the problem of operating heavily loaded helicopters from a restricted area.

DR. FREDRIC H. SCHMITZ joined the Ames Directorate of the U.S. Army Air Mobility R&D Laboratory (USAAMRDL), Moffett Field, CA, in 1970, as a research scientist on rotary-wing aircraft. Graduated from Rensselaer Polytechnic Institute in 1964 with an aeronautical engineering degree he received a PhD in 1969 from Princeton University and worked until 1970 in industry. He has authored articles on optimization and acoustic/performance tradeoffs of VTOL Aircraft.

C. RANDE VAUSE, a research scientist with USAAMRDL since 1966 when it was the Army Aeronautical Activity, has done extensive wind tunnel and flight research, with emphasis on instrumentation for V/STOL research. He has coauthored a number of reports on this work. Vause graduated from Brigham Young University in 1968 with a BS degree in mathematics and in 1971 received an MS degree in aeronautical science from Stanford University.

The Logistics Center's Role in SCORES

By LTC Robert C. Lybarger

SCORES is the acronym for the Scenario Oriented Recurring Evaluation System, developed recently by the U.S. Army Training and Doctrine Command (TRADOC) as a methodology for evaluating combat developments actions within a common framework of standard scenarios and selected real-world conditions of the current time frame. The system also is employed in analyzing capabilities and limitations of current and proposed force structures.

(Following a briefing on SCORES Apr. 17 at the U.S. Army Logistics Management Center, Army Materiel Command Deputy for Logistics Support MG J. W. Pezdirtz expressed a highly favorable response to this methodology.)

The initial application of SCORES involved evaluating, in turn, Department of the Army concepts for rapidly deployable light (Infantry/Mechanized) and heavy (Armored / Mechanized) corps. Currently, a corps organized in accordance with the new Echelons Above Division (EAD) Concept, as approved by the Chief of Staff, U.S. Army, is being evaluated in a European scenario.

This evaluation should evoke wide interest since the EAD Concept introduces significant changes in the logistics structure at the corps level. Geographic areas for other planned standard TRADOC scenarios include Alaska, Panama, Korea, and Southeast Asia.

All requirements originating within the TRADOC community that concern doctrine, organizations and materiel will be evaluated and justified in one or more of these standard scenario situations before they are implemented within the command or recommended for adoption to HQ, Department of the Army.

Logistical portions of SCORES evaluations are normally accomplished in two phases. In the first phase, the U.S. Army Logistics Center, Fort Lee, VA, and its associated logistics schools analyze the requirements and capabilities of a force for logistics support. Recommendations are proposed for combat service support unit additions, deletions, substitutions and deployment sequencing.

The second phase repeats the Phase I force analysis, and considers the impact of subsequent simulated wargaming results obtained from the Combined Arms Combat Developments Activity (CAC DA) at Fort Leavenworth, KS, to make necessary refinements to the force logistics structure.

In addition, major problem areas surfaced in Phase I are subjected to detailed analysis by all of the Army centers and schools to isolate and define requirements for organizational, doctrinal and materiel changes to improve the force in the current time frame.

With respect to methodology, SCORES is both evolutionary and dynamic. These characteristics are well illustrated by the new approaches the Logistics Center has initiated for determining support requirements for field forces. A consuming items model, in lieu of the commonly accepted FM 101-10-1 gross estimation techniques, has been developed for computing requirements for conventional ammunition and bulk petroleum products.

In order to define more precisely the major end item resupply requirements, and to assess a force's capability to recover, repair and evacuate battle-damaged equipment, the Logistics Center, in conjunction with the U.S. Army Ordnance Center and School, also has developed a mathematical procedure for quantifying expected combat losses.

These new techniques are not fully validated nor refined at this time. They are subject to adjustment as more reliable information becomes available and more experience is gained in their use. The following overview of the method of determining Class VII combat losses illustrates that they represent a forward step toward solving problems of predicting battlefield resupply requirements.

The procedure for assessing a force's capability to recover, repair, and evacuate battle-damaged equipment is based on an analysis of battle losses experienced in past wars and the results of war games conducted at CACDA.

With these data and the use of various operations research techniques, combat posture loss factors have been derived for selected tracked, wheeled and aircraft end items. By applying the appropriate combat posture factor to TOE equipment densities, the materiel losses of each unit in each sequence of a scenario can be estimated.

The procedure is being automated and printouts showing materiel loss estimates for a given force can be obtained. This printout information can be evaluated to determine what percentage of the damaged, but recoverable, equipment is repairable within the time and support level constraints of the scenario.

When combined with normal maintenance downtimes, these data form the basis for the total maintenance support requirements of the force being evaluated. Recovery, cannibalization and evacuation workloads for maintenance and transportation units can be identified and unit capabilities assessed. These determinations impact upon and reduce resupply requirements for major end items and repair parts.

In this connection, a list of command designated critical items for a field force is compiled with assistance furnished by TRADOC service schools. The list is correlated by the U.S. Army Quartermaster School with materiel-loss data to aid in tailoring major end items and repair parts in-country stockage requirements.

Provided to Army Materiel Command supply sources, the list is used in determining capabilities of the wholesale supply system to provide replacement items in the required time frame. This retail/wholesale interface evaluation often reveals limitations requiring further adjustments or modifications in the structure of the force in the field.

For example, should critical items losses exceed the wholesale stocks available for resupply, an increase in the general support maintenance capability of the force might become necessary.

SCORES evaluations are not developed in isolation. They represent coordinated efforts on the part of all interested elements of the TRADOC community, Army Materiel Command, and other military services. The system automatically creates situations in which logisticians and tacticians work directly together in solving combat support problems. This is a key feature of SCORES.

SEQUENCES	3	4	5			
EQUIPMENT / POSTURES	9	9	4	5	12	TOTALS
TANKS (54)	1/3	1/3	3/6	2/4	1/1	8/17
APCS (24)	0/1	0/1	1/3	1/2	0/0	2/7
VTRS (7)	0/0	0/0	0/1	0/0	0/0	0/1
MTR CARRIERS (4)	0/0	0/0	0/0	0/0	0/0	0/0
.50 CAL's (24)	1/1	1/1	1/1	1/1	0/0	4/4
WHEELS (96)	2/1	2/1	4/2	2/2	1/1	11/7

Combat Losses for Medium Tank Battalion (Destroyed/Recoverable)

LTC ROBERT C. LYBARGER is chief of the Exercise Evaluation Division, LOGEX Directorate, U.S. Army Logistics Center, Fort Lee, VA. He is a graduate of the U.S. Army Command and General Staff College and the University of Nebraska at Omaha.

Career Programs . .

Influenced R&D Careers . . .

Key Personnel Specialist Cathleen Durkin Retires

DEPUTY CHIEF OF STAFF for RD&A LTG Howard H. Cooksey honors Mrs. Durkin with Certificate of Appreciation.

Many who knew her as a source of career guidance when they were young officers in the Army Research and Development Specialist Program—including a substantial number who have since achieved status as generals—are among those who wish Mrs. Cathleen (Kay) R. Durkin "the very best" on her recent retirement.

Kay has influenced the careers of many hundreds of those who have enrolled in the R&D Officers Program since it was initiated in 1955. The Atomic Energy Officer Program, started in 1953, was joined with the new program. She served as chief, Military Personnel Team, Office of the Chief of R&D, redesignated Dec. 26, 1974, as the Office of the Deputy Chief of Staff for Research, Development and Acquisition.

Born and reared in Brooklyn, NY, Mrs. Durkin graduated from St. Joseph's College for Women and obtained a BA degree from Columbia University. She started her Civil Service career in 1941 at HQ First Army Recruiting Station. Her career has been rewarded by two presentations of the Decoration for Meritorious Civilian Service and 12 Outstanding Performance Ratings. She is recommended and under consideration for a career climactic prestigious award.

R&D Specialty Opportunities Challenging In Officer Personnel Management System

Implementation of the Officer Personnel Management System, based on the concept of dual specialty development for a "truly professional" capability, is expected to stimulate the long-established R&D Career Officer Program.

GEN John R. Deane Jr., prior to departing as Deputy Chief of Staff for Research, Development and Acquisition to take control of the Army Materiel Command in April this year, cited the options available under the OPMS.

In urging officers to "carefully evaluate professional development goals" and to consider all available options, he concluded his statement by saying:

"If you are seeking new challenges and looking for a future in a dynamic and vital field, I urge you to consider an alternate specialty in research and development under OPMS." He cited that the R&D Career Officer Program "has been in existence for 19 years . . . to provide a means of identifying and developing commissioned officers of proven ability for assignment to all R&D positions throughout the Department of Defense and Department of the Army."

GEN Deane stressed also that "the R&D Specialty remains compatible with the concept of OPMS . . . basic strength of the R&D Specialist lies in maintenance of traditional branch proficiency through a career pattern of alternating branch materiel command and staff assignments with assignments in the R&D field."

The ideal R&D officer, he said, brings valuable "user experience" into the R&D process as a result of having maintained proficiency in his basic branch, as his primary skill, while broadening himself in the alternate skill area of R&D.

Under the OPMS concept, the R&D Specialty is not a branch. Rather, it requires expertise and experience available from officers of all branches.

Eligibility involves at least eight years of commissioned service in any branch other than Chaplains, Judge Advocate General Corps, or the Army Medical Department. AMEDD officers may participate in an R&D program operated under direct supervision of The Surgeon General.

In that, by its nature, the R&D Specialty is an advanced entry opportunity for professional development—one that has led exceptional enrollees into grades as high as full general—nearly all position requirements are in field grades. Entrance into the specialty usually begins at the senior captain or major grade, although lieutenants may work into the program.

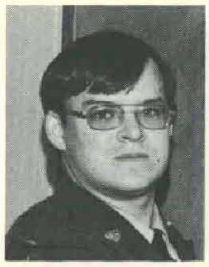
R&D Specialists are not limited to opportunities in research, development, test and evaluation (RDT&E) of armament, vehicles, aircraft, missiles, ammunition and numerous other items of military materiel.

Officers with a long-range, wide-angle viewpoint of opportunities, in both the military and civilian worlds, may develop skills in environmental, life and physical sciences; many areas of engineering, including human engineering associated with behavioral and social sciences; geodesy, nuclear science, and irradiation steriliaztion of food as well as other techniques of food preservation and packaging. Open to them also are virtually all fields of chemistry; materials and metallurgy R&D involving all kinds of metals, plastics, ceramics, alloys and laminates for specialized high-strength requirements; and program planning, budgeting, and management.

R&D Specialists career development opportunities also lead into such fields as ballistics, mechanics, molecular science, development of advanced power sources in a world currently plagued with energy resource problems, and military and civilian applications of laser technology.

As one exponent of the program put it: "Opportunities for R&D Specialists are limited only by the limitations of science, engineering and technology, which anyone with vision and ambition knows are limitless."

BMDSC Man Cites Education as Key to Success



SGT Jeffrey Herrell

Based upon the indisputable fact that education is the key to success, SGT Jeffrey D. Herrell, assigned to the Ballistic Missile Defense Systems Command, Huntsville, AL, appears assured of climbing the career ladder.

During three years he has been in the Army, SGT Herrell has completed 103 correspondence subcourses for an aggregate of 872 credit hours, as established for the military education program in which he is enrolled.

All of the courses are in specialist areas, with emphasis on administrative skills, including 130 of 194 credits needed to complete the Personnel Senior Sergeant requirements. He also has completed 18 semester hours toward an associate degree in business management as an enrollee in the LaSalle University extension program.

DoD, Industry Evaluating Quality of Shale Oil

Ten thousand barrels of refined crude shale oil, produced at the Naval Oil Shale Reserves in Colorado, have been delivered for evaluation to various government and industrial activities.

Recipients of production from the Paraho Oil Shale Demonstration Facility are the U.S. Navy, U.S. Air Force, U.S. Army, U.S. Coast Guard, National Aeronautics and Space Administration and the Energy Research and Development Administration.

Although energy yields from mined shale reportedly range from 84 to 92 percent, the processing is substantially more expensive than normal petroleum production.