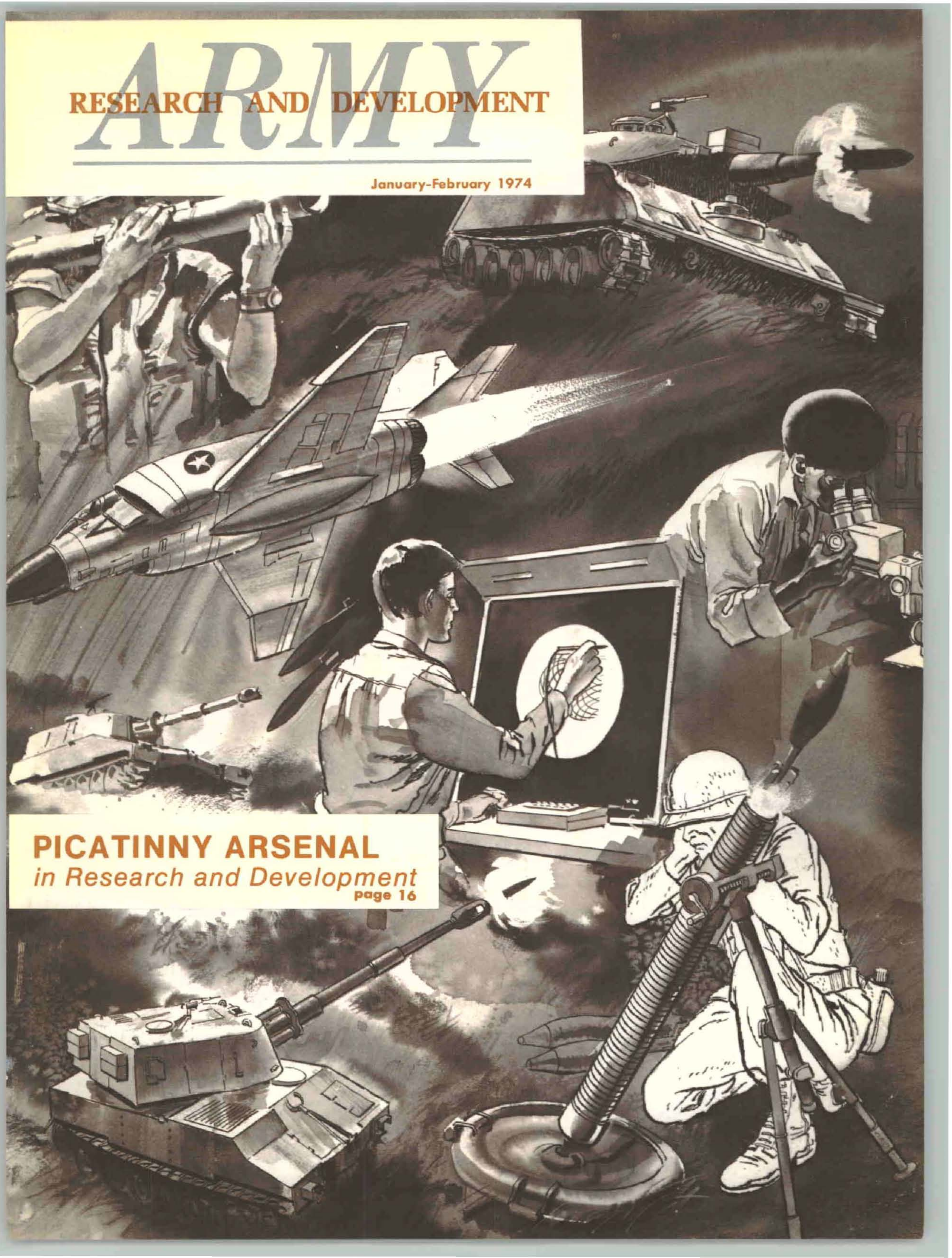
ARMY RESEARCH AND DEVELOPMENT

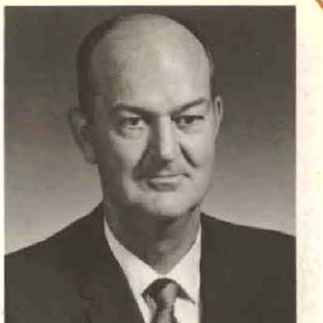
January-February 1974



PICATINNY ARSENAL
in Research and Development
page 16

SPEAKING ON . . .

Development of Energy Resources In Accelerated Interagency Effort



Dr. John L. McDaniel

Recommendations for alleviating the nation's energy crisis by applying the technology transfer techniques used by the U.S. Army Missile Command Research, Development and Engineering Laboratory, Redstone (AL) Arsenal, were presented recently by Dr. John L. McDaniel. Director of the laboratory since early 1970, and an arsenal employe since 1942, Dr. McDaniel spoke at a "Development of Energy Resources" seminar at Athens College, AL. Most of his address follows.

★ ★ ★

It is appropriate to give you some of the background on energy research. When I started checking into the background, however, I discovered that the background is now. In FY 1973, the total federal funding level for energy research was only $622 million, and this includes nearly a dozen federal agencies—Atomic Energy Commission, Tennessee Valley Authority, Department of Interior, and several others.

This funding level is infinitesimal when we consider the vastness of the problem for which some sort of satisfying solution must soon be found. And when we consider the projected energy demands for the future, we find that the vast problem of today will be considered minuscule in comparison. Figure 1 shows energy consumption since 1850, with projected consumption through the year 2000. We can see how the curve takes an almost vertical turn beginning at 1960, and the steepness of the projected curve past the early 1970s may be conservative.

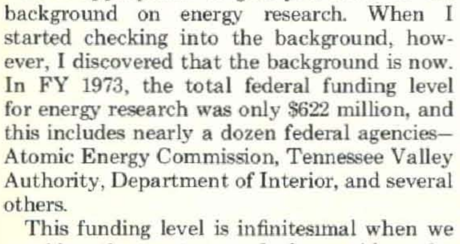


Fig. 1. United States energy profile

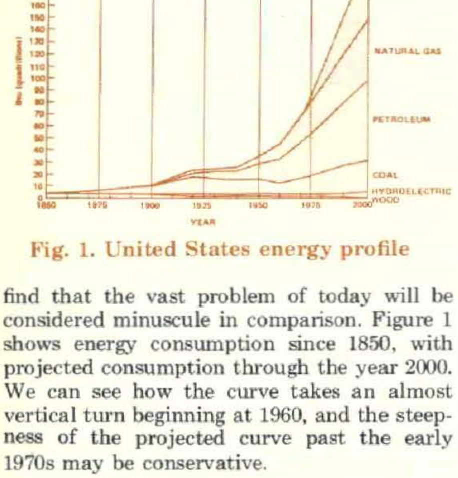


Fig. 2. Electricity consumption & projection

This is obvious when we look at the increase of per capita energy consumption in the form of electricity just from 1920 in the United States (Figure 2). In this one area of energy consumption, the figures have almost doubled every 10 years from 1930 through 1970. Combine this with the population increases during the same period, and it is not surprising that we have a skyrocket effect on our energy demands.

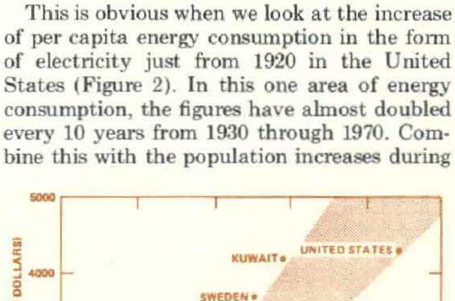


Fig. 3. Income versus energy use in 1970

The reason for this, or perhaps we could say the fact which makes it possible, is the increasing affluence which we enjoy in the United States. The Gross National Product more than doubled between 1950 and 1970, and we see from Figure 3 the very definite relationship between per capita income and per capita energy use. This indicates that energy costs money, and we already have clear indications that the unit cost of energy will also increase.

I think it is obvious at this point that energy supplies face astronomical demands at present, and equally obvious that these demands will increase. This is unfortunate, because the problems of supply have been very close at hand for all of us during the past year. The major concern of oil companies at present seems to be not to stimulate demand for their particular brand, but to fulfill existing demands.

You recall from Figure 1 that virtually all of our energy sources at present are fossil fuels, with all other combined energy sources making up a negligible amount. The problem here is immediate and obvious: Once the supply is gone, that's it.

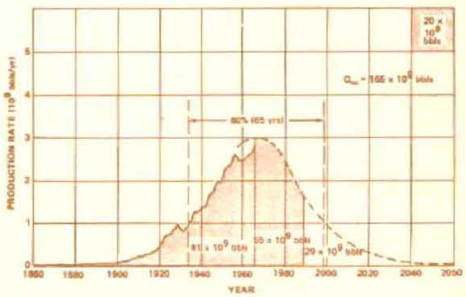


Fig. 4. Production cycle for North American crude oil

Figure 4 is from M. K. Hubbert's *Energy Resources,* in which he predicts that domestic crude oil production by the year 2000 will be well below the 1940 level. By this time all the easily-obtained oil will have been used up, and production will depend on sources now considered economically unfeasible.

Different problems exist for alternative energy sources. Nuclear power plants have elicited sometimes strident opposition based upon concern for the environment or the safety of the nearby population. Also, nuclear fuel has the same limitation as fossil fuels—it can be used up.

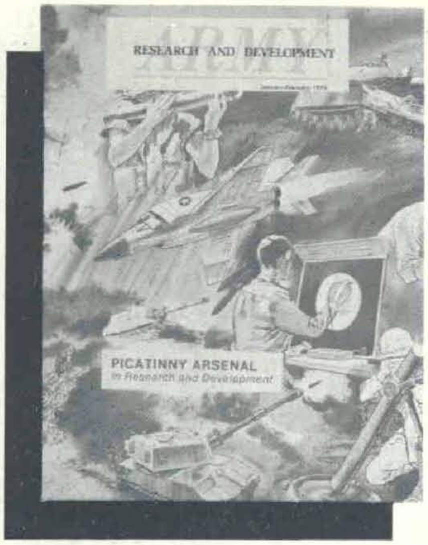
Hydroelectric power has very definite geographic limitations, as well as the problem of space. Even when a river and suitable terrain exist near large population centers, flooding the required number of acres is impossible from both economic and sociological standpoints. Large population centers, of course, have the most urgent demands for power.

Solar power, at its present level of development, costs 100 to 1,000 times that of conventional power generation methods. *Each thousand megawatts would require four square miles of collection equipment, which introduces the problem of space. Also to be considered would be the problem of rainy days.* (Italics added.)

Geothermal power is more theory than possibility at the moment, although a geothermal plant is in operation at the Geysers, 90 miles north of San Francisco. This plant is possible only because natural geothermal phenomena existed to be tapped.

In addition to the other problems cited,

(Continued on page 20)



ABOUT THE COVER . . .

The design is the creation of Picatinny Arsenal illustrator Ray Thorley. Picatinny Arsenal's origin dates to its critical role in manufacturing munitions during the American Revolutionary War, when it was known initially as Middle Forge. Continuingly important since that historic beginning in providing munitions for national defense, Picatinny has developed into one of the Army's major R&D establishments, with a mission involving nuclear munitions, warheads, bombs, mines, grenades, pyrotechnics, fuzes, artillery and mortar ammunition, rockets and numerous other defense products.

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FEATURES

DEPARTMENTS

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Selective Scanner . . .

Device Adds Realism to Missile Component Tests

TELEMETRY EQUIPMENT used with accelerator for XM88 arm-safe device in the Sprint missile system is exhibited by Picatinny Arsenal engineers (from left) Joseph Cappetta, Murray Rosenbluth and Steve Langdo. Langdo holds the carriage that transports the arm-safe device through the tester.

Simulated acceleration tests on intricate missile components may soon reflect more realistic flight environments with a new device developed at Picatinny Arsenal, Dover, NJ, that promises substantially reduced costs compared to actual missile firings.

Identified as a track accelerator, the unit is being utilized initially in testing the XM88 arm-safe device in the Sprint Missile system. During an actual firing, if a missile lacks sufficient acceleration, the arm-safe device can prevent warhead arming.

Use of a centrifuge for acceleration tests on components was ruled out sometime ago because its speed was insufficient to meet the Sprint's acceleration capabilities.

First-stage missile acceleration is simulated through application of an air gun principle to launch the arm-safe device on a carriage through a tunnel to a power-driven rotary drum. Dormant acceleration time is represented by movement of the arm-safe device along a straight path of the tunnel.

Second-stage thrust is simulated by a second acceleration assembly. The total time consumption for the entire mechanical operation along the 150-foot route assembly is two seconds.

Normal radio telemetry transmission frequencies are not adequate for data collection purposes with the new system. However, use of a transformer principle is proving satisfactory.

A transformer coil, located in the carriage, sends signals to a wire above the track on which the carriage rides. Signals sent to a bank of discriminators are transformed into telemetry data.

Objectively, trom the view of the two mechanical engineers, Joseph Cappetta and Steve Langdo, and Murray Rosenbluth, electronics engineer, credited with developing the device, all XM88 arm-safe devices and other similar missile system components will eventually be tested by the track accelerator.

HumRRO Evaluating Self-Paced Instruction

In an effort to find ways to improve self-paced instruction in job training courses, the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has awarded the Human Resources Research Organization (HumRRO) $82,879 for systems analysis of self-paced instruction.

Code named SASPI, the project will be conducted through utilization of the Army's self-instructional clerk-typist training course as its research vehicle. Information will be developed which may be helpful in formulating a model for management of self-paced training programs.

HumRRO researchers will initially examine student training performance at Forts Jackson, SC, and Ord, CA. This will be followed by a SASPI team assessment of the training environment at each center by surveying cadre and staff and a final comparison of training environment versus student performance.

MERDC Device May Ease Container Handling

Improvement goals of materials handling equipment under development by the U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA, include the reduction of weight and hazards, along with reliable, low-maintenance-cost operation.

Shortly before this edition went to press, the center announced that a step in this direction is represented by an in-house-developed top-lifting device for handling internationally standardized 8 × 8 × 20-foot containers.

Made of high-strength aluminum, the prototype device weighs less than 1,000 pounds, which is about one-third to one-half that of similar commercial spreader-bars made from steel.

Design tests have proved the protoype device structurally adequate for loads up to 90,400 pounds. It embodies the option of manual or automatic engagement to the containers, alignment guides, and lock/unlock indicators for all twist locks.

In a typical 8-hour shift, handling 20 containers per hour, the device can lower the load transferred at the crane hook by as much as 320,000 pounds over that customarily experienced.

U.S., Soviets Establish Marine Research Program

United States and Soviet Union scientists recently signed an accord to establish a joint marine environmental monitoring network that would make possible continuous measurement of pollution effects on marine organisms.

Aimed at rapid dissemination of collected data, the pact was signed following a series of meetings held by the U.S.-U.S.S.R. Joint Working Group on the Effects of Pollutants on Marine Organisms. Discussions were conducted under terms of an environmental pollution accord signed by President Nixon and Soviet Chairman Podgorny in May 1972.

The U.S. Environmental Protection Agency (EPA) has announced that the first step of the agreement calls for a bimonthly scientific journal to be published simultaneously in the U.S. and U.S.S.R. in English and Russian. The journal will contain articles reflecting the highest level of marine research being conducted.

The second step provides for establishment of a scientist exchange program, under which as many as 10 marine scientists from each of the two countries will exchange visits each year to lecture and to become acquainted with the state-of-the-art in marine research in the host country. Research methodology will be emphasized during early stages of the program.

Cannon-Fired Projectiles Aid Construction Work

Cannon-fired projectiles are finding hard rock targets in an exploratory technique of blasting for tunnels or emplacements for construction work. The evaluation project is being conducted for the U.S. Army Mobility Equipment Research and Development Center (MERDC) at Fort Belvoir, VA.

Rapid Excavating and Mining (REAM) is one of several methods being investigated. The projectiles are made of concrete poured into plastic casings and discharged into the rock by about 10 pounds of conventional propellant.

The REAM concept has thus far been applied to excavating a tunnel 13 feet in diameter and 45 feet deep, and construction of an atomic demolition munitions emplacement hole. It is viewed as a fast, inexpensive method offering potential for numerous military applications, including excavation for field fortifications, roadway cuts, quarrying, and drilling holes for emplacement of atomic demolition munitions.

Ten pounds of cannon propellant yields an average of over a ton of granidiorite rock during excavation. This ratio of return is about equal to that of high grade commercial dynamite.

Projectiles are fired from 105mm and 90mm barrels mounted on an Army M-107 carrier. Velocities of over 5,000 feet per second with two projectiles have been achieved.

A major advantage of the REAM process, according to MERDC personnel, is that rock in the impact area is shattered without causing extensive cracking beyond the surface of the tunnel walls, resulting in a safe tunnel without ribs, lagging and rock bolts.

WSMR Improves Launch Data Accuracy

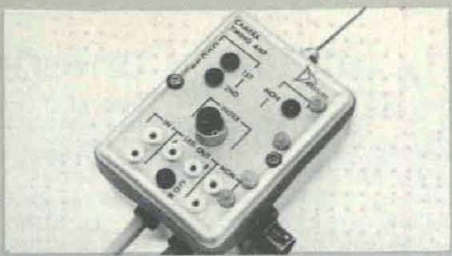


Photo Camera Timing Amplifier

Improvements in a Photo Camera Timing Amplifier are increasing the accuracy of data obtained by optical devices used to track, photograph and record missile launchings at White Sands Missile Range (WSMR), NM.

Often termed "this nation's most highly instrumented test range," WSMR uses cameras, radar and other electronic devices to collect data during missile test flights. In cameras, the exposure time of each frame is coded and marked by the amplifiers.

Manufactured to specifications of WSMR scientists, the improved amplifiers incorporate many new features into a unit about the size of a pack of cigarettes (1¾" × 3¾" × 2¾") to replace the file-drawer-sized amplifiers formerly used.

Replacement of 4-hour neon light sources with solid-state Light Emitting Diodes (LEDs) increases the light-source life to one million hours duration. Solid-state construction of the amplifiers also speeds set-up time by 50 to 75 percent over equipment used in the past. Featured also is an automatic signal polarity correction to insure that line reversal will not introduce time error.

Other new features include an auxiliary LED driver for go, no-go remote monitoring of the time signals to two external LEDs used to mark the film; a flexibility in-drive current and pulse width to accommodate various film types and camera frame rates; and an indexing capability that compensates for the distance from the center of an exposed frame to the point of timing exposure for that frame.

Two hundred of the amplifiers are in service at WSMR.

ECOM Announces New Air Traffic Control Unit

Designed as a part of the U.S. Army's future Air Traffic Management System (ATMS), a new lightweight unit developed by the Avionics Laboratory, Electronics Command, will be used at tactical airfields and helipads.

Air Traffic Control Facility AN/TSQ-97 is housed in a case three feet long and two feet square. It will provide control within a specific zone where visibility is good and instrument control is not required.

Weighing 160 pounds, the system is transportable for short distances by two men and can be fully operational in 10 minutes. A zinc-silver-oxide battery provides 8 hours of power.

Depending on mission requirements, any combination of Army Standard Lightweight Avionics Equipment (SLAE) radios containing an FM set and two AM sets may be adapted to the system. Meteorological sensors are provided for barometric pressure, wind direction and speed, and density altitude measurements.

Ten engineering development models have been tested at Fort Rucker, AL, and Fort Huachuca, AZ. Production is scheduled for early 1974 at the Lexington-Blue Grass Army Depot, Lexington, KY.

ARMY ROTC GOES COED with 3,200 women enrolled in the program at 291 colleges and universities throughout the country. At the University of Florida, these six women recently began the 4-year program that leads to commissioning as a second lieutenant. With COL Charles McKeown, the professor of military science, are (from left) Ronda Norton, Carrie Tuttle, Kathleen Shaw, Mary Deitch, Carmen Parrot and Laura Witter.

SAM-D Completes Successful Canister Firing

Full-scale engineering of the SAM-D (Surface to Air Missile Development) is nearing completion of its second year at White Sands (NM) Missile Range.

The first successful firing of the missile from its own sealed canister was announced recently. This milestone is particularly significant in that the use of sealed canisters for storage and protection of the missile up til the instant of firing is a new concept. The test launch took place at Martin Marietta Corp. facility, Orlando, FL.

The objective of the program is to provide an up-to-date replacement for the Nike Hercules and the Improved Hawk air defense missiles used to stop high performance aircraft.

Employing the latest in space age technology, SAM-D will feature high speed digital computers for reduced reaction time and improved control and coordination, and a phased-array radar that can simultaneously acquire, identify and track targets.

Utilization of SAM-D is expected to significantly reduce equipment and manpower required to defend military installations. Army officials also expect lower operating costs will more than offset development investment costs.

MERDC Unveils Hydraulic System Repair Unit

Improving the maintenance capabilities on hydraulic type field equipment is the objective of a new item recently developed by the U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, VA.

Identified as the Hydraulic System Test and Repair Unit (HSTRU), the trailer-mounted unit provides for oil transfer and contamination control through flushing of entire systems or components. Hose and tubing failures, formerly causing long periods of system "down time," usually can be repaired in less than an hour.

The HSTRU includes diagnostic equipment for pinpointing causes of hydraulic system malfunctions, a capability that is expected to eliminate costly trial and error type repairs.

Based on successful tests at Fort Bragg, NC, and by the Mobile Army Sensor System, Test, Evaluation and Review, Fort Hood, TX, the unit has been recommended as organization equipment for Army field units. Additional tests are scheduled in support of evaluation for standard unit type classification.

R&D News . . .

96 Research Papers Listed for Army Science Conference

U.S. Army Science Conference participants, expected to assemble nearly 500 strong at the U.S. Military Academy, West Point, NY, June 18–21, will be given an insight into the caliber of Army in-house laboratory RDT&E based on 96 technical papers.

Twenty-four additional papers have been selected as supplementary and some of these may be presented if late substitutions are necessary.

The papers to be presented were selected from 471 narrative summary proposals by in-house laboratory scientists, engineers and technicians seeking the distinction of making a presentation before the high-level senior scientists and administrators who attend the Army Science Conference.

All of the 120 papers will be published in the conference proceedings and will be eligible for consideration of honors awards, including the most highly prestigious Dr. Paul A. Siple Memorial Medallion—a biennial tribute to the Boy Scout selected to accompany Admiral Byrd on his first expedition to the South Pole. Dr. Siple later became internationally renowned and was scientific adviser to the Director of Army Research when he succumbed of a heart attack while working in his office.

Additional honors for prize-winning papers will include $3,500 to $4,000, usually spread among 10 to 15 winners, provided through the U.S. Army Incentive Awards Program. All winners also will receive Certificates of Achievement signed by the Assistant Secretary of the Army (R&D) and the Chief of Research and Development.

The 120 papers selected to report on the personal RDT&E efforts of 259 authors and coauthors—52 individuals, 27 2-man, 21 3-man, 12 4-man, 7 5-man and 1 7-man teams. Twenty-five commissioned officers and one enlisted man are listed as authors or coauthors.

Quotas were established by the Army Science Conference Advisory Group as follows: Army Materiel Command, 70 (since the AMC has more than 80 percent of Army in-house laboratories); Army Medical Department, 10; Corps of Engineers, 10; and other elements of the Army, 6. The AMC also has 16 of the supplemental papers, with three each for AMEDD and CE, and 2 for other elements.

Diversity of the Army (RDT&E) effort, encompassing virtually all of the major scientific disciplines and a large percentage of the subelements, is reflected in the range of subject areas reported on in the selected papers.

Titles of the papers, the authors and the agencies they represent are:

OFFICE, SURGEON GENERAL—*Artificial Tendons for War Injuries; Construction and Tissue Response,* by MAJ Roger E. Salisbury, Dr. Arthur D. Mason Jr., COL Basil A. Pruitt Jr., and Dr. Clarence W. R. Wade, U.S. Army Institute of Surgical Research (AISR), Fort Sam Houston, TX; *Metabolic Rate, Ambient Temperature and Catecholamines: Interrelationships Following Thermal Injury,* by MAJ Douglas W. Wilmore, MAJ James M. Long, Dr. Arthur D. Mason Jr., Robert W. Skreen and COL Basil A. Pruitt Jr., AISR; and

Meningococcal Antigens: An Immunochemical Approach to the Development of a Meningitis Vaccine, by CPT Wendell D. Zollinger, Walter Reed Army Institute of Research (WRAIR), Washington, DC; *Transovarial Transmission of California Encephalitis in Floodwater Mosquitoes,* by CPT James W. Le Duc, William Suyemoto, LTC Bruce Eldridge and LTC Philip K. Russell, WRAIR; and

Isolation and Purification of Hepatitis Associated Antigen by Electrochromatography, by Dr. Anthony J. Luzzio, U.S. Army Medical Research Laboratory, Fort Knox, KY; *Predication of Interaction Between Environment, Clothing and Personal Equipment as it Affects Military Operations,* by Dr. Ralph F. Goldman, U.S. Army Research Institute of Environmental Medicine, Natick, MA; and

Interaction Between Mosquito Repellents and Human Skin, by CPT Thomas S. Spencer, COL William A. Akers, Steven F. Bayles, Ronald K. Shimmin and Mark L. Gabel, Letterman Army Institute of Research (LAIR), San Francisco, CA; *Cell and Organ Culture Systems to Evaluate Biodegradation and Biocompatibility of Polymer Implant Materials,* by Andrew F. Hegyeli, James C. Eaton Jr. and Ramchandra K. Kulkarni, U.S. Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD; and

Bolivian Hemorrhagic Fever in Rhesus Monkeys: Treatment with Specific, Homologous Antibody, by LTC Gerald A. Eddy, CPT Michael D. Kastello, CPT Stephen K. Scott and CPT Timothy G. Terrell, U.S. Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD; *Ocular and Skin Hazards from CO_2 Laser Radiation,* by Arnold S. Brownell and Bruce E. Stuck, Frankford Arsenal, Philadelphia, PA.

CORPS OF ENGINEERS—*Experimental Determination of Shock and Vibrator Levels Inside the Safeguard PARB,* by T. E. Kennedy and R. E. Walker, U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS; *A Vehicle-Road Compatibility Analysis and Modification System (VRCAMS),* by N. R. Murphy Jr. and V. C. Barber, WES; and

Mathematical Simulation of Ray Leigh Wave Generation and Propagation in Ground Media, by J. R. Lundien, WES; *Finite Element Analysis of Unconfined Nonlinear Flow Through Porous Media With a Special Variable Time Step Procedure,* by C. S. Desai, WES; *Nuclear Cratering Device Simulation,* by MAJ R. H. Gates, E. J. Leahy, CPT H. H. Reed and CPT W. T. Harvey, WES; and

Reference Scene Generation Techniques to Provide Terminal Guidance Support to a Surface-to-Surface Missile System, by D. L. Conway, U.S. Army Engineer Topographic Laboratories (ETL), Fort Belvoir, VA; *A Sea Ice Terrain and Mobility Model,* by W. D. Hibler, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH; *An Investigation of the Stability of Mortars on Soil Foundations,* by G. W. Aitken and R. W.

NLABS Device Aids Design of Protective Headgear

Scientific design of protective helmets for military combatants and drivers of military vehicles, through precise tri-dimensional measurements for proper fitting and suspension methods, is being aided by a "numerical surface descriptor" developed at the U.S. Army Natick (MA) Laboratories.

Envisioned also are possible applications to civilian requirements such as improved design of helmets for football players, racing drivers and cyclists.

The measuring device consists of a transparent hemisphere containing a series of movable rods used as probes to collect data. The system is termed the first accurate head model to be used in the design of protective headgear.

"Strange as it may seem," an NLABS spokesman states, "there has never been a scientific approach to measuring and collecting data on the wide variety of head sizes and shapes. There is far more uniformity of shape in such common items as eggs or fruit than in human heads. Short of forming a helmet to the exact shape of a person's head, there is no way of providing headgear that will distribute loads evenly on the head."

Even this approach (exact forming) has its drawbacks, he explained, in that it produces too much heat because of the lack of air circulation under the helmet, and also the effect of any blow to the helmet is transmitted rapidly to the head.

The ideal solution is a suspension system that permits the helmet to be worn without wobbling, is free of localized pressure points, is cool to wear, and, most importantly, minimizes the energy transmitted to the head when the helmet is impacted.

The NLABS's system was used to measure subjects at Fort Devens, MA, and the data has been computerized to yield detailed information on the variety of head shapes and sizes. From these determinations, the Army has developed various models covering the complete spectrum of men. By using these models, improved helmets and suspension systems may be developed.

NUMERICAL SURFACE DESCRIPTOR developers (from left) Philip E. Durand, William W. Claus and Lawrence R. McManus demonstrate system for measuring heads for fitting the protective headgear.

Waterhouse, CRREL; and

Numerical Solution of 3-Dimensional Elasticity, by E. L. Marvin and C. P. Altheide, U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL; *A Generalized Kinematic Hardening Theory,* by E. L. McDowell, CERL.

OTHER R&D AGENCIES. *On the Arithmetical Means and Variances of Products and Ratios of Random Variables,* by Dr. Fred Frishman, Army Research Office, OCRD, Durham, NC; *Multistage and Scientific Models for Intelligence Analysis,* by Dr. Edgar M. Johnson and Stanley M. Halpin, Army Research Institute for the Behavioral and Social Sciences (ARI), Washington, DC; and

Development of Test Bed for the Evaluation of Small Unit Doctrinal Alternatives in the Combat Arms, by Dr. Robert Wood and MAJ Larry E. Word, ARI; *The Bulk Filtering Problem,* by Don E. Rice, Army Ballistic Missile Defense Agency (ABMDA), Huntsville, AL; *Resource Allocation and Scheduling in Ballistic Missile Defense Adoptive Control Systems,* by Boyce E. Satterfield, ABMDA, Huntsville; *Microwave Transparent Method of Cooling Microwave Components with Practical Results,* by Dr. Bob L. Smith, Harold L. Basset and Dr. Eugene Colwell, ABMDA, Huntsville.

ARMY MATERIEL COMMAND–*Tracking Reliability Growth,* by L. H. Crow, U.S. Army Materiel Systems Analysis Agency, Aberdeen Proving Ground, MD; *Boundary Layer Studies on Spinning Bodies of Revolution,* by Walter B. Sturek, U.S. Army Ballistic Research Laboratories (BRL), Aberdeen Proving Ground, MD; *Vaporization Waves in Impulsively Heated Materials,* by Henry S. Burden, BRL; and

Large Amplitude Motion of a Liquid-Filled Gyroscope: Non-Linear Interaction of Inertial and Rossby Waves, by W. E. Scott, BRL; *Sequence Laser Interferometry in a Muzzle Jet Flow Simulator,* by Fritz H. Oertel Jr., BRL; *Image Formation by Means of Spatial Intensity Correlations,* by Paul H. Deitz, BRL; and

Propellant Analyses, New Approaches, Improved Capabilities, by A. A. Juhasz, J. O. Doali and J. J. Rocchio, BRL; *Initiation and Propagation of Laser Supported Combustion Waves,* by Frank J. Allen, William F. Braerman and Charles R. Stumpfel, BRL; *The Effect of Explosive Detonation Characteristics on Shaped Charge Performance,* by Julius Simon, BRL; and

A Method of Controlling Shock Induced Damage in Aluminum Alloys, by Andrew Dietrich, V. Greenhut and Stanley Golaski, BRL; *Internal Electromagnetic Pulse Investigations at the Aurora Flash X-ray Facility,* by Ralph D. Genuario, Alan Bromborsky, John A. Rosado and John E. Tompkins, Harry Diamond Laboratories (HDL), Washington, DC; and

Radiation Susceptibility of High Power GaAs Infrared Light-Emitting Diodes, by R. A. Polimadei, S. Share and A. S. Epstein, HDL, and G. F. Gowins and W. J. Naff, U.S. Army Missile Command (MICOM), Redstone Arsenal, AL; *Large Polarization-Dependent Voltages in Ferroelectric Ceramics,* by P. S. Brody and Frank Crowne, HDL; and

New and Improved Technologies for Military Time Fuzing Applications, by Joseph W. Miller Jr., HDL; *Simulation of a Simple Lorentz Plasma With a Random Distribution of Inductively Loaded Dipoles,* by John Dietz and George Merkel, HDL; *Determination of the Sensitivity and Specificity of Vapor Detection Systems for Explosives, Narcotics and Related Compounds,* by William A. Wall and Herbert M. Gage, U.S. Army Land Warfare Laboratory, APG, MD; and

New Materials and Construction for Improved Helmets, by A. L. Alesi, R. P. Ames, R. A. Gagne, A. M. Litman and J. J. Prifti, U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA; *Effect of Interlayer on the Impact Resistance of Acrylic/Polycarbonate Laminates,* by J. L. Illinger, R. W. Lewis and D. B. Barr, AMMRC; and

High Damping Materials, Fundamental Aspects, by R. J. Weiss and K. J. Tauer, AMMRC; *The Preparation and Ballistic Evaluation of Transparent Polyurethane Block Copolymers Based on 2,4-Toluene Diisocyanate,* by Anthony F. Wilde, Richard W. Matton, Joseph M. Rogers and Stanley E. Wentworth, AMMRC; *Suppressive Shielding of Hazardous Ammunition Operations,* by William P. Junkin and Paul V. King, Edgewood Arsenal, APG, MD; and

Controlled Fireballs Effective Kill Mechanisms for Flammable Targets, by Milton A. Tulis, Lawrence D. Whiting III and George E. Roberts, Edgewood Arsenal; *Measures of Biotic Similarity and Their Applications to Clustering Techniques,* by Carlos F. A. Pinkham, J. Gareth Pearson and Kenneth S. Redus,

(Continued on page 6)

1974 Federal R&D Spending Forecast at $16.8 Billion

U.S. Government funding will support about $16.8 billion of research and development, roughly 52 percent of the total projection of $32.4 billion for the national R&D program in 1974–with industry accounting for $13.8 billion in support and actually performing 68 percent of all R&D.

These statistics are included in the annual prediction of the nation's R&D structure prepared by economists of Battelle-Columbus Laboratories.

Although the forecast is for an increase of $2.3 billion over the $30.1 billion estimate of the National Science Foundation for 1973 expenditures, the Battelle estimate is that inflation will account for about five percent of the total 7.6 percent increase.

Energy and environmental factors could cause upward or downward changes in estimates, the report cautions.

Universities and colleges are expected to spend about $1.5 billion and not-for-profit institutions some $480 million. Industrial support will thus account for about 42 percent of R&D funding, colleges and universities 4.5 percent, and not-for-profit organizations roughly 1.5 percent.

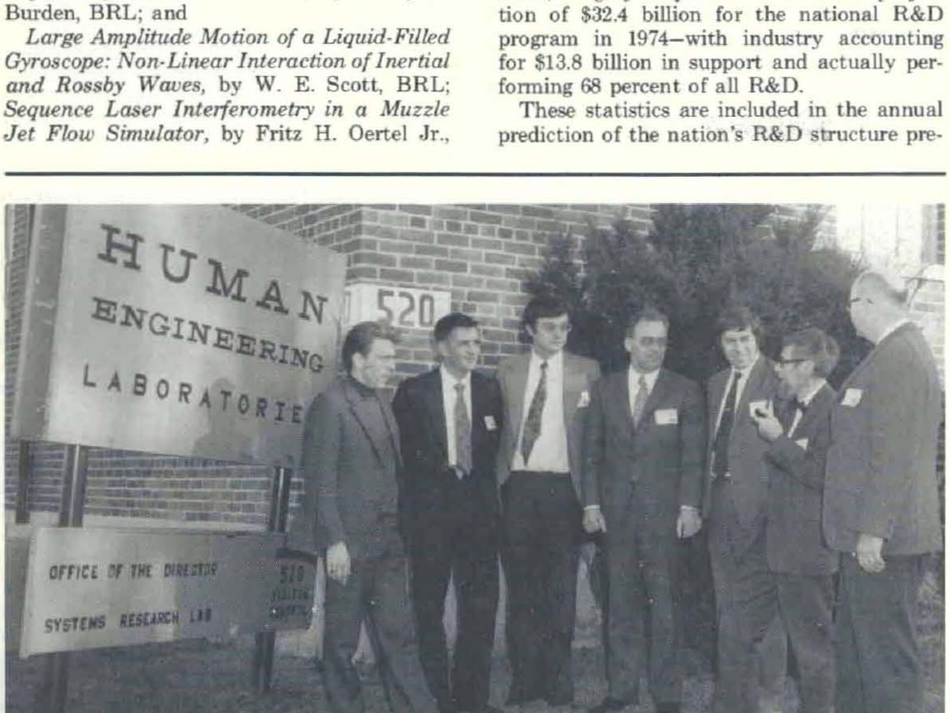
Since 1964, when its share of the national total was 31 percent, industry has steadily increased its proportion of support.

Forecasters at Battelle expect that at least four major industry groups will increase R&D spending in 1974 at a rate greater than the rate of inflation: instruments and related products; food and kindred products; chemicals; and electrical machinery.

Congress is viewed as taking a more favorable view of the importance of increased funding for R&D to maintain a strong national defense posture and to fortify the nation's industrial capacity to cope with local and competitive foreign economic factors.

Universities and colleges are expected to perform about $90 million of R&D and nonprofit organizations $120 million.

Dr. W. Halder Fisher and his Battelle colleagues prepared the forecast, drawing upon data from the U.S. Bureau of the Budget, the National Science Foundation, the McGraw-Hill Survey–Business Plans for R&D Expenditure, and Battelle analyses.



NATO RESEARCH STUDY GROUP 4 (RSG 4), representing seven countries, met recently at the U.S. Army Human Engineering Laboratory (HEL), Aberdeen Proving Ground (APG), MD, to exchange information on automatic target detection capabilities, to assess technology, and to formulate research program guidance to cooperating NATO countries. Dr. David C. Hodge (right), HEL research psychologist and principal U.S. delegate to RSG 4, welcomed them. From left, Louis Pols, Netherlands; Dr. Ian Henderson, Canada; Dr. Claude Roche, France; Dr. Helmut Kazmierczak, Germany; Dr. Ian Liddell, United Kingdom; Lars Brock–Nannestad, Denmark.

96 Papers Listed for Army Science Conference

(Continued from page 5)
Edgewood Arsenal; *Trauma Patient Index,* by W. J. Sacco, Dr. M. A. Goldfarb, Dr. M. A. Weinstein, Dr. T. J. Ciurej and Dr. R. A. Cowley, Edgewood Arsenal; and

Nerve Agents and Pesticides: Value of Computer Analysis of Electroencephalograms in the Diagnosis of Exposure to Organophosphates and Chlorinated Hydrocarbons, by V. M. Sim, Maurice Gaon, James Burchfiel and Frank Duffy, Edgewood Arsenal; *Detection and Identification of Trace Quantities of Organic Vapors in the Atmosphere by Ion Cluster Mass Spectrometry and the Ionization Detector System,* by Charles S. Harden and Thomas C. Imeson, Edgewood Arsenal; and

Rapid Case Design Using Finite Element Stress Analysis and NASTRAN, by JoAnne Brophy, James Harris and Diana Federick, Frankford Arsenal, Philadelphia, PA; *Deformation Textures of Shear Spun Shaped Charge Liners,* by F. Witt, Frankford Arsenal; *Electrostatic Means for Intrusion Detection and Ranging,* by A. D. Aronoff, W. H. Boghosian and H. A. Jenkinson, Frankford Arsenal; and

An Investigation of Infrared Extinguishing Aerosols for Camouflage Applications, by PV2 James J. Pinto, Edward W. Stuebing, Robert W. Doherty and Frank D. Verderame, Frankford Arsenal; *X-Ray Photoelectron Spectroscopy of Explosive Solids,* by J. Sharma, T. Gora and S. Bulusu, Picatinny Arsenal, Dover, NJ; *Correlation of the Vibrations of Molecules and Stability in Energetic Materials,* by Henry J. Prask, Chang S. Choi, Zafar Iqbal and Samuel F. Trevino, Picatinny Arsenal; and

Advances in Explosive Train Technology, by W. Voreck, E. Dalrymple and T. Costain, Picatinny Arsenal; *Experimental and Theoretical Modeling of Fuel-Air Detonations: The Distributed Blast Concept,* by P. Lu, B. Fishburn and N. Slagg, Picatinny Arsenal; *TNT By-Product Isomer Recovery for Credit,* by E. E. Gilbert, Picatinny Arsenal; and

Photo- and Electric Field Effects in Energetic Materials, by David S. Downs, Wayne Garrett, D. A. Wiegand, Thaddeus F. Gora, Marcel Blais, A. C. Forsyth and H. D. Fair, Picatinny Arsenal; *A More Rational Approach to the Stress Analysis of Gun Tubes,* by Shih-Chi Chu, Rock Island Arsenal, IL; *Fatigue Behavior of Metal Laminates,* by J. J. Miller and J. F. Throop, Watervliet Arsenal, NY; and

Helicopter Ground Resonance Analysis in Light of Army Requirements, by C. E. Hammond, U.S. Army Air Mobility R&D Laboratory (AMRDL), Hampton, VA; *An Analytical Evaluation of Airfoil Sections for Helicopter Rotor Application,* by Gene J. Bingham, AMRDL; *Determination of Aircraft Cabin Radiation Conduction, and Convection Heat Transfer Coefficients,* by Emmett J. Laing, U.S. Army Aviation Systems Test Activity, Edwards AFB, CA; and

Wire Obstacle Detection Technique for Rotary Wing Aircraft, by A. Kleider, U.S. Army Electronics Command (ECOM), Fort Monmouth, NJ; *Optical Techniques for the Measurement of Wind and Turbulent Intensity,* by T. H. Pries, J. Smith, F. T. Taylor and E. T. Young, ECOM; *Ionospheric Effects During the Partial Solar Eclipse of July 10, 1972,* by H. Soicher and F. J. Gorman Jr., ECOM; and

Radial Beam Microwave Amplifier, by Louis J. Jasper Jr., ECOM; *Design of Magnetic Sensors for Obtaining an Environmental Safety Signature,* by Herbert A. Leupold and Federick Rothwarf, ECOM and Carl J. Campagnoulo, Jonathan E. Fine and Henry Lee, HDL; and

Radar Warning Receivers for Army Aircraft, by Edwin A. Thomas, ECOM; *Proximity Focused Second Generation Image Intensifiers,* by Herbert Pollehn, ECOM, Fort Belvoir, VA; *An Integrated Approach to Computer Aided Design and Fabrication of Distributed Parameter Microwave Devices,* by George E. Sumrall and David K. Ruppe, ECOM; *Multisensor Mortar Locating System,* by William Fishbein, Donald Foiani and Porter Taylor, ECOM; and

A Technique for Determining a Universal Drag Function for Use in Weapon Location Radars, by Robert H. Pearce, ECOM; *Vibrational Energy Transfer in Hydrogen Halide Lasers,* by John D. Stettler and Norman M. Witriol, MICOM; *Mixing Gas Dynamic Lasers,* by Thomas G. Roberts, MICOM; *Compliant Surfaces for Air Bearing Gyros,* by James V. Johnston, MICOM; and

Fluidic Directional Control Honest John, by B. J. Clayton, MICOM; *A Novel Laser Radar Range,* by E. L. Wilkinson and R. L. Hartman, MICOM; *A Technique for the Validation of Vehicle Models Using the Road Simulator,* by James W. Grant, U.S. Army Tank Automotive Command (TACOM), Warren, MI; *Human Vibration Measuring Instrument,* by Richard A. Lee and William F. Lins, TACOM; and

Evaluation of Clouds of Airborne Fiber, by L. L. Salomon, J. D. Trethewey and M. J. Bushnell, Dugway Proving Ground, UT; *A Methodology/Instrumentation Concept for Total System Test and Evaluation of Army Developmental Materiel,* by CPT T. G. Covington and 1Lt A. H. Wegner, U.S. Army Armor and Engineer Board, Fort Knox, KY; *Automatic Shell Fragment Measurement Technique,* by James Fasig, U.S. Army Test and Evaluation Command (TECOM), Aberdeen Proving Ground, MD; and

Thermal Image Projector/Recorder, by C. M. Redman, U.S. Army White Sands Missile Range, NM; *New Quality Control Techniques for the Rapid Detection of Foodborne Microorganisms,* by D. B. Rowley, J. Previte, R. A. Lampi and D. A. Mikelson, U.S. Army Natick Laboratories (NLABS), MA; *The Behavior of Pressure Stabilized Structural Elements Under Load, by Earl C. Steeves,* NLABS; and

A System for Evaluation of Military Menus, by H. R. Moskowitz, NLABS; *Uniform Wind Trajectories of a Gliding Parachute Using Azimuth Homing,* by Arthur L. Murphy Jr., NLABS; *Investigation of Electrocatalysts by Low Energy Electron Diffraction and Related Techniques,* by Johann A. Joebstl, G. W. Walker and W. A. Adams, U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA; and

Hypervelocity Impact Shock-Induced Damage to Steel Armor, by J. W. Bond and George Ulrich, MERDC; *New Method for Determining Additives and Contaminants in Petroleum Fuels,* by Marjan Kolobielski, MERDC; *Concealed Explosives Detection by Means of Nuclear Resonances,* by J. Roland Gonano, MERDC.

Supplemental papers follow:

OFFICE, SURGEON GENERAL—*Cellular Localization of Calcium Binding Protein,* by CPT Robert L. Morrissey, LTC Thomas J. Bucci, LTC Edward G. Lufkin and CPT Richard D. Empson, Letterman Army Institute of Research, Denver, CO; *Disruption of Visual Function Associated with Laser Environment,* by Harry Zwick, Gerald C. Holst and Kenneth R. Bloom, Frankford Arsenal.

CORPS OF ENGINEERS—*Automated Selection and Location of Terrain Features on the Basis of Spectral Characteristics,* by A. N. Williamson, WES; *Recent Translocation Results Using Navigation Satellites,* by F. M. Gloeckler Jr., ETL; *Piping Design for Hydraulic Transient Pressure,* by C. C. Huang, R. J. Bradshaw and H. H. Yen, U.S. Army Engineer Division, Huntsville, AL.

OTHER R&D AGENCIES—*Night Nap-of-the-Earth Flight Training,* by MAJ Richard L. Cox Jr., Combat Developments Experimentation Command, Fort Ord, CA; *Ballistic Missile Defense Engagement Simulation at the ABMDA Research Center,* by R. S. Pimm, ABMDA, Huntsville, AL.

ARMY MATERIEL COMMAND—*Shock Hardness of Graphite/Epoxy Composites,* by David Roylance, AMMRC; *Stored Energy Microstructure and Shock Damage in Shock Loaded Copper Single Crystals,* by A. Dietrich, V. Greenhut and Charles Ciallela, BRL; *A New Approach to BMD Problems: Real-Time Nuclear Assessment and Mitigation,* by Lawrence J. Puckett, BRL; *Unsteady Heat Transfer Analysis for Any Ammunition, Gun and Firing Schedule,* by Rao V. S. Yalamanchili, Rock Island Arsenal; and

Ballistic Tailoring of Cased/Consolidated Fully Telescoped Ammunition, by Thomas J. Redling and Leon Scott, Rock Island Arsenal; *Computer Simulation of Fabricational Tolerances for Multilayer Optical Coatings,* by J. J. Walls Jr. and R. A. McKyton, Frankford Arsenal; *SADARM Systems Analysis,* by Jack Brooks, Picatinny Arsenal; and

Possible Incapacitants for Military Use and Civil Disturbance Controls: Some Syntheses and Biological Studies in Rats and Monkeys, by Paul C. Bossle, Gaston E. Dudley, Jacob I. Miller, Willard J. Lennox and Walter E. Sultan, Edgewood Arsenal, *Numerical Simulation of Transonic Flow About Airplanes and Helicopter Rotors,* by W. F. Ballhaus and F. X. Caradonna, AMRDL; *High Burning Rate Propellant for Shoulder Fired and Assault Weapons,* by N. C. White, C. W. Huskins and J. D. Burnett, MICOM; *Multi-Signature Vehicle Discrimination,* by Jack G. Parks, TACOM; and

A New Monolithic Crystal Filter Using Piezoelectric Coupling Between Anisotropic Lamina, by Arthur Ballato and Theodore Lukaszek, ECOM; *Dielectric Waveguides for Millimeter Wave Circuits,* by Harold Jacobs and M. M. Crepta, ECOM; *Dynamic Effects in Thermal Blooming in High Power Laser Propagation,* by R. S. Rohde and R. G. Buser, ECOM; and

20 PPS Holmium, Yttrium, Lithium Fluoride Laser Transmitter, by Vincent Rosati, ECOM; *Vegetation Effluents, Microorganisms and Material Degradation in the Tropics,* by James F. Sprouse, U.S. Army Tropic Test Center, Fort Clayton, CZ.

TACOM Seeks Improved Military Vehicle Maintenance Procedures With Automotive Test, Measurement and Diagnostic Equipment

"Test, measurement and diagnostic equipment now being developed is expected to significantly increase vehicle availability, reliability and maintainability, and will dramatically reduce manhours required for vehicle maintenance while providing for greater operational safety."

This quotation is from "Military Automotive Test, Measurement and Diagnostic Equipment," a technical presentation scheduled for early this year at the American Preparedness Association Logistics Technology Symposium, Fort Lee, VA.

Coauthors of the paper, Fred Pradko, Donald Sarna and Daniel F. Ancona of the U.S. Army Tank-Automotive Command, Warren, MI, contend that incorrect diagnosis of existing or imminent trouble sources accounts for many major inefficiencies in automotive maintenance. Often this leads to costly replacement of sound parts instead of corrective or preventive maintenance.

Human errors in diagnosis frequently are caused, in their view, by the virtual inaccessability of many of the points where measurements should be made. The corrective action on which they are working is a thoroughly reliable system of locating trouble sources.

Efforts to develop dependable test, measurement and diagnostic equipment have been in progress for almost a decade but the program that is promising the desired objective was started in January 1971. TACOM investigators are exploring various approaches to reduce faulty diagnosis, the time required, and to substantially improve reliability of maintenance.

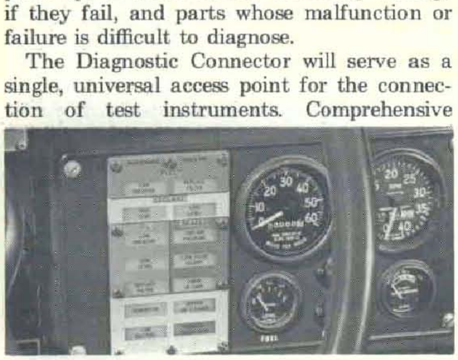
The four systems under development are a Diagnostic Harness and Connector; a Maintenance Indicator System; a Programable Diagnostic Unit; and a Vehicle Test Meter.

The Diagnostic Harness and Diagnostic Connector uses sensors, transducers, electrical connections and some the vehicle's own sensing units (temperature and oil pressure). Sensors are wired to a diagnostic connector and are located to monitor the operation and condition of critical components.

The components to be monitored were chosen as a result of analysis of data derived from surveys of maintenance practices and from "fault trees" based on failure modes.

The analysis showed that improved diagnosis would be most effectively employed on high cost items, high failure rate elements, parts critical to vehicle performance or safety, parts apt to cause serious secondary damage if they fail, and parts whose malfunction or failure is difficult to diagnose.

The Diagnostic Connector will serve as a single, universal access point for the connection of test instruments. Comprehensive vehicle measurements will be made without requiring the mechanic to climb around, under, or in the vehicle engine compartment to make individual connections or attach mechanical or electrical tests devices or adapters.



MAINTENANCE INDICATOR SYSTEM displays information for vehical operator, forewarning him of impending failures and preventive maintenance need.

The dash-mounted Maintenance Indicator System (MIS) display is designed to give the driver far more information about the condition of his vehicle than he has with the present array of gauges.

Information about component performance and condition will be conveyed by 14 indicator lights. They will signal such things as oil filter restriction, high transmission temperature, low vehicle air pressure, poor brake adjustment, low battery voltage and low fluid levels.

Under development by the Teledyne Continental Motors Co., the MIS is designed to alert the vehicle operator and motor pool personnel when maintenance is required, before neglect may cause vehicle failure.

The two pieces of test equipment being developed are a computer-controlled Programable Diagnostic Unit (PDU) and a less sophisticated device for lower-level maintenance, the Vehicle Test Meter (VTM).

When the vehicle is in for servicing or repair at higher levels of Army maintenance, a mechanic will plug a cable from the Programable Diagnostic Unit into the Diagnostic Connector or attach probes and transducers to a vehicle not equipped with the connector.

A magnetic tape cassette inserted into the PDU will contain a test program for the particular vehicle. This program, in conjunction with a CDC 469 minicomputer in the PDU, will allow an entire series of tests to be run in two or three minutes if the vehicle being tested is in running condition.

While the test is being run, the mechanic will monitor and control the operation with a hand-held Set Communicator that will signal areas requiring attention and alert him to critical displays with a buzzer. It will be able to present messages and data groups up to three lines of six characters each.

PROGRAMABLE DIAGNOSTIC UNIT uses a minicomputer with reference information fed into the system from tape.

The PDQ resembles testing equipment now in use in Volkswagen dealer service shops, but it is more compact and has a far greater automatic diagnostic capability.

The Vehicle Test Meter (VTM) being designed by RCA under TACOM contract and the Diagnostic Connector will be used for rapid-fault diagnosis at lower maintenance levels—to determine whether a system or component is malfunctioning on a go/no-go basis.

The VTM will be used to provide a comprehensive assist to the military mechanic in conducting the tests required by operational procedures, plus the ability to make over-all power tests on either spark-ignition or compression-ignition engines. The goal is to run a full set of tests in a fraction of the time presently required.

One of the essential aims of this development program is to make the time required to diagnose automotive problems significantly less than the time to replace components.

Through the use of on-board sensors and indicator systems, many maintenance actions will be accomplished only when needed rather than on a scheduled basis. In addition to reducing maintenance manhours and increasing vehicle availability this is expected to minimize clerical work and record keeping.

U.S. Army Medic Reports to WHO on Microwave Risk

Invited and sponsored by the World Health Organization, COL Bud Appleton of the U.S. Army Medical Research and Development Command recently addressed the International Symposium on Biologic Effects and Health Hazards of Microwave Radiation in Warsaw.

The chief of Ophthalmology at Walter Reed Army Medical Center, and also a consultant to Walter Reed Army Institute of Research, reported on results of studies by his group to determine levels of radiation required to produce cataracts in the eyes of rabbits and dogs.

This experimentation has been related to U.S. Army concern regarding potential health hazards to humans exposed to microwave radiation in their work.

COL Appleton's report covered a 5-year survey conducted at several military installations and involving more than 1,300 personnel occupationally exposed to microwave radiation. Results indicated that there was no greater incidence of cataracts or cataract precursors in microwave workers than in personnel not exposed to radiation.

This determination was supported by another presentation at the conference. Dr. S. Zydeck of the Polish Military Medical Academy's Institute for Postgraduate Study reported that cataracts and cataract precursors found in microwave workers were indistinguishable from those found in personnel not exposed to radiation.

Data accumulated in the U.S. Army study lend support to the adequacy of the current U.S. safety standard of 10 milliwatts/cm^2 for microwave workers.

Major Improvements Predicted With Tri-Service Health Plan

Implementation of a new tri-Service regionalized health care system, announced recently by Deputy Secretary of Defense William P. Clements, is designed to provide more uniform operational capabilities.

Termed the Armed Forces Regional Health Service System, it provides for a cooperative arrangement through categorization of 13 military medical regions based on military population and location of speciality treatment centers. A tri-Service Regional Review Committee will monitor region capabilities.

Major advantages envisioned for the system include availability of new medical services at certain facilities; increased productivity without duplication of resources; and more efficient use of physicians, dentists and other scarce health service personnel.

AMC In-House Research Personnel Brief ASA (R&D) On Significant Advances in Aircraft Development

Progress in aircraft development, selected by the U.S. Army Materiel Command (AMC) as sufficiently significant for briefings to representatives of the Offices of the Assistant Secretary of the Army (R&D) and the Chief of R&D, HQ DA, was reported in November.

Army Chief Scientist Dr. Marvin E. Lasser represented ASA (R&D) Norman R. Augustine. Dr. I. R. Hershner, scientific director, Army Research Directorate, represented the Chief of R&D, LTG John R. Deane Jr.

Representing the AMC, Dr. Gordon Bushey, Office of the Deputy for Laboratories, introduced officials of the Natick (MA) Laboratories and the Langley (VA) Directorate, U.S. Army Air Mobility R&D Laboratory, NASA-Langley Research Center, Hampton, VA.

Arthur L. Murphy Jr. gave the NLABS briefing on Uniform Wind Trajectories of Gliding Parachutes Using Azimuth Homing. He was introduced by James F. Falcone, chief of NLABS' Research and Advanced Projects Division, Airdrop Engineering Laboratory.

Scale Model Tail Rotor Investigation results were reported by Wayne R. Mantay, introduced by John L. Shipley, chief of the Aeronautical Research Group in the AAMRDL Langley Directorate.

Programed but not presented was a briefing on a third important development, an evaluation of the Windecker Eagle—the climax of 14 years of developmental effort as the first commercial all-fiberglass aircraft—and its potential for application to U.S. Army needs. Louis V. Surgent Jr., U.S. Army Land Warfare Laboratory, Aberdeen (MD) Proving Ground, was scheduled to report on the evaluation.

Abstracts of the reports follow: *Uniform Wind Trajectories of Gliding Parachutes Using Azimuth Homing.* Determination of control laws for managing the flight path of a gliding decelerator is a problem of vital importance to the development of advanced airdrop systems capable of precision delivery.

R & D NEWS

Analysis in this area can cover a broad spectrum, ranging from application of the techniques of optimal control theory to investigations concerned with the geometry of the motion. The results of this study are derived from kinematic considerations of a gliding parachute maneuvering through a uniform wind field.

In this treatment, the control law is assumed *a priori* and the resulting trajectory determined through solution of the equations of motion. The characteristics of these trajectories are then investigated to determine their properties.

The controller used in this analysis is one which causes the parachute to maintain a fixed angular orientation between its airspeed vector and a radial line connecting it to the intended target. Methods of this type are advantageous in that the glider aiming reference is earth-fixed at the intended impact point.

This means that the parachute can be made to generally fly a target-seeking course, regardless of changes in wind velocity. In addition, beyond the transmitting and receiving equipment necessary to generate and condition the homing signal, guidance schemes of this type require little additional sensing or computational devices.

The inherent liability with this form of guidance is that the accuracy problem is solved in a plane with no control over the arrival time at the target. Consequently, a final orbital phase must be coupled with a target-seeking trajectory or a primary trajectory with orbital properties established.

For the type of control discussed, exact solutions describing the uniform wind trajectory in terms of space coordinates have been obtained for the general case of azimuth homing. The special cases of Radial and Off-Radial homing are discussed.

Radial homing is shown to produce a target-seeking trajectory under all conditions except when the parachute's intrinsic airspeed is less than the prevailing wind speed. A launch area encompassed by an ellipse is derived as the region in which Radial Homing must be initiated in order to reach the target prior to impact. An orbital phase utilizing a constant rate turn trajectory is derived from the Radial Homing conditions at the target point.

Off-Radial (O-R) Homing is shown to demonstrate spiral characteristics with terminal convergences at the target. This property may be useful in establishing acceptable accuracy with O-R homing without employing an orbital phase.

Scale Model Tail Rotor Investigation. Difficulties in maintaining yaw trim have been encountered by helicopters operating near the ground in low-speed tailwinds. The problem arises from a large vortex that interferes with tail rotor/fin operation at windspeeds of 12 to 15 knots. This vortex is formed by the combined action of the main rotor downwash and the wind in ground effect.

This phenomenon has been investigated in a parametric study of five tail-rotor/fin configurations. A quarter-scale model was tested in the Langley full-scale wind tunnel. Results indicate that at a windspeed of 12.5 knots and wind azimuths between 150° and 240°, the conventional tail-fin produces a large adverse fin-force. This force causes correspondingly large increases in the tail-rotor thrust, collective pitch, and power required to maintain yaw trim.

Among the four configurations using the conventional tail fin, the tractor-tail rotor with the top blade of the rotor moving aft was found to have some advantage. A V-tail configuration with a pusher tail rotor, and top blade moving aft, was found to reduce significantly the adverse fin-force and tail-rotor thrust, collective pitch, and power required for yaw trim.

At 240° wind azimuth, the conventional fin (with pusher-top aft tail rotor) required 170 percent of the tail-rotor power required with the V-tail. Considering the model results, the V-tail appears to be a satisfactory solution to the yaw control problem of helicopter operation in tail winds in ground effects.

Plastic Airplane Program. The Windecker Eagle, the first commercial all-fiberglass aircraft, has been evaluated to determine its potential for U.S. Army applications. Specifically, the radar, acoustic, infrared, and ballistic properties of the aircraft have been measured and the impact of these properties assessed.

The construction of this aircraft resulted from a 14-year development effort by Windecker Industries leading to type certification of this first composite airplane in 1969 and subsequent production of several aircraft. From this effort evolved a new composite chemistry overcoming the previous disadvantages of fiberglass construction.

The aircraft is a monocoque design fabricated with nonwoven, unidirectional fibers laid up in female molds and foam laminate stringers. In comparing metal versus fiberglass construction, there are significant advantages of this new construction, including virtually no corrosion, a 70-percent reduction in the total number of parts, simplification of assembly and repair.

Radar signature tests performed on this aircraft have shown that the aircraft has a substantially lower radar cross section than the equivalent metallic air frame. In addition, the radar cross section data is not as sensitive to aircraft aspect angle, radar frequency, or polarization.

Ballistic tests performed on samples of this aircraft under load have shown that there is no crack propagation or spallation associated with impacts of .30 caliber projectiles.

Another important advantage of this construction technique is that it enables all antennae for both communications and surveillance equipment to be located on the interior portion of the airplane looking through its virtually transparent skin. This has been demonstrated using a radar sensor package to locate simulated enemy radars.

This technology has been applied to the design and construction of two low-cost drones which have been designed for low radar, infrared, and acoustic signatures. Complete air frames built with this material will cost approximately $2,500 for a drone capable of flying 170 knots and carrying a 225-pound payload.

HDL Development May Ease Calculations for Decisions

Design and other "desk type" engineers required to make complex mathematical calculations in considering decision factors are expected to find a new Harry Diamond Laboratories development valuable in their work.

HDL mathematicians have written a compiler that translates Fortran IV into Wang 520/600 calculator language, enabling a user to input a Fortran program and obtain a listing of the translated Wang code. They also have written a "loader" to punch the fully assembled Wang code onto cards for Wang card reader input directly into the calculator.

These developments make it possible to run a Fortran program on the Wang desk calculator without knowing Wang machine language. Significant also is the usability of the vast store of Fortran programs and sub-routines by the owners of Wang 520/600 calculators.

More Effective Control . . .

Government, Industry Consider Methods of Combating Aquatic Weeds

What progress is being made in technology to control or eliminate the undesirable proliferation of aquatic plants in numerous U.S. waterways?

That was the question considered by about 70 scientists, engineers, businessmen and governmental officials and scientists who convened recently at the U.S. Army Engineers Waterways Experiment Station (WES) in Vicksburg, MS.

Participants were concerned with methods of combating aquatic weeds that are increasingly clogging many major navigable and recreational waters.

Several species of these "weeds," including the particularly beautiful water hyacinth, are becoming a rapidly growing nuisance to commercial and leisure-time users of rivers and lakes, particularly in the South.

Dr. Edward O. Gangstad, who is in charge of the aquatic weed control program under the auspices of the Office of the Chief of Engineers, calls an annual meeting of all concerned persons to look at what has been done through research and development efforts to eradicate or reduce the proliferation of these weeds. Historically, the incipient problem was recognized by the Corps of Engineers at the turn of the century. The intensified, systematic extermination program dates to 1958 when Congress enacted Section 104 of Public Law 85-500 authorizing a substantially expanded control effort.

"We are a group of optimists," Dr. Gangstad stated at the recent meeting. "This problem has been with us for many years and has not yet been solved."

Because of the current national concern with methods of protecting and preserving ecological balance, scientists are especially interested in finding ways of getting rid of weeds without using herbicides. The program included presentations on chemical, biological and mechanical means of controlling aquatic weeds.

Herbicides, however, have not been categorically discarded. "I have been convinced for a long time that the only way to combat hyacinths is to spray every one you can get to," remarked one participant in the conference. Lawsuits from ecology-minded people in his own area had been filed to block this method, he added, and the judge decided in favor of spraying.

New techniques of using herbicides are being investigated. William Thompson, of the New Orleans District of the Corps of Engineers, reported on efforts to develop "controlled-release-rate materials" that would produce a slow, steady buildup of poison in aquatic weeds, sufficient to kill them without undesirable ecological impact. Field use of such materials, he said, has not proved as successful as experiments under laboratory conditions.

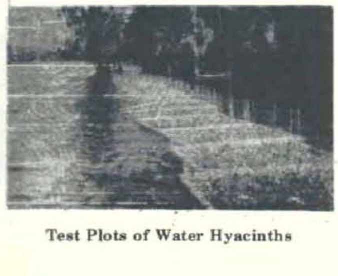
On the biological front, research is being conducted to find fish, insects and plant pathogens that can control the growth of noxious weeds. The white amur, also called the grass carp, has been studied as a possible destroyer of water hyacinths. Because this species comes from the Far East, some people are fearful that ecological balance in U.S. waters would be upset. State governments have so far been reluctant to release the fish into waterways.

Some success has been reported in controlling alligator weed with the agasicles flea beetle, but it is proving highly effective only in areas with winter temperatures that will permit overwintering—so that a spring population can be built up by at least mid-June. However, the species seems to be acclimatizing to cooler temperatures and is moving north each year.

The use of plant pathogens to control aquatic weeds is considered rich in possibilities, since there are countless plant diseases that are easily disseminated and are not harmful to man.

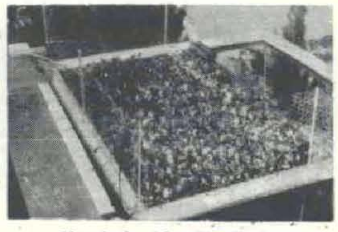
A mechanical means of controlling aquatic weeds is being studied by

CO_2 Laser on Barge



Test Plots of Water Hyacinths

Hyacinths Before Irradiation



Hyacinths After Irradiation

the Waterways Experiment Station where engineers have experimented with laser irradiation of water hyacinths. A closed-cycle CO_2 electric discharge laser, mounted on a barge, has been used in two series of tests in Louisiana waters—the first in the Bayou Gauche area, the second in Lake Concordia.

The Bayou Gauche tests were conducted in late October 1972 with a primary objective of determining how well the laser would function in an outdoor environment. In determining the operational efficiency of the laser, WES personnel irradiated six sample plots of water hyacinths. The plots, about two meters square, had plants ranging from 30 to 60 centimeters tall that were irradiated at levels between 10 and 45 J/cm^2.

A spherical mirror was used to reflect the laser beam down onto the plants. This caused an uneven distribution of energy, leaving a "blind" spot near the center of the pattern and decreasing energy levels away from the center. Moreover, there were many "hot" and "cold" spots.

The hyacinths were examined for damage in mid-November and early December—before heavy frosts. No effects of the laser radiation were apparent on the first visit. However, the second visit showed that damage had occurred—primarily in the petiole areas of the plants, where the tissue was discolored in gradations from yellow to brown, depending on the level of energy to which the plants had been subjected.

Four WES personnel independently ranked the plants according to their estimate of the amount of damage. Two essential conclusions were drawn: (1) damage to the plants may be attributed to the irradiation, since all irradiated plots were rated above the control, i.e., nonirradiated plot of water hyacinths; (2) a strong correlation between damage ranking and irradiation level was not evident.

The laser was moved this year to Lake Concordia for the second series of tests, with a primary objective of establishing the effects of CO_2 laser radiation on water hyacinths by carefully planned, controlled dosage and data recording.

Thirty plants were placed in each 2-meter-square frame. The plants averaged in height, 18 cm; diameter, 25 cm; weight, 157 g. Eight levels of irradiation were used in each of the three series of treatments, Aug. 29, Sept. 16 and Oct. 3. These levels were: 0 (for the control plot), 1, 2, 5, 10, 20, 50 and 100 J/cm^2.

When the test data were evaluated, WES researchers found some evidence that length of time as well as level of irradiation is determinative in the damage to plants. An examination of the biomass decline of the plants at 17, 30 and 51 days following irradiation showed that the decline increases with the passage of time.

General conclusions drawn by WES researchers about laser use on water hyacinths were: (1) Biomass and propagation rate show a decrease after an increase in irradiation and in the time following irradiation; (2) the area covered by the hyacinths seems to decrease after an increase in irradiation and in the time following irradiation.

Researchers say additional testing is needed to define more clearly the effects and to make a cost-effectiveness evaluation of laser irradiation as a control method.

One interesting sidenote to come out of the aquatic weed conference was a confirmation of the well-known observation that east is east and west is west and that with respect to water hyacinths, at least, the twain shall never meet.

An official from Florida reported that while on a trip to a Southeast Asian country he discovered alligator weed growing there. Thinking that he might be able to offer some advice to the natives on how to get rid of the weed, he approached the subject, only to learn that they do not want to get rid of it—that, in fact, they eat it.

HLH 1975 Flight Test Projected . . .

Component Technology Program Meeting Development Goal

Component development for the U.S. Army prototype Heavy Lift Helicopter (HLH) is progressing on schedule toward its initial flight test planned for August 1975, recent contractor reports to HQ U.S. Army Materiel Command indicate.

Dynamic tests of the flight-representative engine and the drive and rotor systems are planned for early this year.

This joint Army/Navy program was a result of investigations and feasibility studies of future helicopter requirements which began in the early 1950s. The Army was designated as the lead service to undertake an Advanced Technology Component (ATC) program. In June 1971, a contract was signed with the Boeing Vertol Co. to develop the critical components of an HLH.

The HLH program is being managed by BG Jerry B. Lauer, whose office is located at the U.S. Army Aviation Systems Command, St. Louis, MO.

Stated objectives of the ATC program are to reduce development risks, secure a realistic cost-data base, improve technology, and advance industry expertise associated with the development of an HLH.

Among systems and components that are being developed in the ATC program are the rotor/drive system, the fly-by-wire flight control system, the cargo handling system, and the engine for the Dynamic Systems Test Rig (DSTR).

Boeing Vertol's contract responsibility was extended in January 1972 to development of the engine required to support the HLH ATC program. Requests for Proposals (RFPs) elicited three bids and Boeing Vertol chose Detroit Diesel Allison Division (DDAD), a division of General Motors, to build a flight-representative developmental engine.

Two contracts were signed in January 1973 for the construction of a single, austere prototype HLH designated the XCH-62 (Boeing Vertol), and the development of a prototype preliminary flight-rating test engine (DDAD). This "next most logical step" in the weapons acquisition process is in full support of the policy of prototyping major weapons systems and further supports a production decision.

Results of these efforts will be the integration of the critical components and subsystems, developed under the ATC program, into an airworthy flying test bed which will proceed into performance substantiation tests and an early user assessment of the HLH design concept.

The prototype, due to its austerity, will have weight and space provisions only for many of the items which are not necessary to satisfy "fly before you buy" requirements.

The prototype HLH will be a tandem-rotored, shaft-driven helicopter powered by three gas-turbine power plants, rated at 8,079 horsepower each, with a design gross weight of 118,000 pounds.

The basic mission capability of the HLH is to be demonstrated in a flight test in which it will pick up a 22½-ton load, deliver it over a distance of 25 nautical miles, return to the point of origin and repeat the process, making two round trips without refueling. By reducing the number of round trips and the range, and under lower ambient conditions, the aircraft has the capability to lift up to 35 tons.

XCH-62 Heavy Lift Helicopter (HLH) is designed as a tandem-rotor, shaft-driven helicopter, with a gross weight of 118,000 and an alternate gross weight of 148,000 pounds.

The 92-foot-diameter rotor system (four blades at each rotor head) results in a disc loading of 8.9 pounds per square foot at design gross weight. The transmission system is rated at 18,133 horsepower. Tanks in the landing gear pods will carry 20,100 pounds of fuel.

Carrying a 22½-ton external load, the HLH will have a speed capability of over 130 knots. By employing ferry fuel tanks, the ferry range will exceed 1,500 nautical miles at a maximum alternate gross weight.

Length of the aircraft with blades turning will be 162′3″ and 89′3″ with the blades folded. Maximum width with blades folded will be 29′10″. With the rotors turning, the maximum width will be 92′.

The crew will include pilot, copilot, flight engineer, load controlling crewman and crew chief. The troop compartment has space for 12 occupants.

The HLH will be designed to provide a vertical airlift capability for large and heavy loads that cannot be airlifted with current helicopters. Developers say it will permit deployment and retrieval of tactical and logistics loads rapidly without dependence on roads, bridges, railways, docks, landing craft, runways, or other surface facilities.

The primary mission for which the HLH is designed, however, is the movement of containerized cargo from ship to shore. Since the mid-1950s, the use of containers has been increasing steadily and it is estimated that 90 percent of the U.S. merchant fleet shipping capacity will be containerized cargo by 1983. Department of Defense officials report that a goal of 80 percent has been established for containerized movement of Army logistics.

The design point lift capability of the HLH was selected to airlift the standard Department of Defense 8′ × 8′ × 20′ MILVAN container, which has a maximum gross weight of 22.4 tons. The user determined that this payload capacity would allow enough of the Army's portable equipment to be airlifted for an optimum balance between economy of operation and useful load capacity.

Rotor Drive System. The transmissions used in the drive system will have integral lubrication and cooling systems—removing the necessity for long, vulnerable, and often leaking fluid lines and oil coolers. Additionally, a secondary system will provide the minimum essential lubrication for critical components if the major portion of transmission oil is lost.

Present large helicopter transmission designs do not have auxiliary systems. A central lubricant supply requires hundreds of feet of tubing to connect the supply unit to each transmission.

Gears in the HLH transmission are made from a new steel (VASCO X-2). Reportedly, this steel provides higher load capacity and increased reliability and survivability under marginal lubrication conditions.

Many other advanced technology features have been incorporated into the HLH transmissions, resulting in increased load-carrying capacity, reduced vulnerability, and lower noise and vibration levels. The HLH transmissions will utilize high-speed tapered roller bearings, operating at higher speeds than were previously possible. Noise and vibration of the transmissions have been reduced by use of newly developed gear tooth forms and by tuning the main drive gears.

In mid-1973, Boeing Vertol engineers, technicians and production personnel successfully assembled and cured the largest composite (fiberglass and graphite-fiber) helicopter rotor blade ever built. Weighing 750 pounds, and

40.5 feet in length, this blade consists of a fiberglass D-Spar with a pneumatic failure detection system to indicate potential blade failure.

A closed "D" spar configuration was chosen because it has the highest torsional stiffness per pound and results in a complete, fully inspectable spar assembly. The leading edge of the blade is covered with a titanium nosecap to provide erosion and lightning-strike protection and additional strength to the blade. It has been termed the "largest creep-formed titanium component known to the aircraft industry."

Incorporated in the rotor head design are redundant load paths for fail-safe operations, permitting safe flight after damage to one load path. Elastomeric bearings will eliminate hinges and hinge lubrication requirements while greatly reducing the number of required hub components. This parts reduction is designed for improved reliability and reduced maintenance requirements.

A DSTR for simultaneous testing of the rotor blades, head, aft transmission, combiner transmission and engines has been constructed on a remote site at Fort Dix, NJ. The DSTR will be used to test and validate the design, fabrication and integration of the rotor and drive components during a 200-hour test program.

Four flight-representative 501-M62B engines to power the DSTR have been delivered by DDAD under the subcontract to the Boeing Vertol Co. Currently this engine has over 400 hours of engine cell time.

Fly-by Wire Flight Control System. The HLH flight-control system is a departure from conventional helicopter control concepts. It will be the first fly-by-wire system without mechanical back-up to be used in helicopters.

By eliminating the push-pull tubes, rod end bearings, and the myriad of fixtures, bolts, and hydraulic lines of conventional systems, the fly-by-wire system permits great weight savings and provides precise control, high reliability, redundancy, and improved maintainability and survivability.

Under the ATC program, this system has been tested on an integrated test stand for more than 1,000 hours. The Boeing Vertol Model 347, a stretched version of the CH-47 Chinook, was flown in early September 1973, utilizing a fly-by-wire system without any back-up mechanical controls installed in the aircraft.

Through the use of this flying test bed, Boeing Vertol successfully demonstrated the fly-by-wire concept to be used in the HLH. Additional flight tests will evaluate feasibility of digital stability and control augmentation.

Cargo Handling System. The HLH will have a pneumatically driven, high-speed cargo-handling system. The hazards and unreliabilities normally associated with hydraulic lifting systems are eliminated. Bleed air from the engines is used to drive two turbine motors which power the winches. A dual point-suspension system will be employed during normal operation to provide improved longitudinal stability and increased helicopter productivity.

The ATC program will demonstrate the feasibility, functional performance and reliability/maintainability of the system on a Cargo Handling Rig (CHR). The CHR is a test tower 70-feet high located on-site at Boeing Vertol where it was used in November 1973 to integrate HLH cargo handling winches, their pneumatic drive systems, and the necessary controls for HLH cargo acquisition and discharge operations.

Engine Development. The HLH prototype engine will draw extensively from the DSTR engine program and build upon this base line to achieve what is now designated the XT701-AD-700 engine.

At the intermediate power level, the XT701 engine develops 8,079 shaft horsepower at static sea level, standard day conditions. The intermediate power level is the power level at which an engine can safely be operated for 30 minutes.

Selection of a 3-engine configuration was based upon a compromise between total installed power to meet HLH requirements for operation with one engine inoperative, the complexity and cost of multiple engines, and the availability of gas-turbine engines in the appropriate size classes.

The three engines will drive into a single combiner gear box. A relatively high engine output speed of 11,500 rpm minimizes weight of the engine and drive shaft.

Combined power of two of the XT701 engines will be sufficient in an emergency to allow the HLH to hover-in-ground-effect while carrying a full 22½-ton load at sea level with the air temperature at 95° F.

Design-to-cost provisions are included in both the prototype and the engine contracts. The government will be better assured, by incorporating this effort early in the program, that the final design of the HLH and its engine can be produced at the least possible cost. Incentive award fee provisions in both contracts stimulate contractors to reach the design-to-cost goals.

The first flight of the HLH, scheduled for August 1975, is expected through thorough testing to permit a well-founded decision relative to the advisability of entering engineering development.

Army Executives Selected For AGARD Technical Panels

Two executives of the U.S. Army Air Mobility R&D Laboratory (AMRDL), Ames Research Center, Moffet Field, CA, have been elected as deputy chairmen of technical panels of the Advisory Group for Aerospace R&D (AGARD), North Atlantic Treaty Organization (NATO).

Paul F. Yaggy, AMRDL director, is serving a 2-year term on the Fluid Dynamics Panel, following his election at the panel's 33d meeting in Brussels, Belgium, Dr. Irving C. Statler, who heads the Ames Directorate of AMRDL, was elected to a 1-year term on the Flight Mechanics Panel at its 43d meeting in Florence, Italy.

The AGARD panels exist to bring together representatives of NATO nations in science and technology relating to aerospace. They recommend use of NATO R&D capabilities, provide scientific and technical assistance to the military committees, and stimulate technical advances through international cooperation and data exchange.

Four other U.S. Army civilian aviation research scientists/engineers are appointed or reappointed to serve until Sept. 30, 1976 as U.S. members of various AGARD panels.

Dr. Robert B. Dillaway, U.S. Army Materiel Command Deputy for Laboratories, was reappointed as a U.S. member of the Guidance and Control Panel. Donald D. Weidhuner, chief of the Power Branch, R&D Directorate, AMC HQ, AGARD panel member and U.S. coordinator from 1961 through 1968, was appointed to the Propulsion and Energetics Panel.

Robert S. Berrisford, chief of the Structures Technical Area, AMRDL, Fort Eustis, VA, was appointed to the Structures and Materials Panel and Theodore J. Sueta, deputy director of the Avionics Laboratory, U.S. Army Electronics Command, Fort Monmouth, NJ, was reappointed to the Avionics Panel.

Other U.S. Army panel members of AGARD are: Richard L. Ballard, chief of the Aeronautical Technology Team, Office of the Chief of Research and Development, HQ DA, Structures and Materials Panel; MAJ N. Bruce Chase, chief, Aviation Medical Research Branch, Medical R&D Command, Aerospace Medical Panel; I. Kullback, Electronics Command, Electromagnetic Wave Propagation Panel; and Martin Wolfe, Electronics Command, Ad Hoc Group of the Avionics Panel for Lasers.

Foreign Technology . . .

Switzerland's Skyguard Fire Control System

By Stephen J. Foster, Analyst

Communications & Electronics Division
Foreign Science & Technology Center

Switzerland's state-of-the-art in weapons fire control systems is incorporated in the "Skyguard" modular unit displayed at the 1973 Paris Air Show. There it was judged by military observers to offer "significant advantages" over the widely used "Superfledermaus."

Compact and capable of configuration in several ways, including use with guns or missiles, Skyguard is, like the Superfledermaus, a development by Contraves A. G. of Switzerland. The system features combination search and track doppler radars, a TV-tracker, digital signal processing, and a frequency diversity capability. It is expected to be widely deployed in the 1980s.

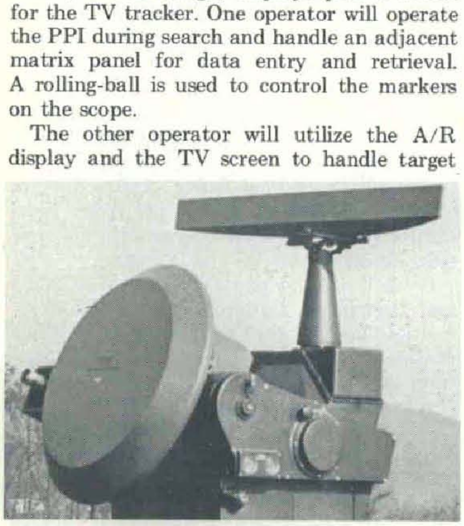
Designed for mounting on a truck, trailer or tracked vehicle, Skyguard reportedly is capable of giving fire-control information to on-board and off-board missiles, or to off-board gun systems. It also can be used as a fire direction center by providing surveillance and target acquisition information to additional fire control radars.

Separate pulse doppler search and track radar antennas are mounted on a common pedestal. A common transmitter, operating at I-band frequencies (8 to 10 GHz), feeds both antennas through a variable power splitter. The search antenna is a cassegrainian-fed pillbox rotating at 60 rpm.

The tracking radar also uses a cassegrainian antenna encased in a radome and has a monopulse tracking capability. The TV tracker is boresighted with the tracking radar antenna for additional accuracy. Most of the RF power is fed to the search radar until target acquisition by the track radar or the decision to engage, and is then split for engagement. The search radar can continue the search during the tracking mode.

The fire-control system uses two operators seated at the console inside the van. The console has a PPI (plan position indicator) and A/R (azimuth/range) displays plus a screen for the TV tracker. One operator will operate the PPI during search and handle an adjacent matrix panel for data entry and retrieval. A rolling-ball is used to control the markers on the scope.

The other operator will utilize the A/R display and the TV screen to handle target



Skyguard Antenna

Skyguard Trailer Configuration

engagement and monitor the ECM (Electronic Countermeasures) environment. A joy-stick, in front of the TV display, can be used for manual or aided-rate tracking.

The radars have the ability to track two targets simultaneously and to switch instantaneously to the target chosen for engagement. The predicted point of intercept is then displayed on the operator's console. An alarm is sounded on the console if the radar detects the launch of an air-to-ground missile.

Signal processing is performed digitally in "real time" by the Contraves CORA II M solid-state digital computer, which performs threat evaluations based on information derived from the search radar.

Capable of calculating firing data for both guns and missiles, the computer monitors the Skyguard subsystems, automatically performs functional and performance checks of the entire system, and can provide operator training by simulating combat situations. A digital data transmission system is used to pass target and aiming data.

The body of the Skyguard module unit is constructed of reinforced fiberglass, weighs about four tons, and is compact enough to fit in a Cheyenne helicopter. The system employs two 400 Hz Bendix generators, housed together and removable from the van for external operation for long-period operation at one location.

One of the generators provides power for the digital equipment and the other powers the radar system. The trailer version can be prepared for action in 10 minutes for use with missiles or 15 minutes for guns.

Coarse leveling of the trailer version is manually controlled but fine leveling is automatic. Both antennas and the TV tracker are folded into the Skyguard module for travel.

Compared to the Superfledermaus, the Skyguard offers distinct advantages in versatility, compactness, and capability. It can be used as a focal point for operating gun and/or missile systems by incorporating search, target acquisition, and tracking functions—all in a compact, mobile package. Skyguard illustrates the modern trend in fire-control system development and serves as an excellent example of what can be expected to be deployed in the 1980s.

Foreign Technology Abstracts

This is the introduction to a planned periodic listing of selected abstracts of foreign technology study reports prepared by the U.S. Army Foreign Science and Technology Center, Charlottesville, VA. The documents describe research and development activities of special significance to those engaged in U.S. Army R&D planning and programing.

* * *

Title: Infrared and Night Vision Research and Development: Eurasian Communist Countries (U); study classification, Secret, no foreign dissemination; publication number, ST-CS-05-40-73; publication date, June 30, 1973; author, J. Kosiewicz/S Div/428.

Abstract: (U) Eurasian infrared and night-vision research and development is analyzed. Major elements include infrared thermal and photon detectors, low-light-level image tubes and intensifiers, pyroelectric detectors, and parametric up-conversion detection techniques. Some supporting areas of direct application to night-version research are also included.

Title: Ultra-High Pressure Processes (R&D)-ECC (U); study classification, Secret, no foreign dissemination; publication number, ST-CS-01-02-73; publication date, March 1973; author, CPT B. Smith/S Div/428.

Abstract: (U) This study discusses present Soviet static high pressure physics, including both present and projected future capabilities. Major topics included in this report are: diamond technology, classification, synthesis, and use of diamonds and borazon; and high pressure equipment currently in use and under development in the USSR. The Soviet program to obtain megabar pressures with large working volumes is discussed from the points of view of equipment, materials, and future research. Threats, both military and economic, associated with high pressure physics research and developments, present and future, are pointed out whenever possible.

Title: Significant Foreign Applications in Packaging; study classification, Unclassified; publication number, FSTC-CW-07-08-73; publication date, Mar. 5, 1973; author, Miss K. Prelle/GET Div/411.

Abstract: (U) Significant foreign developments in the following areas of packaging are discussed: reusable containers, basic plastic technology, preservation techniques, foam-in-place systems, unitizing systems and methods, and dessicant and barrier systems. The portions of basic plastic technology and preservation techniques are limited to Soviet developments. The remaining topics concern Free World developments. (U) Collapsible, corrugated plastic, and fiber-reinforced plastic (FRP) containers are discussed for their role as reusable containers. Polyvinyl alcohol shrink wrapping, biologically stable paper, and waterproof corrugated materials are covered in the section on Soviet plastic technology.

Title: Ground-Based Sensors (Except Radar)—Eurasian Communist Countries (U); study classification: Secret, no foreign dissemination; publication number, ST-CS-05-05B-71; publication date, Mar. 1., 1973; authors, D. Mennerich/CE Div; F. Pearson/CB Div;

E. Smith/GE Div.

Abstract: This amendment updates the previous compilation of military ground-based sensors (except radar) known to be employed by Eurasian Communist countries. New information is presented on infrared sighting and night-driving equipment; acoustic range and direction finders; optical sighting and surveillance equipment; and surveying and geodetic instruments. Predictions are made as to probable military materiel to be observed in Eurasion Communist forces in the next 10 years.

Title: Food Technology of Military Significance-Foreign Report No. 1, Food Flavor Research(U); study classification, Unclassified; publication number, FSTC-CW-01-01-73, No. 1; publication date, October 1972; author, Mrs. V. Dibbern/GET Div/411.

Abstract: (U) This study is Part I of a series of publications under the general title of Food Technology of Military Significance.

A review evaluation of foreign food flavor research on a country basis is provided in terms of the (1) idenfitication of flavor components, (2) synthetic flavor compounds, (3) effects of processing, (4) flavor retention, and (5) prevention of flavor deterioration. The results are related to foreign military rations. It was found that no known foreign flavor research is being conducted specifically for military rations with the possible exception of the Netherlands, the United Kingdom, Japan, and India. Eastern European Communist countries conduct limited flavor investigations on exported foodstuffs. Flavor research in the USSR has low priority. Japan, the Netherlands, the United Kingdom, and West Germany are expected to continue to publish good quality flavor research.

Title: New Foreign 20-40mm Ground-Based Automatic Guns—Free World (U); study classification, For Official Use Only; publication number, FSTC-CW-07-06-72; publication date, July 1972; author R. Black/CB Div/475.

Abstract: (U) This study presents tabulated technical/performance data, some cost analysis data, and illustrations of new foreign free world ground-base automatic guns and their ammunition in calibers from 20mm to 40mm. Except for the recently deployed West German 20mm Rh 202 and possibly the new French 20mm M621, all the included guns are in various stages of development, from design to pre-series production models being final-tested. It is anticipated that this material will be of assistance to Army R&D agencies involved in establishing a technological base for the design/evaluation of a U.S. gun system in the 20mm to 40mm category.

MICOM Scientist Invents Spectrophotometer Change

Interest of research laboratories in many parts of the world reportedly is increasing in an invention by a U.S. Army Missile Command scientist that makes possible inexpensive modification of a standard absorption spectrophotometer to measure accurately Faraday rotation and optical rotary power.

Physicist Dr. George Tanton explains his invention as a "new technique for measuring rotation of the plane of polarization of plane-polarized light by a medium. With this technique, the optical rotary power of a medium can be determined in the absence of an external magnetic field.

"General analytical measurements can be made, for example, determining the amount of optically active material in solution. With another option, Faraday rotation—rotation induced by an applied external magnetic field—can be measured to study materials properties at atomic and molecular levels."

Comparing his technique to existing methods, Dr. Tanton continued:

"The conventional method for measuring Faraday rotation requires separating the specimen from an inherently large background, due to scattering and absorption of the light beam, and Faraday rotation in the ancillary optical components.

"The separation is frequently accomplished by using a superconducting magnet to produce large rotation within a specimen, and a mechanically rotating analyzer to measure rotation of the specimen as a function of phase angle."

Surface reflections and specimen absorption are compensated, using the new technique in such a way that high-sensitivity measurements can be made, giving three advantages over conventional methods, as follows:

- Much less costly to put into operation and operate. Using low-field permanent or electromagnets, results are obtainable that are comparable to results conventionally requiring high-field superconducting magnets, which are expensive to purchase and require liquid helium for operation.
- Uses standard laboratory equipment and does not require any permanent modification to the standard absorption spectrophotometer. To convert the standard spectrophotometer to measure rotation, only a polarizer and an analyzer are needed. It is not necessary to modify the existing optics or electronics of the spectrophotometer.
- Versatility, both absorption and rotation, can be measured by the same instrument. (Faraday rotation and optical rotary power are determined conventionally by separate instruments.)

Tanton's invention grew out of his work at MICOM's Physical Sciences Directorate in developing an optical isolator to isolate the stages of a high-energy laser. His principal assistant was Joe Williams, a technician.

MERDC Reports on Army Standard Water Purification Unit

Wastewater generated in Army field operations can be treated with a modified standard Army purification kit featuring the ERDlater and reused or safely disposed into the environment.

The Sanitary Sciences Division of the U.S. Army Mobility Equipment R&D Center, Fort Belvoir, VA, has made this determination as the result of a field study of a process utilizing powdered activated carbon, a cationic polyelectrolyte and the modified Army standard water purification unit.

Among conclusions of the report are: a high-quality water is produced by treating shower and blended wastewater; blending the kitchen and laundry waters with shower water reduces or eliminates problems encountered when treating the water as unmixed batches.

Other findings are that the carbon sludge can be reused as a supplement to fresh carbon for treating the wastewater, the sludge produced is easily dewatered, and the small volume of sludge generated minimizes the disposal problem.

Wastewater from military shower, laundry, kitchen units and a commercial laundromat were successfully clarified and disinfected in the tests at the Army installation at Camp A. P. Hill, VA.

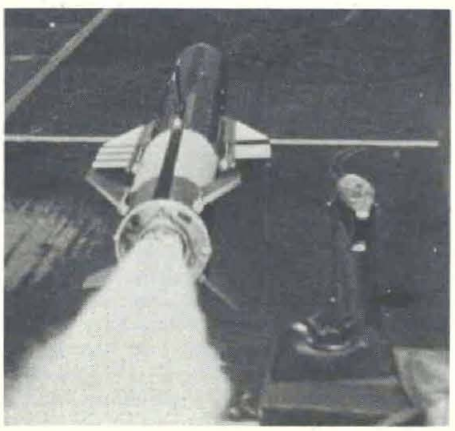
MICOM Considering Feasibility of Helicopter-Launched Missile

Competitive feasibility tests, designed to provide two contractors complete freedom and ingenuity, are being conducted on a new helicopter-launched missile system by HQ U.S. Army Missile Command, Redstone Arsenal, AL.

The Air Defense Suppression Missile (ADSM) system utilizes dual-mode seekers for countering antiaircraft defenses. Corporate contractors are Rockwell International, and Martin Marietta, each under an award of about $1 million.

Under a new prototype development concept, each contractor is designing and testing equipment to meet performance goals rather than detailed specifications.

Five missiles have been fired by each contractor. All computer simulations and captive flight tests have been conducted by Redstone Arsenal personnel. Following completion of the tests, the Army may select one or both prototypes for further development.



Synthetic Flight Instrument Examined

An examination of an off-the-shelf fixed-wing aircraft instrument training device, and the methodology and concepts associated with its use, is presented in a newly issued Human Resources Research Organization (HumRRO) publication.

Identified as *Research on Synthetic Training: Device Evaluation and Training Programming Development, Technical Report 73-20,* this study compared trainees at the Army Aviation School who received synthetic flight training and those who did not.

Conclusions suggest that use of the new training device along with newly developed instruction programs can result in savings to the Army in inflight training time and that new concepts devised during this research have applications to other flight training courses.

'A Great Day in a Proud Tradition' . . .
Secretary of Army Callaway Pays Tribute To HDL's R&D Contributions to Defense

HARRY DIAMOND'S GRANDSON, 8-year-old Robert Goldstein, uses a sword to hack at the corner of the commemorative cake for the 20th anniversary of the Harry Diamond Laboratories. Observing are (l. to r.) Deputy Assistant of the Army (R&D) Charles L. Poor, HDL Commander COL David W. Einsel Jr., and proud parents Mr. and Mrs. Steven Goldstein. She is one of two daughters of the inventor.

SECRETARY OF THE ARMY Howard L. Callaway was among a long list of dignitaries, including AMC Commander GEN Henry A. Miley Jr., who plied a trowel in adding a bit of mortar to seal the cornerstone of the headquarters building in HDL's new laboratory complex at Adelphia, MD. Behind that cornerstone, with many historic documents, is a copy of the *Army R&D Newsmagazine.*

CORNERSTONE LAYING ceremonies for the headquarters building in HDL's new laboratory complex were attended by a great many dignitaries. Shown (l. to r.) are Wilbur S. Hinman, HDL's first technical director, and his current successor, Billy M. Horton; AMC Deputy for Laboratories Dr. Robert B. Dillaway (overlooking Robert Goldstein); Deputy ASA (R&D) Charles L. Poor, Mrs. and Mr. Steven Goldstein and COL David W. Einsel Jr.

Pictures record historical events in a way that even the most gifted writers are unable to portray by the magic of word imagery—which is why these glimpses at some of the highlights of the 20th anniversary celebration at the Harry Diamond Laboratories are published.

Until the last moment of the absolute deadline for publication in the November-December edition of the *Army Research and Development Newsmagazine,* the editors waited for pictures to support a brief report on the dedicatory ceremonies for HDL's new $40 million research complex at Adelphi, MD.

Still, good pictures have a timeless value and those selected for a permanent recollection of a "truly great day in the proud history of the Army's Harry Diamond Laboratories"—chosen from a large batch that were taken—meet the requirement. As such they are deemed deserving of "historical publication," that is, more than three months after the event they recorded.

Another justification is one we are more than a bit ashamed to admit. But it certainly *demands* publication of at least one of the pictures, in a somewhat vainglorious effort to rectify one of those inexplicable errors that make editors susceptible to what is known as "the professional disease."

Secretary of the Army Howard H. Callaway, the principal speaker at the dedication ceremonies, was pictured in our November-December report on the Association of the United States Army annual meeting.

Somehow, however, our printer transposed his picture and that of AUSA President Edward C. Logelin, resulting in erroneous identification. It happened after we had checked revised page proofs, which were all right, in the final process of preparing the printing master plates. The printer has written a letter of apology to us, and the picture of Secretary Callaway shown here is *our way of expressing our regrets to him.*

Secretary Callaway's address was a highly appreciative tribute to the Harry Diamond Laboratories, including:

". . . Your history of major contributions to our defense posture, beginning in World War II—but especially since your official inauguration as the Harry Diamond Laboratories in 1953—is an impressive one of dedication, mission-orientation and service. There can be no doubt of the value of your contribution to this Nation's successes, to shortening the battle, and to saving the lives of thousands of American soldiers."

In advocating the maintenance of a "research program strong, dynamic, far-sighted and responsive to the Nation's needs," Secretary Callaway continued: "We must be watchful that our research efforts do not lag. Perhaps the greatest adversary of our technological advantage is time. . . . Research itself takes time, often unknown amounts of time, and usually great amounts of time.

"With an effective research organization, we may somehow be able to do great things in a comparatively short time. But time is also necessary for building up that research capability. If that capability is not maintained at a sufficient level, if we do not keep pace with technology and change, we are liable to remain forever far behind a more farsighted power. . . ."

Secretary Callaway was introduced by GEN Henry A. Miley Jr., commander of the U.S. Army Materiel Command, parent organization of the Harry Diamond Laboratories.

The anniversary celebration followed the dedication and laying of the cornerstone for HDL's impressive new complex of buildings at Adelphi. The first phase of a 3-phase relocation program, spread over a 3-year period, began in January 1974, involving some 500 of HDL's approximate 1,400 employes.

Plans for the relocation and an explanation of the working environment that will be provided in the new complex were detailed at the ceremony by HDL Technical Director Billy M. Horton. COL David W. Einsel Jr., HDL commander, made the closing remarks, followed by the playing of The National Anthem by the United States Army Band and the benediction by Chaplain (COL) William V. O'Connor, Army Materiel Command staff chaplain.

Dignitaries present for the cornerstone laying included all except one of HDL's past commanders, HDL's first technical director (1953–1961) Wilbur S. Hinman Jr., Congressman Gilbert Gude of Maryland, Executive Director Charles H. Conrad of the National Capital Planning Commission, Deputy Assistant Secretary of the Army (R&D) Charles L. Poor, Army Materiel Command Deputy for Laboratories Dr. Robert B. Dillaway, Army Chief of R&D LTG John R. Deane Jr. (representing Assistant Secretary of the Army (R&D) Norman R. Augustine), and MG D. A. Raymond, Army Deputy Chief of Engineers.

YPG Tracks Artillery Projectiles With Lasers

What is believed the first successful tracking of four artillery projectiles by a laser beam, using a new system, was reported recently by Yuma Proving Ground, AZ, an element of the U.S. Army Test and Evaluation Command, Aberdeen (MD) Proving Ground.

The Precision Aircraft Tracking System (PATS) is a low-power system designed to track manned vehicles such as helicopters and jet aircraft. Maximum signal return is provided by an optical retroelector mounted on the tracked object.

Fired from a 105mm howitzer, all four of the test projectiles were tracked from the gun muzzle to point of impact. These trackings were part of a series of tests which included evaluation of free-falling objects from an altitude of 2,500 feet and Cobra helicopter trackings.

Naval Center Selected for Health University Site

Selection of the National Naval Medical Center, Bethesda, MD, as the future site of the Uniformed Services University of Health Sciences was announced by Secretary of Defense James Schlesinger.

Authorized by Public Law 92–426 (Uniformed Services Health Professions Revitalization Act of 1972), the University was established to educate physicians and other health care professionals for the Armed Forces duty. Graduation of a minimum of 100 physicians annually by 1982 is required by law. Also established is the Armed Forces Health Professions Scholarship Program which is designed to provide the military with adequate numbers of professional health care personnel. A continuing quota of 5,000 scholarships has been authorized.

ECOM FY-73 Posture Report Lists R&D Achievements

Development of the AN/PVS-5 Night Vision Goggles, a head-mounted 1.85-pound unit-power device, is listed among the five most noteworthy technical accomplishments of the U.S. Army Electronics Command (ECOM), in the Executive Summary of the FY-73 Laboratory Posture Report.

Currently undergoing development and operational tests, with production planned in FY 75, the goggles provide the individual soldier with a capability that allows freedom of movement while performing nighttime tasks with daytime efficiency.

The other major accomplishments include advances in the universal-viewer concept through far-infrared sensor development, low-level night operations of aircraft, advanced development of lithium-organic power sources, and design techniques that reduce the cost of microwave integrated-circuits hardware.

The posture report summarizes responsibilities and achievements of ECOM's seven major laboratories, plus the R&D Technical Support Activity (RDSTA), as follows:

Combat Surveillance and Target Acquisition (CS&TA) Laboratory, Fort Monmouth, NJ. The CS&TA Laboratory, assigned Army Materiel Command Lead Laboratory responsibility in its field, conducts a balanced program to meet the Army's needs in battlefield surveillance, target designation and acquisition, identification friend-or-foe (IFF), and radiological survey.

Among 18 major accomplishments listed during FY 73, the laboratory initiated an analytical and experimental program for the multisensor mortar-locator; established feasibility of a scanning-type gun infrared-flash detecting sensor; and demonstrated capability of laser devices to detect gun-fired effluents.

The program was highlighted by initiation of a number of new advanced and engineering developments such as a Radio Data Link (AN/GRA-114) for the Sound-Ranging System; Remotely Piloted Observation Detection System (RPAODS), an RPV program for target detection, location, and designation; Handheld Laser Target Designator (AN/PAQ-1); Laser Search and Track Set (helicopter-mounted) AN/AAS-32; and IFF Systems for Stinger and SAM-D.

The following CS&TA major efforts also continued according to schedule: Radar Set AN/PPS-15, REMBASS (Removely Monitored Battlefield Sensor Systems) support, and completion of development and operational testing of Interrogator Set AN/TPX-46.

Night Vision Laboratory (NVL), Fort Belvoir, VA. The NVL has responsibility for providing the Army with a night vision capability to enable night operations with near daylight efficiency for ground, ground-vehicle, airborne and missile applications.

Among 21 notable technology base accomplishments listed in the FY 73 report, the laboratory completed major tests and type-classified Night Vision Goggles AN/PVS-5, successfully tested the Pocketscope, discovered eight new near infrared flash lamp pumped-dye lasers, developed IFF systems for the Stinger and SAM-D missiles, and completed advanced development of the Passive Night-Driving Periscope AN/VVS-2.

Atmospheric Sciences Laboratory (ASL), White Sands Missile Range (WSMR), NM. The ASL program is designed to provide knowledge of the atmosphere necessary for tactical decisions and the effectiveness of Army weapon systems. In support of military operations, the meteorological equipment development program was focused on:

Continued engineering development of the Meteorological-Data Sounding System, AN/UMQ-7 and its components and subsystems, which include the Hydrogen Generator and Fast-Rise Balloon System.

Type classification and start of production of Meteorological Measuring Set, AN/TMQ-22.

In support of research, development and testing activities, the ASL continued its participation in the Multiagency Meteorological Rocket Network, and provided specialized meteorological support by meteorological teams located at numerous sites throughout CONUS, Alaska and the Panama Canal Zone.

Avionics Laboratory, Fort Monmouth. The over-all objective of the avionics program is to establish and maintain a system and technology base to support development of airborne and ground-avionics systems; also, the equipment required for Army air airmobility operations during day, night and adverse weather conditions, from nap-of-the-earth to service ceilings, under a mid-intensity antiaircraft threat.

Typical of 19 listed technology base accomplishments were the performance of flight-test capability assessment in the Research Aircraft Visual Environment (RAVE) of various sensors that enable an Army pilot to fly low-level under night conditions; and completion of flight testing of the LORAN/Inertial System.

Highlights in the development program include installation engineering and test support for several R&D aircraft systems and appropriate in-service aircraft systems (UH-1, AH-1G, CH-47, U-21); also, the initiation of a "fly-before-require" program for a navigation/stabilization system for Medevac aircraft.

Communications/Automatic Data Processing Laboratory. The primary efforts of this laboratory cover single-channel net communications systems, automatic data processing systems, and peripherals.

Twenty-three accomplishments listed as notable in the technology base research program include completion of a Tactical Radio Communications Systems (TRCS) concept study, and testing of a Variable-Rate Adaptive Multiplexer. The laboratory designed and tested a new dual-mode interconnection link utilizing light-emitting diodes for SAM-D applications, and achieved significant reduction of design time in a new subset compiler of Programing Language/1.

The Communications/ADP development program included numerous contractual awards and delivery of systems for test and evaluation.

The laboratory completed initial experimental models of the AN/URC-78; neared completion by the contractor on engineering development of Radio Set AN/PRC-70, for special forces applications; and completed acceptance tests of engineering development models of Multiplexer TD-968 for the Defense Communications System.

Electronic Warfare Laboratory, WSMR, and Fort Monmouth, NJ. The objective of the Electronic Warfare (EW) Program is to improve the capability of the Army to intercept, identify and locate the source of enemy emissions; to permit operation in a hostile electromagnetic environment; and to minimize the enemy's effective use of the electromagnetic spectrum. Accomplishments included:

Completion of development of the Direction Finding Set AN/TRD/26, and shipping of the equipment to the user for tests.

Successful acceptance testing of the Airborne Fuze Jammer, Counter-measures Set AN/ALQ-67, was followed by submission to TECOM for the start of developmental testing.

Completion of an advanced development model of a Single-Site Location System.

Electronics Technology and Devices Laboratory. ETDL programing is rooted in the belief that newly evolving Army electronic systems must have continuously updated technology bases in electronic devices, materials and techniques. To this end, a diversified, mission-oriented applied R&D program—focusing on the barrier technology problems associated with next-generation components and equipments—was selectively pursued in FY 73. Nineteen areas of achievement are listed.

Accomplishments include development of lithium organic electrolyte and also methanol-air high-powered batteries. A 1,100-wat feasibility model Power Generator PP-6128(U)/U was one of the highest-power, flame-fired thermoelectric power sources developed. Externally grown single cyrstal magnetic films were successfully applied to memory devices operating at output data rates in excess of 100 kilobitts/second. Notable also was the design and evaluation of a portable calimetric system to measure nuclear radiation and dose rates at nuclear weapons simulators.

R&D Technical Support Activity. This organization develops advanced techniques and experimental systems for computer-aided design/engineering and performance assessment. It also provides mathematical analyses and the use of computers for scientific and engineering purposes.

FY 73 accomplishments listed as notable include completion of eight service-test models of Mast AB-864 (U)/G, and fabrication of engineering test/service test models of the Man-Portable Visual Air Traffic Control Facility AN/TSQ-97.

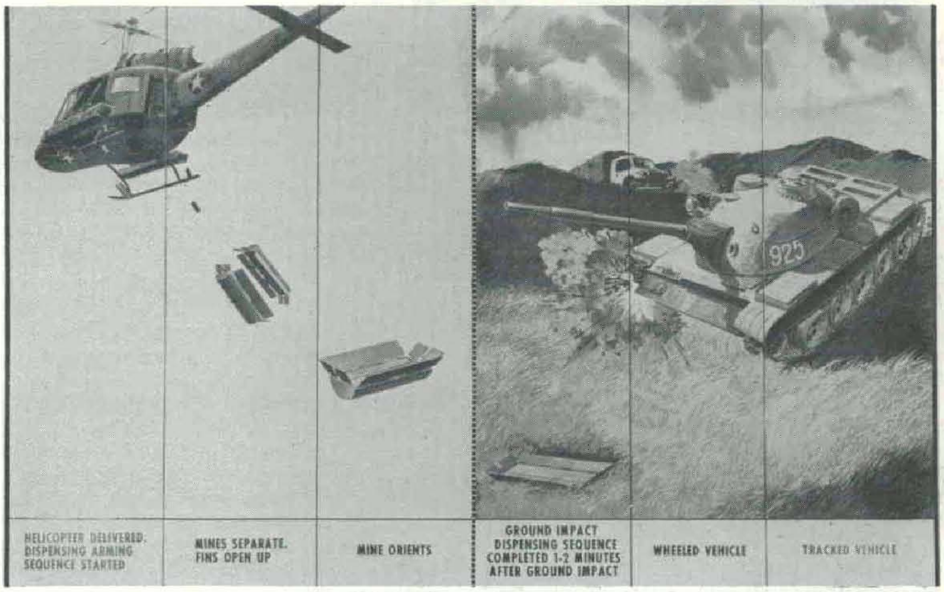
ECOM's FY 73 Laboratory Posture Report contains narrative and tabular information on development of the ECOM Electronic Systems Plan (ESP); Organization of ECOM RD&E; Project Reflex; Recognitions-Papers-Patents; Influences on RD&E; Inter-Service Cooperation; Funding; and Technical Achievements Leading to Dollar Savings.

In summarizing developments completed and type-classified during FY 73, the report included the AN/PVS-5 Night Vision Goggles; AN/APN-171A (V) Electronic Altimeter Set; AN/PRC-74C Radio Set (with AN/PRM-31 Test Set; BA-525/U Battery; AN/TSQ-71A Landing Control Central; and the AN/TRN-30 Low-Frequency Beacon.

The report also analyzes the technology transfer of ECOM laboratory research to nonmilitary applications. Material spin-offs to civilian applications include the Pocketscope, Starlight Scope, Handheld Thermal Viewer, Multipurpose Infrared System, Tactical Landing System (localizer unit), a Defibrillator-Pacemaker feasibility model, Thermoelectric Generators, and NV Searchlights.

Picatinny Arsenal in Research and Development

By Harry W. Painter
Technical Director



Sequence of Operations for XM56 Mine Dispersing System

Linked to Picatinny Arsenal's proud tradition is esprit de corps in long being heralded as the "Cradle of American Ammunition," a term originating from its manufacturing role when it was named Middle Forge and was privately operated in producing munitions during the Revolutionary War. In 1907 the enterprise became Picatinny Arsenal.

A "new" Picatinny has evolved in recent years. The change has established the installation as one of the Free World's principal research, development and engineering centers for conventional munitions and nuclear weaponry—with a strong interest in many RD&E areas.

Today, the arsenal's 5,700 employes at Dover, NJ, are proud of being an important element of the Armament Command, headquartered in Rock Island, IL, and the parent U.S. Army Materiel Command, headquartered in Alexandria, VA. They like to consider themselves "creatively conscious" of their mission in research, development and engineering activities to support priority objectives of the national defense establishment.

Approximating, Picatinny's staff has varied over recent years from peaks of about 9,000 employes, in times of emergency, to sustaining levels of 5,000 to 6,000 for normal operations.

Maintaining a strong in-house capability to respond rapidly and effectively to critical requirements is intrinsic to the prevailing operational concept. Still over half of Picatinny's workload must be accomplished by contracts and effort with other federal agencies.

Contributions of the nation's research, development, academic and industrial organizations are essential to fulfillment of the arsenal's mission. Recognizing this as a basic factor in successful operations, Picatinny's highly trained and expertly experienced scientific, engineering and technical professionals strive continuously to integrate effort practicably with the general scientific and industrial community.

Technical capabilities of the arsenal are concentrated in five major areas. The first is *Munitions Development*, encompassing the full life cycle from creative concept through program formulation, design, engineering, evaluation, and production of reliable end-items of materiel, including support to industry and the Government-owned, Contractor-operated (GOCO) complex.

Currently, the arsenal is responsible for about 350 munition end-items, both conventional and nuclear types. Requirements include munitions for large-caliber weapons, such as field artillery guns and howitzers, mortars, tank weapons and recoilless rifles.

Other activities involve warheads for missiles and rockets, grenades, antipersonnel and antitank mines, demolition devices (including atomic), explosive, propellant and pyrotechnic devices, and techniques, tools and devices for explosive ordnance disposal.

Research and technology in energetic materials is a second major area of effort, constituting a substantial portion of the arsenal's technological base, since Picatinny has been designated by the Army Materiel Command as "Lead Laboratory" for activities in this field. Energetic materials include explosives, pyrotechnics and propellants.

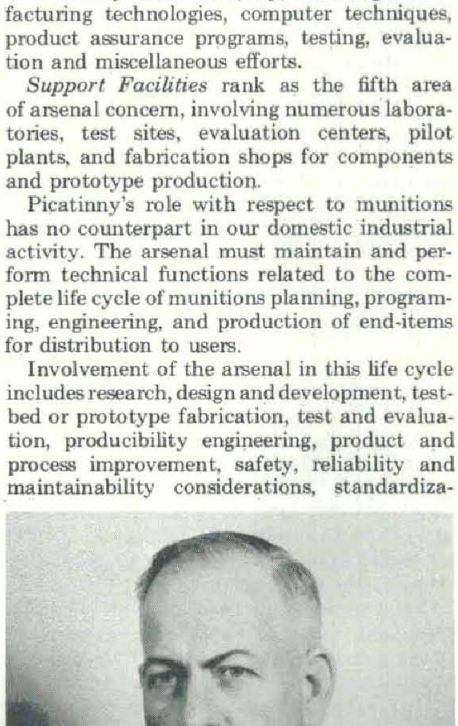
Manufacturing Technology, the third area, involves development of new processes and definition of new equipment to modernize the production base.

Support Technologies is a fourth major area of Picatinny RD&E activity, including manufacturing technologies, computer techniques, product assurance programs, testing, evaluation and miscellaneous efforts.

Support Facilities rank as the fifth area of arsenal concern, involving numerous laboratories, test sites, evaluation centers, pilot plants, and fabrication shops for components and prototype production.

Picatinny's role with respect to munitions has no counterpart in our domestic industrial activity. The arsenal must maintain and perform technical functions related to the complete life cycle of munitions planning, programing, engineering, and production of end-items for distribution to users.

Involvement of the arsenal in this life cycle includes research, design and development, testbed or prototype fabrication, test and evaluation, producibility engineering, product and process improvement, safety, reliability and maintainability considerations, standardization, manuals preparation and new equipment training, cataloging, and procurement and logistics technical support.



COL Jonathan L. Holman Jr.
Picatinny Arsenal Commander

Over the years, the arsenal's over-all productivity record reflects the effectiveness of the review process in initiating creative R&D programs. The list of effective contributions to advanced materiel technology has firmly established Picatinny's progressive position in the defense structure.

One of the outstanding recent developments is rocket-assisted, high-explosive projectiles (RAPs) for the 155mm and 105mm howitzers. These are the Free World's first operational artillery-launched, zoned RAPs.

RAPs provide all existing howitzers with one-third more range and more than 100 percent greater area coverage. Because RAPs incorporate in design a new high-fragmentation steel, they provide significant increases in lethal effectiveness. In fact, the M548 cartridge provides existing 105mm howitzers with the effectiveness of the M109 and M114 155 howitzers using the standard M107 high-explosive ammunition.

Successful development of the RAPs opens the way for considering new lightweight, highly mobile, extended-range weapons of many types—from shoulder-fired to helicopter-mounted. They are expected to revolutionize artillery technology and tactics.

Another of the more significant developments in the long history of ammunition is the HEAT-T-MP 152mm M409 cartridge with a nonmetallic cartridge case. Used with the M551 General Sheridan Armored Reconnaissance Airborne Assault Vehicle and M60A2 Tank, the 152mm ammunition was the first having a nonmetallic cartridge case; also, the first fired successfully from a gun missile-launcher.

The cartridge is unique in that it performs multiple missions including armor defeating (antitank) and antimateriel/antipersonnel (high explosive and fragmentation). This single-round, dual capability permits the prime weapon system to carry a more balanced ammunition complement with reduced total vehicle load.

In addition, use of a cartridge case that is consumed in firing of the round disposes of the problem of hot. spent metal cases rolling around in the vehicle, and hazardous ejections.

Complementing the 105mm howitzer ammunition as the workhorse for the artillery in Southeast Asia were the 40mm cartridges for the infantry and 2.75" rockets, which for air-to-ground engagements provide an advanced capability.

For example, the helicopter-mounted 2.75" rocket system, as used in Southeast Asia, has been limited largely to the antipersonnel role —using high-explosive fragmentation and flechette warheads. The Department of the Army in April 1971 initiated work to develop a warhead that would also be effective against armor.

The result was the XM247 high-explosive, dual-purpose warhead, given an unexpected baptism of fire in the spring of 1972 when the North Vietnamese moved into South Vietnam with tanks and armored vehicles.

Some 1,000 of the dual-purpose rockets were fabricated at Picatinny on a crash basis and air-transported to the battlefield. Our helicopter pilots were soon praising the new rocket as a valuable interim antitank weapon that will be complementary to the TOW Antitank Missile System.

The Aircraft Mine Dispersing Subsystem M56 has recently become the first of several scatterable mine systems presently under development to become type classified as standard. The primary purpose of the M56 is to emplace antitank/antivehicle mines using U.S. Army rotary-winged aircraft.

This system will provide battlefield commanders with quick response and flexibility to meet rapidly changing tactical requirements. It provides the capability to rapidly create protective, defensive barrier and nuisance minefields, as well as route mining, interdictory mining and aerial denial.

Forty-nine canisters, each containing two antitank mines, are placed in a dispenser and two dispensers are mounted on a UH-1H helicopter. The mines are ejected by actuating selector switches from the cockpit as desired for the mission. Upon leaving the canister the mines separate and the fins open up, orienting the mine for proper position on ground impact, after which the arming sequence is completed.

Continued development and improvement of the family of 40mm cartridges has resulted in many notable accomplishments. The M430 high-explosive, dual-purpose 40mm cartridge represents a success in providing helicopter armament with a multipurpose munition for engagement of enemy personnel, lightly armored vehicles and barricaded targets.

The M430 cartridge is capable of penetrating at least two inches of homogeneous steel armor plate at zero degrees obliquity. It is compatible with helicopter 40mm weapons and can be fired at ranges up to 2,200 meters. In addition, it has lethality equivalent to the existing M384 40mm cartridge in the latter's antipersonnel role.

The M433 high-explosive, dual-purpose cartridge gives the infantryman the capability of using his M79 grenade launcher or M203 grenade launcher attachment for the M16A1 rifle. It can successfully engage lightly armored vehicles such as personnel carriers, weapon carriers, amphibious vehicles, trucks and jeeps.

The M433 also has the capability of defeating brick and concrete structures, sandbag and log fortifications, supply dumps and ammunition, and gasoline storage areas. It is effective also against personnel with its hundreds of small, high-velocity fragments.

An urgent request from U.S. Army forces in Southeast Asia gave Picatinny engineers the task of developing 40mm smoke canopy cartridges—for use by infantry squads in ground-to-air signaling and communicating in dense jungle-type terrain where the signature from conventional smoke grenades would be obscured.

The results of that effort are yellow, green, white, violet and red smoke-canopy cartridges, which are fired vertically from the M79 launcher or M203 grenade launcher attachment through overhead foliage to an altitude of about 300 feet. At this point the smoke candle with the attached parachute is ejected.

Two other 40mm cartridges, the M583A1 white star parachute and the M585 white star cluster, provide a means of visual communication and signaling capabilities in one round. In comparison with the current standard hand-held rocket signals, they have the advantage of one-third less weight and volume per round and a 50 percent increase in flight directional stability at one-half the cost per round.

The reduction in weight and volume permits greater combat effectiveness and the increase in flight stability results in improved accuracy and safety. Additionally, the 40mm configuration allows the signal rounds to be carried in the standard 40mm vest.

Picatinny efforts are continuing in development and improvement of Beehive rounds of ammunition for use in howitzers and guns of the M60 and M48 series tanks. Beehive rounds are filled with flechettes, small arrows or darts, usually about 1½ inches long, although some have been much larger. Several thousand of them, mass assembled on a belt by a process also developed by the arsenal, can be packaged into a projectile.

The word Beehive refers to the way the flechettes are compartmentalized in the shell. The great advantage of the Beehive round is that it can function at the muzzle or at any desired point downrange.

Fielding of the M590 90mm flechette canister cartridge provided the M67 90mm recoilless rifle a close-in defense against massed enemy assault as well as a means of assault on personnel in deep grass or dense foliage.

Within four months of authorization to begin work on the cartridges, concept feasibility was established, engineering development tests and launch safety tests were completed, safety release obtained and 200 cartridges shipped to Southeast Asia for field evaluation. The cartridge's effectiveness against massed enemy assaults was demonstrated under combat conditions, resulting in high praise from users.

The Mechanical Time-Super Quick (MTSQ) XM557E1/XM582E2 fuze is another major arsenal accomplishment. Used with the 105mm cartridge, 155mm and 8" rounds, the fuze underwent extensive production engineering efforts over a 5-year period.

The effort resulted in design for automated assembly and inspection; an accuracy improvement by a factor of three; greater firing reliability; overhead safety until three seconds before set time (making it possible to fire safely over friendly forces); and a rain-insensitive point-detonating feature to eliminate premature firings that might otherwise occur during monsoons should the fuze be in its Super Quick PD mode.

The M572E2 is another arsenal-developed fuze with a one-piece body designed for automated assembly and inspection processes to eliminate or reduce the load, assembly and pack (LAP) operations of multi-contractor metal parts at GOCO plants.

Picatinny efforts in the missile warhead area include work on the Lance missile, which provides the Army with a highly advanced, lightweight, mobile and versatile system to replace both the Honest John and Sergeant missiles. The nuclear warhead section design for Lance incorporates numerous advances in missilery state-of-the-art.

The M42EI sequential timer illustrates one of these improvements. This is the first electronic timer to enter stockpile and has an accuracy one order of magnitude greater than conventional mechanical timers. The warhead section also utilizes a low-weight, high-strength honeycomb structure to encase the warhead and arming and fuzing systems.

Research and development efforts at Picatinny provided the Army with a nuclear capability for its 155mm artillery weapons. In adapting the AEC nuclear components into a complete round configuration, Picatinny developed the projectile case design, the XM76 locking device, and later an improved propelling charge. The fuzing for this round was provided by the Army Materiel Command's Harry Diamond Laboratories.

This projectile may be used against a variety of targets to provide direct support of infantry, mechanized and armored forces, and for reinforcing and general-support missions in conjunction with other field artillery nuclear delivery capabilities, at both division and corps/Army levels.

Picatinny activities are supported by its Scientific and Engineering Computing and Data Processing Facility. This extensive and still growing facility consists of a Control Data Corp. 6500 large-scale digital computer complex and an Electronic Associates Inc. 8900 hybrid computer.

The CDC 6500 is the hub of a data communications network which services three different types of terminals (teletypewriter, batch and interactive graphics) at Picatinny Arsenal and at remote sites throughout the country, including Philadelphia, Detroit and Rock Island, IL.

Through teletypewriter terminals the user can compose new programs or draw upon existing ones stored in the computer's files at the central site. Answers can be requested and received immediately. The ability to examine results, rethink the problem, and request additional answers at a pace determined by the working engineer is a very powerful tool in reducing the lead time required in Army R&D programs.

The arsenal's line-drawing interactive graphics terminal is a relatively new kind of display device. It is a powerful, man-oriented input and output cathode ray tube display permitting the designer to work directly with drawings, graphs and the pictorial logic of his problem.

This pilot interactive graphics project has now come to fruition with the "first-time" development of usable computer graphics design programs in the areas of curve fitting, ballistic matching, printed circuit board layout, stress analysis, fuze component mechanics, electronic circuit analysis, and applied mathematics for its CAD-E (Computer-

(Continued on page 18)

Picatinny Arsenal in Research & Development

(Continued from page 17)

Assisted Design-Engineering) projects.

An additional computer, a CDC 6600, will be installed shortly to supplement the existing CDC 6500 system. This will more than double Picatinny's computer capacity.

The EAI 8900 analog/hybrid computer system is a composite system which marries two different types of computers—an analog computer with a digital computer, expanding capabilities of both many times. The main features include the high-speed solution capability of analog computers (solution time in the millisecond range is common) with the memory and storage capabilities of the digital computer.

Picatinny has been a leader in carrying out the President's executive order requiring federal facilities to take the lead in eliminating pollution problems. Accomplished through the Manufacturing Technology Directorate (MTD), this effort directly supports the AMC project manager for Munitions Production Base Modernization BG Robert J. Malley.

Picatinny scientists and engineers are responsible for establishment of new manufacturing processes, as well as pollution control and operational safety measures, at most of the U.S. Army munitions manufacturing facilities. These functions require close coordination with the Army Corps of Engineers, the Office of the Surgeon General and the Environmental Protection Agency.

Prerequisite engineering efforts include studies to develop improved processes for the manufacture and loading of propellants and explosives, design of advance machine and materials handling systems for assembly and packaging of munitions, establishment of protective structural design criteria, development of pollution abatement technology, and development of computer techniques for process simulation and control.

Examples of notable achievements in the past four years include: Development of an optimum process for the first U.S. Nitroguandine plant; establishment of a pilot plant representing an advanced, continuous melt-pour process to be installed in modernized munitions loading plants; pilot-scale demonstration of controlled incineration techniques for disposal of waste propellants and explosives; providing the technical input for the Tri-Service Safety Manual, TM5-1300, "Structures to Resist Effects of Accidental Explosions," and supplements thereto.

In July 1973, Picatinny assumed responsibility for management of the National Bomb Data Center (NBDC). Operated by the Arsenal's Munitions Support Directorate for the Federal Bureau of Investigation, the NBDC was originated in 1970 by the Law Enforcement Assistance Administration—under a contract with the International Associations of Chiefs of Police as part of the President's efforts to combat crime. Located originally in Gaithersburg, MD, the NBDC was brought to Picatinny by an agreement with the Federal Bureau of Investigation.

Established to give technical assistance including immediate response to terrorist bombing activities throughout the country, the NBDC provides a variety of services to some 4,000 federal, state and municipal agencies. Responsibilities include preparation and distribution of technical publications citing methods for improving the security of potential targets; techniques to use at bombing sites; "homemade" bombs, explosives and incendiary materials; also, "render safe," dismantling, and disposal methods and procedures.

Additionally, the NBDC provides technical consultants to resolve, on an around-the-clock basis, problems encountered by participating agencies; tests and evaluates bomb-handling equipment and techniques; develops instructional materials, including visual aids, for use in special classes given to law enforcement personnel; and maintains a national technical information center containing bombing reports, text books and other publications.

Test and evaluation facilities are located throughout Picatinny Arsenal, but are consolidated organizationally within the Technical Services Directorate. These facilities include equipment for subjecting munitions to virtually all natural or imposed conditions likely to be encountered in the manufacture-to-target sequence.

Test items, components and systems can be shaken, spun, dropped, heated to 350° F., and chilled to −100° F.; they can be subjected to radio frequency hazard effects, altitudes of 150,000 feet, to salt spray, dust, wind, rain, high humidity, low humidity, and many combinations of these.

Picatinny has facilities for evaluating the terminal effects of munitions. These include fragment velocity-mass distribution, shaped-charge effects, armor penetration, fragment penetration of various target materials, and other terminal effects.

The arsenal can provide complete in-house telemetry support from engineering design through field firing and data acquisition to reduction of recorded flight test data. Telemetry packages have been designed and developed for the warhead sections of many missile systems, including the Pershing, Lance, Honest John, Nike Hercules and Spartan.

Virtually all of the ammunition developed by the arsenal—from 81mm mortar rounds to 40mm projectiles to bomblets—is subjected to static and dynamic characteristic testing in the arsenal's wind tunnels. These are capable of simulating free flight velocities from low subsonic to high supersonic, and are used to determine the aerodynamic forces and pressure characteristics of various munition shapes in the Mach number range of .1 to 3.5.

The Feltman Research Laboratory at Picatinny conducts investigations in energetic materials such as explosives, propellants and pyrotechnics; materials relating particularly to plastics and adhesives; and engineering sciences such as aeroballistics, mechanics, optics and solid-state physics. These disciplines and technologies support and are applied to all arsenal commodities.

Assigned Army Materiel Command Lead Laboratory responsibility in the area of energetic materials, Picatinny Arsenal is concerned with all aspects of the science and technology of energetics. Picatinny represents the Army, nationally and internationally, and also serves other government agencies in a consulting and operating capacity.

Basic research effort is directed towards the understanding of the principles that govern the existence and behavior of highly energetic chemicals. Fundamental studies are based on the physics and thermodynamics of initiation, combustion, deflagration and detonation.

Additionally, efforts are directed toward discovery of new energetic molecules, and hence, synthesis of new materials. Applied research in energetics puts major emphasis on alternate explosive fills, illuminant and delay composition, new formulations, processing, characterization, ignition, combustion, detonation and explosive trains.

Picatinny's energetics laboratories are equipped with the latest research tools—electron microscopes, diffractometers, mass spectrographs, and spectrometers, covering the complete range of spectroscopy, including optical, microwave and nuclear.

For nuclear spectroscopy and irradiation studies, in-house and out-of-house facilities are used, including those at the National Bureau of Standards Research Reactor, Washington, DC.

Picatinny radiation research facilities include two high-intensity cobalt-60 sources capable of providing gamma dose rates up to two megarads per hour. Complemented with X-ray and neutron sources, this assembly of tools provides a strong basis for the study of radiation effects on energetic materials.

For the study of energetic materials via radioactive tracers, Picatinny maintains six radioisotope areas. Typical studies conducted include mechanisms of chemical reaction, physical processes, nuclear gauging and nuclear activation methods for elemental analysis.

In the field of the safety and useful life potential of propellants, Picatinny acts as the Army's central reference point for the surveillance of approximately 20,000 propellant samples and charges from master lots worldwide stocks. The arsenal maintains, in the area of pyrotechnics, the highest degree of scientific expertise and background of any Free World industrial or government facility.

Many of the instruments were designed and developed by Picatinny scientists. Facilities are exceptionally well-equipped to permit engineers and scientists to perform studies and experiments in visible and covert illumination, marking, signaling, photo flash decoys delays, and other pyrotechnic items.

Pyrotechnics facilities include a 90-foot outdoor tower with a displacement system for simulating parachute drop; two completely instrumented high-altitude chambers where conditions up to 100,000 feet can be simulated to measure pyrotechnics output; a dynamic test facility located at Yuma (AZ) Proving Ground, designed by Picatinny for measurements of illumination during flight tests; and a pyrotechnic terrain model for determining the effectiveness of flares.

The model is 40 feet long by 10 feet wide and contains simulated SEA terrains on a 160 to 1 scale. Use of the terrain model, in contrast to engineering field experiments, permits critical parameters to be controlled, repeated and varied at substantially reduced cost—so that quantitative data as to their effects on target acquisition and recognition can be obtained reliably and efficiently.

Materials engineering capability at Picatinny is mainly in plastics, composites and nonmetallics having defense-oriented application, including reinforced plastics, composites and adhesives. The arsenal conducts research, development, and engineering application studies, and maintains the Department of Defense Plastics Technical Evaluation

Center (PLASTEC). This represents the largest in-house effort in this area within the Department of Defense.

Guide to Test Methods for Plastics and Related Materials, an arsenal publication, is unique. It marks the first time that test methods for plastics—representing a cross-section of the methods employed in government and industry, and as recommended by the various societies—have been tabulated and integrated in one document. The report makes available to industry, the public, and technical communities at large, test data on the chemical, physical and mechanical properties of the available variety of commercial plastics.

The plastics laboratory is well equipped with research and evaluation apparatus, and equipment used in processing plastics or fabrication of prototype componentry for new materiel.

As a part of its materials technology base, Picatinny maintains an in-house capability for conducting investigations into many metallurgical problems in support of its product line. Determinations are made of mechanical, physical and chemical properties; also, stress analysis, corrosion factors, surface fracture, and crystallographic structure.

Engineering sciences investigations in munitions are conducted for a wide variety of potential applications to military requirements. Emphasis is placed on analytical approaches to design problems, supported by laboratory experimentation.

Picatinny's physics research includes semiconductors, electronic materials, fuzing devices, power sources, lasers, holography, ceramics, ferroelectrics, physics of failure, and other technologies related to munitions.

The arsenal has established a strong product-assurance capability for independent control and assessment of munitions quality, safety and reliability. These functions are supported by laboratories capable of performing all examinations, measurements and evaluations. Special emphasis is on nondestructive testing.

An extensive radiographic facility is employed to evaluate explosive and nonexplosive items nondestructively. In addition to X-ray systems, a holographics capability as well as an experimental neutron radiographic system has been developed, using a multimilligram Californium-252 source.

Neutron radiography has proved an excellent complement to conventional X-ray and gamma radiography for nondestructive testing of ordnance devices. Unlike X-rays and gamma rays, neutrons interact with hydrogen-containing compounds in preference to dense metals. Neutron radiography thus provides images of such materials as explosives, propellants and plastics.

Another important facility in support of product-assurance technology is the Metrology Laboratory, which provides a fully equipped central point for all arsenal calibration tasks.

A unique product assurance program at Picatinny Arsenal is the Nuclear Reliability Program. Coordinated with the Atomic Energy Commission, it involves both laboratory testing and actual firing of the weapons systems, with nuclear portions replaced by substitute test instrumentation.

The over-all purpose of the stockpile reliability program is to assure that design reliability is maintained in storage. Representative samples, selected randomly from existing stockpiles, are tested under simulated and actual conditions.

Results of this testing are assessed and compared with assessments performed at a prior stage of the life cycle of the item. Thus, any deterioration of stockpiles can be detected and reported. Information regarding causes for deterioration of reliability is available to the professional staff engaged in R&D of current munitions.

This type of program requires, for economic reasons, the continuing development of technologies and statistical techniques to sample size and test effort without jeopardizing the reliability conclusion.

Fall-out, by-product or spin-off benefits—all terms used for applications of military technological innovations to civilian requirements—have resulted from numerous Picatinny R&D efforts. While doing research on land mines, for example, two Picatinny engineers of the Technical Support Directorate succeeded in measuring the complex forces exerted by the human foot in walking. This knowledge has potential for numerous applications to civilian needs.

Another example is a Feltman Research Laboratory contribution to technical data on Eastman's polymer adhesive cyanoacrylate. The feedback to Eastman was eventually published in technical journals, with the result that cyanoacrylate now has many more commercial applications where instantaneous bonds are required.

Picatinny scientists working with polymers were the first to report on the potential of DuPont's polyurethane as a highly desirable material for cryogenic applications. The information furnished DuPont in the course of munitions research led to the further application of the product on commercial items requiring sealing and coating at extremely low temperatures.

The Armed Services and commercial and industrial facilities handling explosives and other hazardous materials have benefitted similarly from a Picatinny safety design manual, TM 5-1300, "Structures to Resist the Effect of Accidental Explosives."

The manual is the result of extensive arsenal exploratory programs, in coordination with other governmental agencies and private industry, under the auspices of the Armed Forces Explosive Safety Board, to establish procedures predictably adequate for design of protective structures.

Who would have thought that permissive action links (PAL) designed by Picatinny for Army nuclear weapons would have possible civilian applications? But they do. When adapted to nuclear weapons, these mechanical devices prevent unauthorized use of the weapons. The locks are improvements over commercial items, significant enough for industry to exploit them to improve the security of civilian safes, home locks, safe deposit boxes and the like.

Arsenal scientists have designed a wiring system which has found wide commercial use in aircraft equipment, computers and communications systems. Preassembled strips of contacts are used to permit rapid termination with automatic processes and simple assembly procedures, eliminating up to 50 percent of the soldered connections required by standard methods.

Picatinny propellants R&D led to the successful demonstration of a completely inert-until-activated liquid explosive, linear-shaped charge that could be incorporated into the fuselage of commercial aircraft to provide emergency exits. This work was done for the Federal Aviation Administration to provide a means of rapid evacuation from large passenger aircraft.

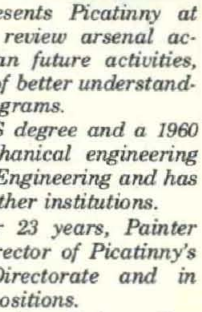
Helicopter flights are safer because of arsenal research that resulted in an ingenious process acting on titanium oxide to improve its durability. This treatment is being used by several large helicopter manufacturers.

Value Engineering at Picatinny accounted for $16,662,700 savings during FY 73 when 93 in-house VE projects were initiated in addition to 13 contractor VE proposals. Savings represent a return of approximately $15 for each VE dollar invested.

We have been paying considerable attention to the needs of the Army of the future, maintaining active liaison and participation with our TRADOC (Training and Doctrine Command) counterparts, the Army Management Systems Analysis Agency, Ballistics Research Laboratories, and other Army Materiel Command major commands and laboratories to evaluate and generate future weapon systems requirements.

The preceding material summarizes many examples of the capabilities available within Picatinny Arsenal. We have noted how these capabilities, in concert with those of other government laboratories and industry, have been applied to research, development and engineering of munitions. We also have noted the many successful munitions and weapons that have resulted from this effort in meeting U.S. Army requirements.

The challenge of wisely allocating and managing decreasing resources to provide this support and achieve this objective will be a persistent problem in the years ahead—a problem that must be faced head on and solved by Picatinny, and all members in the defense community, in order that effective support to national defense will continue.



Picatinny Arsenal Technical Director Harry W. Painter also serves as the commander's principal assistant for research, design, development, production, process and maintenance engineering, quality assurance, and effectiveness of the program.

In addition, he represents Picatinny at top-level conferences to review arsenal accomplishments or to plan future activities, including the promotion of better understanding of assigned R&D programs.

Painter has a 1950 BS degree and a 1960 master's degree in mechanical engineering from Newark College of Engineering and has done graduate work at other institutions.

A federal employe for 23 years, Painter has served as deputy director of Picatinny's Nuclear Engineering Directorate and in other arsenal key R&D positions.

A member of the American Defense Preparedness Association, Scientific Research Society of America, Morris County Engineers Club, and the Advisory Committee Board of Trustees of Newark College of Engineering, he also serves as chairman of the Industrial Technology Advisory Committee for the County College of Morris, NJ.

SPEAKING ON . . .

(Continued from inside front cover)

each of these methods has faced opposition from ecological or environmental groups. There seems to be no doubt that both the production and consumption of energy create an adverse effect on the environment.

So vast are the ramifications of energy that its totality is difficult to comprehend. Moreover, the related R&D is pursued at so many levels, and in so many different types of institutions, that it is not easy to derive a composite picture of *what is being done, what is being neglected,* and *what should be started* now if a possible future disaster is to be averted.

In contrast to a field like defense, no U.S. Government agency has primary responsibility for the civilian energy sector—let alone energy R&D. Very recently (earlier in 1973) Executive Order 11726 created the Energy Policy Office. Under ideal conditions, this office could be established sufficiently within six months to a year to play a significant role in shaping or developing a national energy program. Under the worst conditions, the office could become so entangled in separate emergency facets of the crisis that potential for over-all guidance would be negated.

If we are to have a complex of energy resources that can meet constantly changeable needs and choices, the energy planning for the future must provide a dynamically balanced program that makes optimum use of the various energy resources, that maximizes the potential of this country's diverse R&D apparatus, and that encompasses R&D efforts at different levels of technological advances.

Before such a system can be achieved, it is imperative to recognize the existence of several conditions that, unless corrected or adjusted, would hamper or inhibit a long-term R&D program for civilian energy:

• A dearth of R&D talent exists in many areas. It is futile to urge initiation or intensification of specific R&D if a body of trained scientists and engineers is not available. For years, young research workers have gravitated toward jobs in the more prosperous areas of space, defense, or the life sciences.

Structure and scope must be given to energy R&D—so that young minds will be encouraged to contribute to those fields that desperately need the stimuli of imagination and ideas. Far-sighted planning for the education of sophisticated energy technologists must be instituted.

• Until recently, the glamor of certain disciplines and the relative ease of funding tend to accentuate space- and defense-oriented energy R&D. Although some colleges and technological institutions are engaged in some education and research for energy, the efforts are widely dispersed and diffused.

• Government needs to readjust in those areas where it supports research and to revitalize those agencies involved in energy R&D that have lost ground in the face of modern developments. Such experience and talent could be capitalized upon were they to be given cognizance over new or expanded programs—or were they to be made responsible for major feasibility analyses.

• The U.S. Government needs to sponsor certain kinds of basic research that are difficult to fund privately.

• A major deficiency is the lack of communication and of data interchange between and among energy research groups in different fields. Findings in one area are not necessarily available to another, nor is there productive cross-fertilization among activities.

No single professional society is broadly concerned with energy. No technical journal serves as a clearinghouse for energy information. Communication gaps should be plugged.

However, if all these suggestions were implemented yesterday, we would still be late. We cannot avoid the energy crisis, since it is already upon us, but we can lessen the impact. Wise management and utilization of energy research can result in decided improvement, but ignoring the need for this research can result in catastrophe.

Obviously, this research must be centrally coordinated, departing from the piecemeal and probably duplicative efforts which now exist. Research priorities must be established to solve the long-term problems. To solve the immediate problem, we may face the necessity for establishing consumer priorities.

Nationwide gasoline rationing has already been mentioned, and there is a possibility that electricity could be rationed, with the power disconnecting automatically when a certain number of kilowatts had been consumed each month. You can imagine going into surgery by candlelight because the hospital has used up its quota of electricity, but hospitals would no doubt be high on the priority list.

Solving the energy problem will require a great deal of technological effort. Fortunately, effort is a commodity with no acute shortages in the foreseeable future. Also, the supply of technological know-how can be replenished, which is not the case with fossil fuels.

In the past, virtually all technological efforts have resulted in developments which consumed energy, with no thought given to conserving energy. If all of this effort could be rechanneled or transferred to the task of conserving or locating new sources of energy, there is little doubt that the problems would be speedily solved.

Some technology transfer has already taken place. Automotive engineers rechanneled their knowledge of building higher performance engines into efforts to decrease the pollutants which these engines expelled into the air. Unfortunately, the pollution control devices used even more energy, or gasoline, which did nothing to help the energy situation. Thus it appears that one additional transfer of objective might be desirable in this case.

Technology transfer has received increasing interest in the U.S. Government recently, and several federal agencies now have specific budget items for the transfer and maximum utilization of technology.

The General Accounting Office recommended in a 1972 report:

• A government-wide policy for technology transfer with guidelines issued to federal agencies to implement a formal, active technology transfer process;

• That the Secretary of Defense establish policy and procedures to encourage more extensive application of existing defense technology to civilian problems; and

• The establishment of a technology transfer consulting team as a central focus to assist federal agencies in the matching of technological resources with pressing national needs.

Although technology transfer is not new, the urgency of current requirements calls for much more comprehensive and cohesive action than has been taken in the past. The traditional means of transferring technology—such as the intersectoral movement of people, organizational diversification, conventional library systems, technical journals, and college classrooms—while still important, are no longer wholly adequate.

The Missile Command has been deeply involved in technology transfer since its inception. Some of the technology which evolved from development of the now-obsolete Redstone can be found in virtually every missile

	CLOSE SUPPORT		GENERAL SUPPORT		AIR DEFENSE		MULTIPURPOSE
	DIRECT	INDIRECT	MEDIUM RANGE	LONG RANGE	LOW ALTITUDE	HIGH ALTITUDE	
FIELDED SYSTEMS	M-72 TOW SHILLELAGH 2.75" FFAR M-22		HONEST JOHN SERGEANT	PERSHING	REDEYE HAWK CHAPARRAL	HERCULES HAWK	
DEVELOPMENTAL SYSTEMS	DRAGON A/B TOW		LANCE		STINGER	SAM-D	
FUTURE SYSTEMS	NEW LAW SEAS ACVWS/90 HELLFIRE	HELLFIRE ACVWS/90	DSM AER ARTY CLGP	GSM	LOFAADS MANPADS		ATAADS BEAM

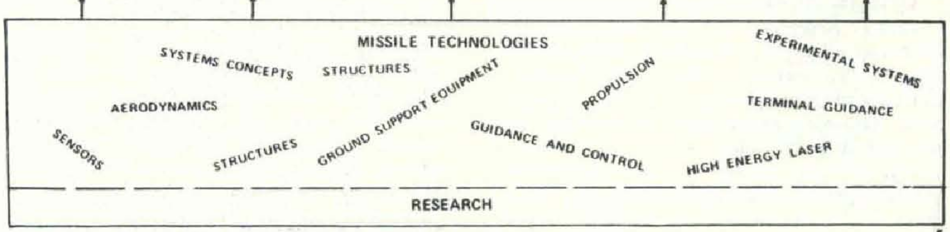


Fig. 5. U.S. Army Missile Command Technology Base

system in existence today.

Our technology, however, is directed toward missile system development, and Figure 5 shows the method by which this is brought about. This chart represents over 30 missile systems and more than 1,300 people in research and development support. This support stays with a missile system throughout its life cycle, and the transfer of technology takes place in all directions.

The knowledge gained in developing older systems, is, of course, utilized in the development of newer systems, but the reverse is also true. Improvements discovered in developing new systems may be incorporated in older systems, such as Pershing or Sergeant, even though they have been in the field for years.

One of our organizations charged specifically with the responsibility of transferring technology is the Redstone Scientific Information Center, which also supports NASA's Marshall Space Flight Center. When difficulties were encountered in the first Skylab launch, I understand NASA scientists were swarming the center, searching for any recorded solution which might be transferred to their current problems.

The Independent Research and Development (IR&D) program is another area in which MICOM has greatly expanded its technology transfer capability. As mentioned previously, we have devised the only automated IR&D technology utilization program within the Department of Defense.

IR&D is a program supported by the U.S. Government and not sponsored by contract or grant, but by a negotiated agreement. The system consists of analyzing and indexing the tasks being performed by approximately 125 companies or profit centers under the government's $600 million annual investment. Bibliographic information on each task is stored in a computer. Each month new entries are selectively disseminated to the functional activities of the laboratory, depending upon technical interest profiles.

In addition to IR&D, our laboratory has on-line access to the Defense Documentation Center and NASA Library of Research and Technology Resumes. As in the case of IR&D, each year before we forward our proposed tasks to higher headquarters for approval, we check our tasks against ongoing DoD and NASA tasks to assure ourselves that we are not duplicating the efforts of others.

The AMC (Army Materiel Command) terminal homing data bank was established at MICOM in January 1971. The over-all purpose of the data bank is to provide an Army-wide target signature measurements data base that will accelerate the development of unique and effective terminal homing weapon systems.

Though we have and use transfer mechanisms to check our in-house tasks against those being performed by Army, Navy, Air Force, NASA, and industry, no convenient mechanism for checking against other departments of the U.S. Government exists. We are working on this problem now.

Another example of effective technology transfer is our development of a laser scalpel for the National Institutes of Health.

Personnel of the National Cancer Institute requested the Army's assistance in conducting experiments to assess the potential of a high-energy laser to destroy cancerous tumors in experimental animals. Although we were pursuing only military missions, the fact that we possessed a capability to deliver large amounts of laser energy made us a unique source for such experimental equipment.

The laser scalpel was built in-house for the cancer research experiments. The beginning of this effort was made possible by the effective transfer of Army laser technology.

MICOM's parent organization, the Army Material Command, has established 14 lead laboratories to cover specific technologies. For example, MICOM has been designated lead laboratory for guidance and control/terminal homing and high-energy laser technology.

Twelve other AMC laboratories have lead responsibility in various technology areas. One of the essential functions of the lead laboratory is to assure technology transfer from bench scientists to developing systems.

Time does not permit a full discourse on the transfer of missile technology, and you may already be wondering what relationship this has to the energy crisis. The point I hope I have made is that we as a nation have the ability, and, yes, we even have the resources, to solve our energy problems on a long-range basis.

However, the available technology must be guided into the most effective channels. The decision we must be prepared to face is: How determined are we to solve these problems? (Italics added.)

To solve the problem on a long-range basis, I recommend that several points be considered, the first being that we, as a nation, redirect our thinking so that conservation of energy is a top-priority item. This involves more than saving a few cents on your utilities bill each month. If each family nationwide can save a few kilowatts each month, the national total can be staggering.

Auto engineers can place a higher priority on efficient gasoline utilization if the public so demands. Until very recently, gasoline consumption was not a major selling point for an automobile, but recent commercials indicate that the auto manufacturers have already gotten the message.

The same holds true in other areas. It is a safe bet that you did not think to check on power consumption the last time you bought a clothes dryer, and you probably would not have been able to, even had you thought about it. Efficient power consumption has not been a major selling point in the past.

My second recommendation is that we determine the trade-offs or expense necessary to achieve the desired results. We must, of course, first determine what the desired results are. Then acceptable trade-offs or expense could especially have a pronounced effect on the short-term energy situation. At current consumption levels, coal is by far our most plentiful fossil fuel.

In addition to increasing expense, however, additional problems have arisen in connection with coal production and the environment. Strip mining increases the availability of coal, but restoring the land to its pre-mined state adds to the expense. And the question also arises as to what is an acceptable approximation of the pre-mined state.

And of course this isn't the end of the environmental problem. Coal-burning power systems are among the biggest contributors to air pollution, and controlling this pollution consumes more energy. *For example, just one air pollution control system employed by Bethlehem Steel takes as much electric power as 1,700 average homes. And this energy is no doubt supplied by a coal-burning electric generating plant.* (Italics added.)

If a method could be found to obtain energy from the pollutants, it would not only break the vicious circle just mentioned; it would help you get better mileage from your automobile.

Another recommendation is that we establish a national clearinghouse or coordinating point for the effective dissemination and transfer of energy technology. This responsibility could be assumed by the recently established Energy Policy Office. This "Energy Center" could prevent the duplication of effort which would be more likely to occur as the nation became more energy-conscious and more work was initiated.

The same methods used at MICOM in the IR&D transfer process would prove highly effective. Such a center could evaluate energy research programs and recommend priorities for those that appeared most promising, using what we at MICOM call the "Systems Approach."

Finally, I urge that we encourage and provide additional funding, if necessary, for the most promising energy research programs. This may be relatively simple if the most promising program happens to be conducted by a federal agency. However, there is little doubt that industry will be conducting individual research programs aimed at conserving energy resources. If one of these appears to have exceptional promise, a government contract could be awarded to conduct this program on an intensified level.

The energy crisis has been caused, in large measure, by ignoring facts which were known, but which were thought to be problems of the future. The future may have been the past summer for some of you, if you traveled in certain sections of Florida or Colorado where the gasoline shortage was especially severe. The future could be this winter, when there may not be enough gas or electricity to keep our homes at a comfortable temperature.

Along with the gloomier signs, there is optimism. We are waking up on the national level to the magnitude of our problem. This seminar today proves this. If such a topic had been suggested 10 years ago, no one would have taken the idea seriously. You have heard deep concern voiced here today, and this concern is even more evident in population centers such as New York City where electric power shortages are relatively common.

I don't wish to paint a bleak picture of lines of stalled cars with empty gasoline tanks against a backdrop of dark buildings with dead electric sockets. We can see now that such a picture is possible, of course.

However, if the full resources of American technology are pitted against the energy crisis, there is no doubt in my mind that technology will win.

Computer-Aided Design Finding Many Applications at ECOM

By V. G. Gelnovatch and R. A. Reitmeyer Jr.

Computer-Aided Design (CAD) is showing its enormous power in solving complex problems in hundreds of design applications in industrial and military laboratories and engineering centers.

In electronics, ballistics, physics, architecture, bridge design, and numerous other major areas, CAD is proving itself as a marvelous means, literally, for "talking" or interacting with the computer–using either a cathode ray tube (CRT) display or just the printed numerical output to assess continually the design as it progresses.

The U.S. Army Electronics Command's R&D Laboratories at Fort Monmouth, NJ, have established several such CAD-dedicated facilities to complement the Burroughs 5500 and the IBM 360 computers generally serving the fiscal and scientific communities.

One of the most challenging technology problems confronting electronic circuit designers relates to the class of electronic devices popularly identified as Integrated Circuits (ICs) which form the building blocks for the next generation of Army equipment.

In fabricating integrated circuits, total electronic functions are designed into a tiny chip of silicon crystal involving hundreds and even thousands of transistors and diodes.

With their interconnections on the chip, ICs resemble a microminiature printed circuit board and frequently involve up to six or even eight layers of processed circuitry, all overlaid in near perfect juxtaposition.

In the solution of this kind of sophisticated topological problem, the CAD becomes an indispensable design tool in any modern microelectronics laboratory.

Another dimension of sophistication in microelectronic design evolved when the IC concept was extended to the microwave region. Result: a still different form of an electronic device called the Microwave Integrated Circuit (MIC) was born.

In MIC technology, by proper layout of conductor lines on a flat dielectric (ceramic) substrate and their interconnection with chip transistors and diodes (and ICs), it is possible to make–in a small flat package–a functional equivalent of the massive "plumbing" typical of waveguide microwave systems.

Two basic steps are involved in effecting a practical IC. First is the electrical solution of the circuit in terms of fundamental component values. Then the equivalent of this circuit must be fabricated in the flat format.

For the purpose of illustration, the CAD art may be divided into two general areas, basically design and fabrication. Design of electronic networks containing many active and passive devices is a complex exercise.

With regard to the design of MICs, the problem gets worse because of the difficulty of handling the hyperbolic functions of a complex variable usually associated with distributed microwave circuit transfer.

Obviously, the design engineer needs help. After an electrical solution or circuit is generated, it must then be fabricated (reduced to practice). In modern IC technology, this means that oversize layouts must be generated and actual size photographic negatives or "masks" fabricated to print the patterns onto the integrated circuit surface.

Computer-Aided Design has had considerable impact on reducing the time and effort required for both initial circuit design, and in achieving the final physical embodiment.

Computer-Aided Circuit Design. The first step of a generic chain in satisfying an Army requirement with respect to an IC is the electrical design of a circuit that meets boundary conditions as defined for the end-item performance. Until CAD was introduced, this was accomplished by essentially trial and error procedure–largely by allowing a computer to perform analysis of suggested circuits considered viable candidates for the desired solution.

This method of solution involves using computer analysis programs and iteratively changing the values of circuit elements until some sort of an optimum is reached.

Many of these programs (ECAP, CORNAP, CIRCUS) are utilized within the U.S. Army Electronics Command (ECOM) for alternate current, direct current, transient and stability analyses. A serious drawback is that none can handle distributed microwave circuits.

Design engineers realized that the previous iterative optimization techniques were crude at best, since the man/machine interface is never very efficient. Generally, it gets worse in direct proportion to the degree of freedom given to the designer.

Realizing this, USAECOM developed DEMON (Diminishing Error Method of Optimization for Networks) in 1969, an "optimal seeking" computer program for the design of distributed microwave circuits.

In 1971, a commercially available general-purpose design program called COD (Constrained Optimal Design) was purchased to cover nonmicrowave IC designs. Both programs are capable of synthesizing the correct design without human intervention.

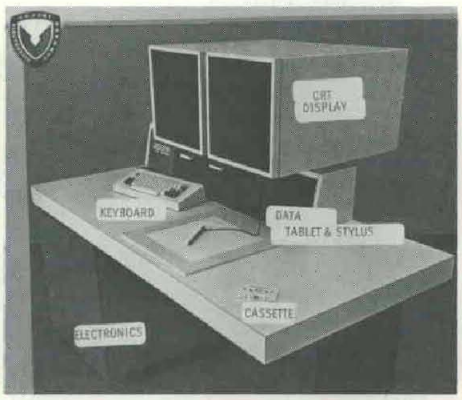
Currently, almost all IC design is accomplished through the use of these optimal seeking computer programs. Typically, these programs can optimize 30 to 100 circuit elements in one to three minutes, a feat which could under the worst case take a designer's "professional lifetime" to optimize manually.

The usual inputs required are very simple: circuit and objective description, constraints, and various machine instructions. The output is the optimized element values and circuit response. Both DEMON and COD deliver a complete optimal electrical solution which then must be interpreted and implemented.

Computer-Aided IC Layout. The layout design and mask-making phases for ICs are both so critical that much of the over-all development cycle has been spent to insure proper and accurate completion.

Traditionally, the layout of ICs has been done at an enlarged scale (200 X, 400 X or even larger). The master artwork is manually created by cutting precision openings into the opaque surface of a plastic film–one master film for each layer in the multilayer circuit, with layers perfectly aligned to match.

Cutting and peeling off the opaque surface to define the pattern is a slow, tedious and very monotonous process, prone to error for even the simplest IC. Since registration of individual masks is critical in IC fabrication, all levels must be cut with exacting precision.



MINICOMPUTER-BASED interactive graphic system, used to display physical representations of transistors and other common microelectronic devices, is termed a breakthrough for IC design.

Once the oversized patterns for each layer are cut, peeled, and found acceptable, a multistep photo reduction process is performed. A huge reduction camera (typically room size) will do the task, but only after it has been precisely set up to reduce the patterns to final size, or 10X, onto photographic glass plates.

This manual method became impractical with the advent of the medium-scale IC (MSI), the large-scale IC (LSI), and a new class of charge-coupled devices (CCD) IC. Some of these have hundreds or even thousands of transistors in a single semiconductor chip, requiring critical dimensional accuracies measured in millionths of an inch.

Availability of a dedicated CAD facility permits USAECOM to support its microelectronics mission with increasingly rapid turnaround time, either for a new design or a variation of an old one.

The laboratory now uses a modern minicomputer-based interactive graphics system for the design layout of printed circuits, ICs (MSI, LSI) microwave ICs, and on up to today's rapidly developing CCDs.

This system features a storage tube display on which the computer draws the required artwork in accordance with the designer's instructions. Thus, the display acts as a "window" onto a computer-based drawing table. Each user has a library of devices available for positioning and moving on the pseudo drawing surface.

With a stylus and magnetic tablet or electronic keyboard, selected circuit elements can be copied, stepped and repeated into arrays, moved, stretched, shrunk, rotated, etc.

Since any element can be multileveled up to 16 distinct levels, all of which track exactly together, there is no worry regarding registration when masks are fabricated and overlaid.

Another positive aspect is that during layout design, the system is digitizing automatically. This means that precise positioning information is readily available and is used to drive automatically a numerically controlled machine to generate the masks.

The Electronics Technology and Devices Laboratory at USAECOM is thus enabled to design and fabricate routinely the ICs for military customers, applying to each problem all the techniques mentioned. Following synthesis of a circuit using DEMON or COD, etc., a typical layout follows an automated pattern. First, active and passive devices are called up from a library of available components, placed on the drawing table (CRT display), and interconnected.

The layout system automatically punches a mylar tape for each mask required during processing. Next, the tapes are read by the numerically controlled photomask generator to produce 1X or 10X, etc., precisely aligned patterns directly onto photographic plates. No intermediate photo reductions are needed.

Work which previously required months is cut to a few days. Mask changes can be effected easily and rapidly since the entire layout drawing, library of devices and system commands are stored on a digital cassette tape. Within minutes necessary changes are made and new mylar tapes punched.

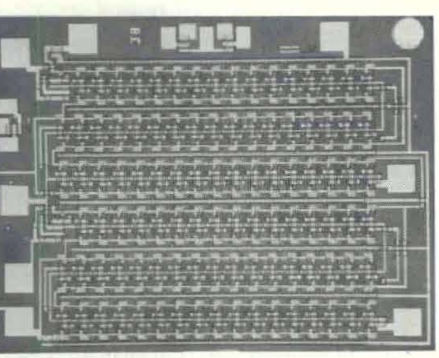
One of the system's attractive features is the low cost of purchase and operation, in that a large computer is not required and no in-house computer experts are needed.

Computer-oriented practices have made over-all operation highly efficient in meeting user requirements. Some of the circuits designed and fabricated so far have been thin-film multiresistor patterns for temperature- and voltage-controlled crystal oscillators, charge-coupled device shift registers, 1-2 GHz and 2-4 GHz thin film transistor amplifiers.

Additionally, the internally developed DEMON program has been furnished to at least 50 industrial and military laboratories and is in general usage throughout the country.

Future plans include the design of a high-speed parameter-measurement system that will feed data directly into design programs such as DEMON or COD. Methods also are being developed to take the optimal solutions generated by DEMON or COD and use them directly to drive the fabrication software.

Advanced technology, represented by CAD, has ushered in a new era in circuit design/fabrication. USAECOM plans to continue to impact on lower circuit cost to Army users by taking advantage of the latest in machine-oriented techniques.



FIFTY-BIT integrated circuit shift register contains 100 transistors in a semiconductor chip that is 0.060 inches × 0.075 inches. This circuit illustrates a high level of miniaturization, but is relatively simple compared to LSI circuits featuring 10,000 transistors in a chip.

V. G. GELNOVATCH received his BS degree in electrical engineering from Monmouth College, West Long Branch, NJ, in 1963 and an MSEE from New York University in 1966. As an employe of the U.S. Army Electronics Command, Fort Monmouth, since 1963 he has engaged in the design and fabrication of microwave integrated circuit (MIC) components, including original research into synthesis of transistor amplifiers to cover octave bands in the L–S and C regions.

Gelnovatch has pioneered the introduction to optimal-seeking, computer-aided design to MICs. He prepared the first of the MIC computer programs (DEMON) for which he received a U.S. Army R&D Achievement Award in 1972. Currently a team leader in the Integrated Electronics Technical Area, he is responsible for the over-all R&D of microwave integrated circuits and devices. He is a senior member of the Institute of Electrical and Electronic Engineers.

R. A. REITMEYER JR. received a BS degree in electrical engineering from Monmouth College, West Long Branch, NJ, in 1965 and an MSEE from New York University in 1968. Since 1965, when he joined the staff of the Electronics Technology and Devices Laboratory, U.S. Army Electronics Command, he has been engaged in the design and application of linear integrated circuits and semiconductor devices to a broad range of Army equipment requirements.

Reitmeyer has served the past three years as project engineer of an Army Materiel Command-sponsored CAD-E project that has resulted in the development of a wide variety of computer-aided techniques for microelectronic circuit and layout designs.

Currently serving in the Semiconductor Devices and Integrated Electronics Technical Area, he has prime responsibility for the design automation of integrated circuits through an interactive graphics layout design and automatic photomask pattern generator system. He is a member of Sigma Phi Sigma and Lambda Sigma Tau.

DoD Reports on FY-73 Military Contract Awards

Five companies accounted for 20.1 percent of $31.627 billion in FY 1973 military prime contracts for research and development services, equipment, supplies and construction. The top 100 out of more than 100,000 contractors and subcontractors shared 68.6 percent of the total awards.

This information is listed in the Department of Defense Comptroller's annual report issued in November. Statistics show that the number of firms each exceeding $1 billion in awards declined from seven in FY 1972 to four in FY 1973—the smallest number to achieve this status since FY 1970. The FY 1973 total of $31.627 billion reflected a $1.735 billion decline from the FY 1972 total.

Companies above the billion mark, listed in numerical order, are Lockheed Aircraft Corp., General Electric Co. (fourth in FY 72), Boeing Co., and the McDonnell Douglas Corp. Companies that dropped out of this select circle in 1973 are General Dynamics, American Telephone and Telegraph, and Grumman Corp.

The top 100 contractors and their subsidiaries or subcontractors are predominately major weapon system and equipment suppliers. Total awards ranged individually from about $36 million to $1.659 billion, with the latter figure enabling Lockheed to maintain its No. 1 rank for the fifth year in a row.

Lockheed's total declined from $1.705 billion in FY 1972. Aircraft contracts assignable to the C-5 Galaxy put Lockheed in the first place in prior years. In FY 1973 the largest contract volume was for the S-3A Viking Anti-submarine Warfare Aircraft. Other major awards to Lockheed were for the C-130 Hercules transport aircraft and major missile work on the Poseidon and Trident nuclear-powered submarines.

Awards received by General Electric amounted to $1.416 billion, a gain of $157 million from FY 1972. Nuclear reactors and turbojet and turbofan aircraft engines were GE's major work. Other activity included R&D for the B-1 bomber and work for the Minuteman missile.

Boeing Co., in fifth place last year, moved up to third. Fiscal 1973 contract volume reached $1.229 billion, up $58 million from last year. Boeing's major defense work continued in missiles and aircraft. Missile programs include the Short-Range Attack Missile (SRAM) and the Minuteman. Aircraft work included spare parts production for the B-52 Stratofortress and work on the B-1 bomber.

McDonnell Douglas Corp. lost $557 million from its FY 72 total awards, declining to $1.143 billion. Its major contracts were for the all-weather F-4 Phantom, the F-15 fighter, the A-4 attack aircraft, and the Dragon missile.

The most significant position change in dollar volume and rank from FY 1972 to FY 1973 was made by Textron Inc., which jumped from 24th position to 7th. FY 1973 major awards were for work on the UH-1 Iroquois and the 214-A helicopter.

The largest dollar volume of awards is concentrated in a few categories of procurement. For example, in 1966, the most recent year for which data are available, a study of Air Force procurement showed four aircraft engine contractors receiving 86 percent of total aircraft contract awards.

ABMDA Developing . . .

Technology for Infrared Signature Measurements

By Boyd C. Wooton Jr.

In its mission of developing advanced ballistic missile defense techniques, the Department of Defense is examining applications of optics technology in discrimination of radar reentry vehicles and countermeasures in a potential threat to national security.

Objects passively radiate energy due to their temperature and this radiation, which has its maximum intensity in the long wavelength infrared (LWIR), can be sensed against the cold background of space by optical sensors.

In 1969 the U.S. Army Advanced Ballistic Missile Defense Agency (ABMDA) initiated, as one of its major research and development efforts, the Fly-Along Infra-Red (FAIR) Program. This is part of its plan to gather a body of data on LWIR target, background, and phenomenology signatures. The objective is to develop and demonstrate the technology necessary to implement optics systems for potential ballistic missile defense applications.

The FAIR Program was planned as a 2-phase investigation: the first, to address the more immediate threats with existing state-of-the-art technology; the second, to operate with more advanced threats, including optical system countermeasures, and improved optical technology for potential application in defensive homing interceptors.

The FAIR system to date has measured and recorded, in discrete optical wavelength regions, the "signature" characteristics of a variety of phenomena and target objects, with the goal of validating a computerized signature prediction code currently under development. Resulting signature calculations are expected to permit rapid identification of future unknown objects in exoatmospheric flight. Infrared measurements also have been made of celestial and earth backgrounds.

The validated signature base will provide the ABMDA system analyst with the tool necessary to complete accurate parameterized tradeoffs for potential ballistic missile defense techniques against a wide variety of scenarios, that is, theoretical threat considerations.

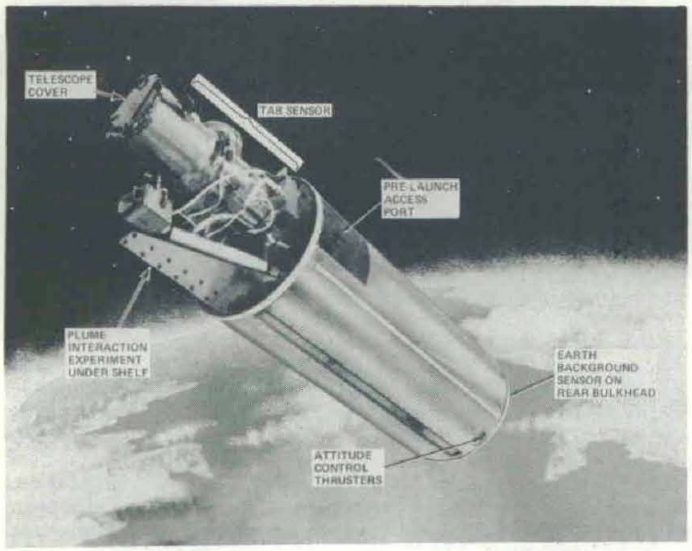


Figure 1. FAIR Vehicle
Target and Background (TAB) Sensor before uncapping

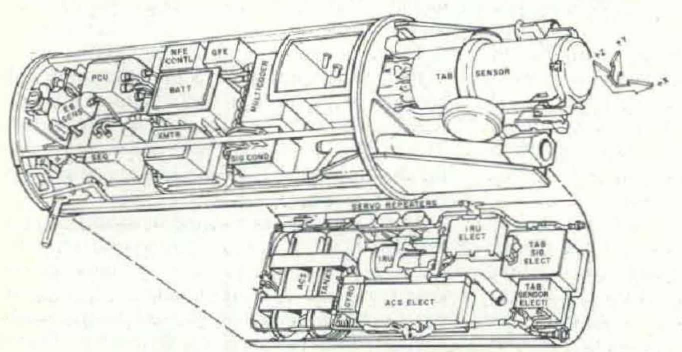


Figure 2. INTERNAL view of FAIR vehicle

The FAIR vehicle (Figs. 1, 2) is generally cylindrical in shape. One end has a platform supporting the principal infrared telescope on one side and a plume interaction experiment on the other. The remainder of the structure contains an earth-viewing sensor, attitude control system, instrumentation, telemetry, and power subsystems. Vehicle components are covered by a shroud to protect sensor optics from contamination during prelaunch, launch, and deployment conditions.

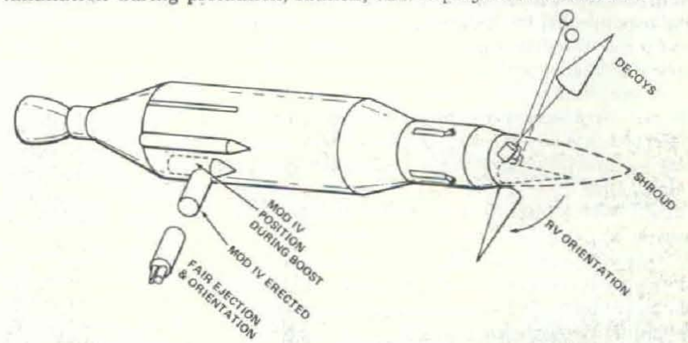


Figure 3. DEPLOYMENT of FAIR and targets

FAIR is carried aloft on the side of an Atlas booster (Fig. 3). At the desired altitude, a Mod IV Payload Ejection Mechanism uses a cold gas ejection system to deploy the FAIR vehicle in a direction away from the booster. After separating from the Atlas, at a predetermined distance, the FAIR uses its own attitude control system to orient the sensor toward targets deployed from the booster.

A cross-sectional view of the target telescope assembly is shown in Fig. 4. The outer housing is 10 inches in diameter and 25 inches long. The f/2.0, folded-Gregorian telescope consists of primary and secondary mirrors and has a one-degree field-of-view.

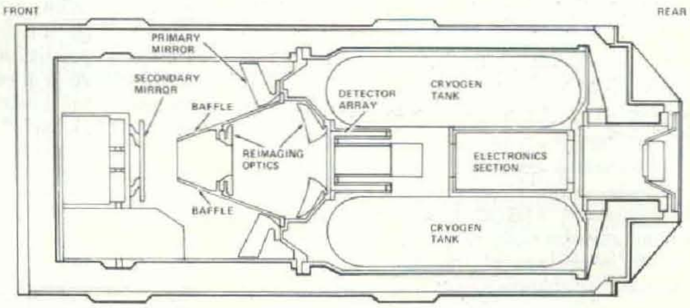


Figure 4. CROSS-SECTION of TAB sensor

The image formed by these first two mirrors is subsequently reimaged by two additional mirrors before reaching the detectors. This design effectively baffles the light-gathering system against stray radiation from out-of-field sources and scattered radiation from the mirror surfaces.

A 32-element array of detectors, covering the total spectral region of interest, is mounted in the focal plane area of the telescope. Operating at very low temperatures, the detectors require extensive cooling subsystems (cryogen tanks) indicated in Fig. 4. Temperature of the optics is controlled by an electronic thermoregulator and a blackbody calibrator for the detectors is located in the telescope optics. The temperature of the calibrator is controlled to ± ½ percent.

The FAIR program represents the first time that such an on-board device has been used to maintain careful radiometric calibration of an infrared sensor. Cooling the optical elements also reduces random emissions of photons which are recorded by the detectors and contribute to system noise.

A servo-controlled gimbal subsystem supports, aligns and points the telescope in both azimuth and elevation. The gimbal assembly also includes the telescope cover mechanism that ensures the vacuum integrity of the sensor. Upon receipt of the appropriate external command, the cover fully retracts and unlocks the gimbal assembly.

Successful operation of the FAIR sensor required the establishment of careful quality control procedures during fabrication, to eliminate possible contaminants in the system, and extensive testing of all components before launch. A class 100 "clean room" with a laminar flow area was used for the final assembly.

Extensive washing of the system with Freon removed virtually all particulates in the optics. Calibration of the sensor was performed at the Advanced Sensor Evaluation and Test (ASET) facility (Fig. 5).

Virtually any operating environment an infrared sensor will encounter can be simulated at this facility. The complete optical and electronic characteristics of the sensor can be determined.

The FAIR vehicle contains a set of plume interaction experiments designed for the important study of infrared radiation contained in the plumes of typical rocket motors. The plume generation equipment (Fig. 6) is located on the target sensor platform on the opposite side from the telescope. Two pulsed, liquid-fuel engines (hydrazine and hydrogen peroxide) are aligned with the longitudinal axis of the vehicle, and a solid-fuel motor acts through the vehicle center of gravity. The approximate thrust level is five pounds.

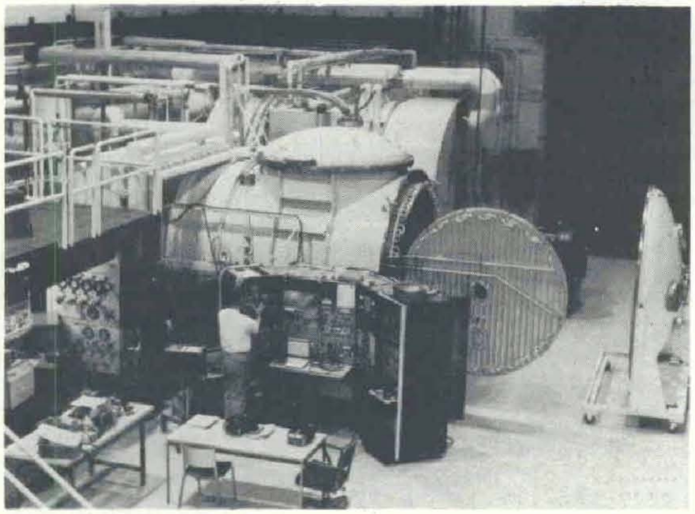


Figure 5. ADVANCED SENSOR Evaluation and TEST (ASET) facility being prepared for reception of FAIR sensor

Interest in the plume interaction experiment stems from the current need for better understanding of the processes that generate infrared radiation from rocket plumes in the thin atmosphere at altitudes of a few hundred kilometers. Two effects have been identified at present.

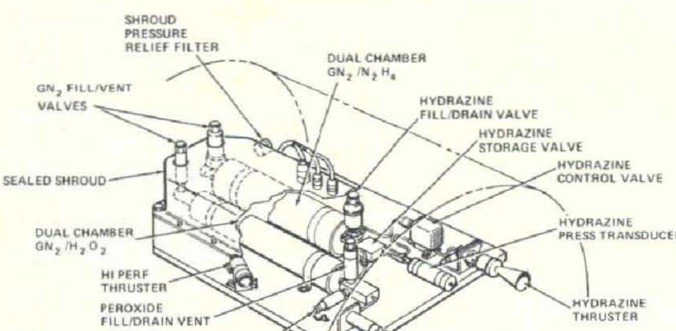


Figure 6. PLUME Interaction Experiment

The radiation derived from hot plume constituents is called "near field" radiation. Reasonable success has been made in predicting this effect with ground testing techniques. In contrast to this, the interactions of plumes with the rarified atmosphere, called "far field" effects, have not been verified to date.

The FAIR Program provides an excellent opportunity to gather pertinent information on both near and far field effects. The exoatmospheric locale of the experiments and the high speed of the vehicle provide the perfect environment to obtain relevant and useful data.

Low pressure and a long-particle mean free path and high kinetic energy are needed to study the far field effects. These conditions cannot be reasonably generated even in specially constructed laboratories. The choice of three separate rocket engines enables the infrared effects of various constituents to be separately analyzed.

In addition, the physical arrangement of the plume interaction experiment and the sensor allows evaluation of any degradation of performance due to interaction with the various propellant flow fields.

A mission profile for a typical FAIR flight is shown in Fig. 7. Following ejection from the Atlas and orientation of the sensor, a scan is begun by the telescope and gimbal assembly. A representative scan might cover a frame of size 20° in elevation and 3° in azimuth.

The first experiment shown in the figure is a scan of a selected portion of the celestial sphere. Since it is known that some stars emit considerable energy in the infrared, and many of these have been cataloged, such a known star is included in the scan frame if possible.

The second experiment is a scan of an array of small tumbling discs and calibration spheres deployed from an experiment module on the booster. Both emissive and reflective types of discs are used. This scan and the star frame measurements are performed while the targets are separating from the FAIR vehicle. The targets at this time are too close to the sensor for measurements, in that irradiance would saturate the sensor.

Following this, the RV, the decoys and the chaff package are scanned in a series of frames. As is indicated in the figure, the FAIR vehicle is placed into a trajectory lower than that of the booster—so that the

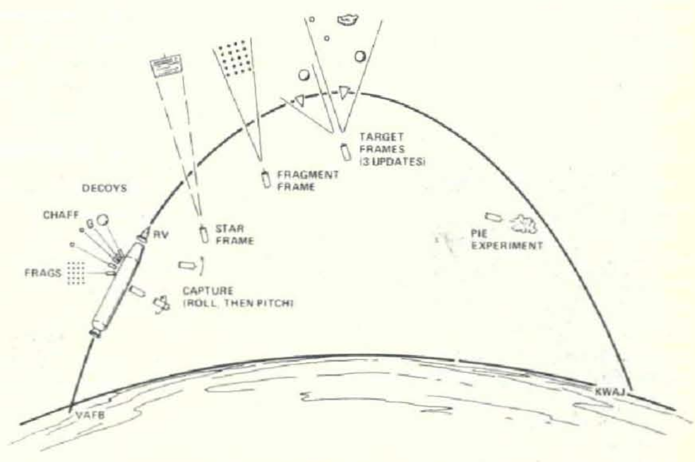


Figure 7. FAIR Mission Profile

targets can be viewed against space and a second radiometer can concurrently detect radiation from the earth. This second infrared detector (earth background, "EB" sensor in Fig. 2) is located at the opposite end of the FAIR vehicle from the target sensor. It has an 80° field-of-view which is entirely on the earth during its operation.

The object of this experiment is to gather data on earthshine in the infrared portion of the spectrum. This data is later used in accounting for the earthshine contribution to the infrared signatures of the targets.

Finally, at the end of the mission, the plume interaction experiment (PIE) is performed. This is done last partly to avoid loss of data on the target signatures if the sensor is degraded by the plumes, and partly to gain data on the far field (atmospheric) plume effects that require interaction with the rarified atmosphere.

Data collected throughout the FAIR flight are telemetered to receiving stations at Vandenberg Air Force Base, Point Pillar, Hawaii, and Kwajalein atoll, and recorded at a rate of 950,000 bits a second.

Somewhat over one billion bits of information are received from the flight. The exact trajectories of the FAIR vehicle and targets are ascertained from radar tracking and from infrared observations made by the AMOS telescopes on Maui, Hawaii.

The FAIR Program is divided into two phases, as previously mentioned. FAIR I (3 flights) has been completed and has met all its objectives. Data collected and interpreted were used in defining specific experiments for the second phase and for ground laboratory programs. Major additions to the earth background and earth limb IR data bases were made during phase one.

(Continued on page 26)

Infrared Signature Measurements

(Continued from page 25)

The first flight of FAIR II was recently completed successfully. Preliminary examination of the plume interaction experiment results shows that the near field data validate the existing laboratory measurements and theoretical calculations. Far field data indicate a need to reexamine the basis for current theories. Target data were obtained on reentry vehicles and penetration aids considered to be of advanced design. FAIR II also provided confirmation of exoatmospheric celestial background data, used also as a system calibration check.

The Aeronautics Division of the Philco-Ford Corp., Newport Beach, CA, is prime contractor for the FAIR Program. The infrared sensors are supplied by the Autonetics Division of Rockwell International, Anaheim, CA, and by the Hughes Aircraft Corp., Culver City, CA. The ASET facility is operated by McDonnell Douglas Astronautics Co., Huntington Beach, CA.

Chris H. Horgan, the ABMDA project engineer for the FAIR Program, succeeded Everett E. Sanmann, who served from May 1969 to June 1973 and is now enrolled in a doctoral program at the University of Oklahoma under government sponsorship.

The FAIR Program was developed by ABMDA under the management of Robert A. Norling and, subsequently, Dr. John J. Jamieson. It is an element of ABMDA's Midcourse Defense Technology Program directed by Vahey S. Kupelian.

BOYD C. WOOTON JR. is a physical scientist in the Optical Group, Area Defense Program Office, U.S. Army Advanced Ballistic Missile Defense Agency (ABMDA) in Arlington, VA. Graduated from Western Kentucky University in 1956 with a BS degree in physics and mathematics, he has done graduate work in nuclear physics, electromagnetic radiation and optics.

While employed for six years by Sperry Rand Corp. in Gainsville, FL, he was responsible for development and production of miniature reflex klystrons and traveling wave tubes. Later he was employed by the U.S. Army at the Nike-X Project Office in Huntsville, AL, with responsibility for light gas gun experiments and various optics programs. In 1968, he established ABMDA's Optics Group in Huntsville and in 1969 joined the Arlington office where his primary responsibility is planning and managing optics programs.

HQ ECOM Relocation Involves 3,500 Employes

U.S. Army Electronics Command major staff and operating elements, involving about 3,500 employes, have started the exodus from 102 World War II temporary buildings—long sadly outmoded for today's requirements—into a new building more spacious than the new headquarters of ECOM's parent Army Materiel Command.

Completion of the relocation is scheduled by the close of FY 1974. Not involved in the changes are the expansive laboratory facilities at HQ ECOM, Fort Monmouth, NJ, and those at White Sands (NM) Missile Range and Fort Belvoir, VA.

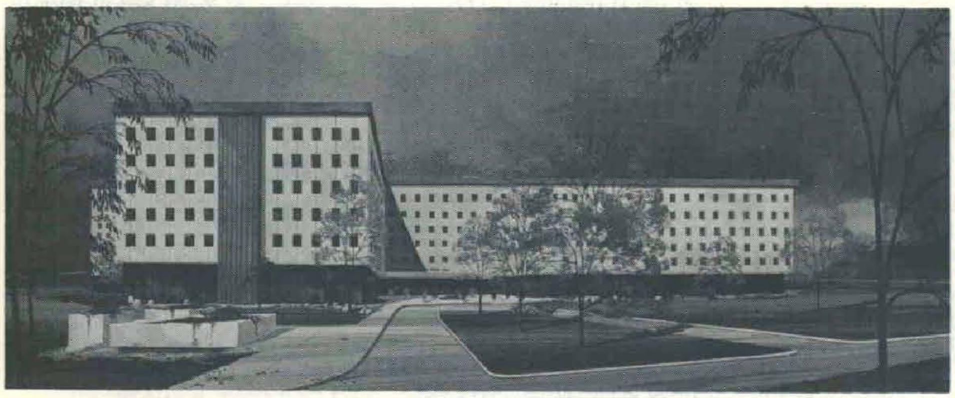
Like the 13-story ultramodern structure occupied by HQ AMC personnel, who also relocated from World War II temporary buildings in Washington, DC, during the first quarter of Calendar Year 1973, the new HQ ECOM is a gleaming, starkly white building. Both buildings are leased and the ECOM edifice offers about 30 percent more usable office space—535,000 as compared to about 400,000 sq. ft. in HQ AMC.

ECOM's new management control center at New Shrewsbury, NJ—within sight of ECOM's huge Hexagon Building nerve center of R&D activities—is a 6-story structure formed in an off-centered, staggered-cross configuration. Facilities it offers will make possible the vacation of a Government Services Administration (GSA) building in Philadelphia, as well as the widely scattered facilities now used at Fort Monmouth. Plans call for razing of the 102 temporary buildings.

Bids were solicited and a contract signed in August 1971 between the GSA and Dworman Building Corp. in New York City for construction of the new building.

Completely air-conditioned, with tinted-glass windows to reduce sun radiation as well as glare, the headquarters is modernly designed for efficiency and flexibility of operations. Features include a 164-seat auditorium that can be separated into two rooms by an electrically controlled movable wall—thus providing 104 theater-type chairs and 60 desk-type seats.

Thirteen conference rooms have audio-visual equipment, a cafeteria is supplemented by food vending machines in six areas, a medical dispensary is convenient for authorized care, computer and reproduction facilities are vastly improved, and there is a variety of retail stores at ground floor level. Ramp entrances are provided for the handicapped, and the main lobby offers an attractive though not ostentatious appearance.



U.S. Army Electronics Command Headquarters

Army Increases Participation in Executive Development

Under sponsorship of the U.S. Civil Service Commission and the Office of Management and Budget, the Department of the Army will be a major participant in pilot programs to increase FY 1974–75 government executive development.

Primary objective of the Executive Development Program is improved over-all management of the executive branch of government by increasing opportunities to prepare for greater responsibilities through classroom training and tailored developmental experiences. Efforts will complement guidelines issued in April 1973 and will be broad-ranging.

Specified developmental programs will be geared toward mid-managers at the GS-13 through GS-15 levels; senior managers at the GS-15 levels; and incumbent executives in grades GS-16 through GS-18.

Twenty-five outstanding GS-15 employes will receive two months initial training during FY 1974 at the Federal Executive Institute, Charlottesville, VA, followed by developmental assignments at federal agencies.

Some incumbent Army executives in grades GS-16 through GS-18 will be selected to attend the Federal Executive Institute Residential Program. An additional five percent will receive a permanent job change or assignment of up to four months duration involving a significant change in duties. Others are scheduled for at least one week of formal management training.

Additionally, 10 percent of Army mid-managers identified as having high potential will receive a mobility assignment. The remainder will receive at least two weeks of classroom instruction.

Primary management for Army participation in this project will be through the existing career program system. Career program managers at installation, command and DA levels will play a major guidance role.

Experts Discuss Radio System

Radio systems operations in forested and/or vegetative areas were examined and discussed by nearly 100 scientists and telecommunications experts at a recent 4-day workshop sponsored by the U.S. Army Communications Command, Fort Huachuca, AZ.

Pnncipals in the meeting included Victor L. Frederick, Office of the Assistant Secretary of the Army (R&D); Dr. A. H. LaGrone, University of Texas; George A. Hagn, Stanford Research Institute, Washington, DC; Robert A. Kulinyi, U.S. Army Electronics Command, Fort Monmouth, NJ; Carl W. Bergman, Defense Communications Agency, Reston, VA; William E. Cory, Southwest Research Institute, San Antonio, TX; and Dr. G. E. H. Ballard of the ACC's Advanced Concepts Office, Fort Huachuca.

Personnel Actions...

MG McEnery Gets Key Defense Nuclear Energy Post

MG John W. McEnery assumed new duties as deputy director for Operations and Administration, Defense Nuclear Agency, following service since July 1972 as assistant commander, 1st Cavalry Division, Fort Hood, TX.

MG John W. McEnery

Following graduation from the U.S. Military Academy in 1945, he was assigned to the Ground General School, Fort Riley, KS, and then attended the Armor Officers Basic Course, Fort Knox, KY. He is also a graduate of the Army Command and General Staff College, Air War College, Spanish Army Staff College, and has an MS degree in international affairs from George Washington University.

MG McEnery commanded the 2d Brigade, 1st Armored Division (now the Air Cavalry Combat Brigade), Fort Hood, TX, during 1971–72. In 1970 he was secretary, General Staff, HQ Continental Army Command, Fort Monroe, VA, after serving during 1968–69 as commander, 3d Squadron, 11th Armored Cavalry, Vietnam.

Other key assignments have included: chief, Materiel and Program Branch, Military Assistance Advisory Group (MAAG), Madrid, Spain; Combat Developments Directorate, Office, Deputy Chief of Staff for Operations, HQ DA; and tank company commander, 2d Battalion, 40th Armor and S-3, 2d Reconnaissance Squadron, 10th Cavalry, 7th Infantry Division, Korea.

Among his military awards and decorations are the Distinguished Service Cross, Silver Star with Oak Leaf Cluster (OLC), Legion of Merit with OLC, Bronze Star Medal, Air Medal (26 awards), Joint Service Commendation Medal, Army Commendation Medal and the Purple Heart.

Egbert Directs Site Defense Project Office

BG John S. Egbert

BG John S. Egbert, former deputy director, Planning and Program Analysis Directorate, Office of the Assistant Vice Chief of Staff, HQ DA, is now director, Site Defense Project Office, U.S. Army Safeguard Systems Command, Huntsville, AL.

A 1948 graduate of the U.S. Military Academy, BG Egbert has an MS degree in civil engineering from the Massachusetts Institute of Technology. His military schooling includes the Army Command and General Staff College, Naval War College and the Industrial College of the Armed Forces.

During 1971–72 he was chief, Plans and Operations Division, Directorate of Military Engineering, U.S. Army Corps of Engineers (CE). He commanded the 35th Engineer Group in Vietnam in 1970–71 following a 3-year tour as district engineer, CE, Savannah, GA.

Other key assignments have included action officer, Office, Assistant Secretary of Defense (Installations and Logistics); chief, Base Development Branch, Construction Directorate, Military Assistance Command, Vietnam; and commander, 24th Engineer Battalion, 4th Armored Division.

BG Egbert is a recipient of the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, Meritorious Service Medal, Air Medal, Joint Service Commendation Medal and the Army Commendation Medal with OLC.

Turner Takes Over as ABMDA Commander

COL James M. Turner Jr. is the new commander of the U.S. Army Advanced Ballistic Missile Defense Agency, Washington, DC, following assignments in 1972–73 as staff officer and later acting chief, Missiles and Special Weapons Division, Office, Chief of R&D, DA.

Other key assignments have included chief, Special Operations Branch, Surface Operations Division, Military Assistance Command, Vietnam (MACV); chief, Nuclear-Biological-Chemical and Reports Division, HQ North American Air Defense Command; and HQ U.S. Army Combat Developments Command.

COL James M. Turner Jr.

COL Turner has a BS degree in chemistry from Louisiana State University, a master's degree in physics from the U.S. Naval Postgraduate School, and is a graduate of the Army Command and General Staff College.

Among his military awards and decorations are the Legion of Merit with Oak Leaf Cluster (OLC), Joint Service Commendation Medal and the Army Commendation Medal with two OLC.

TECOM Names Gaffke ADMTD Director

COL Frank M. Gaffke

COL Frank M. Gaffke, former director, Operations and Training, U.S. Army Air Defense Command, Ent Air Force Base, CO, is the new director of the Air Defense Materiel Testing Directorate, HQ U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, MD.

A graduate of Quartermaster Officer's Candidate School, COL Gaffke earned his commission in 1942. He has attended the Army Command and General Staff College, Army Ordnance School, Army Artillery School and the Artillery and Guided Missile School.

During 1969–71 he served as executive officer, assistant chief of staff G-3, and later as chief, Artillery Branch, Plans Division, HQ Eighth U.S. Army, Korea. He was assigned (1967–69) to the Missile Division, Materiel Directorate, U.S. Army Combat Developments Command, Fort Belvoir, VA.

COL Gaffke served in the Office of the Inspector General from 1959–62 following a tour during 1958 as chief, Personnel Management Branch, J-1 Division, U.S. Army Element, HQ United Nations Command, Korea.

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

Eineigl Becomes Seattle District Engineer

COL Raymond J. Eineigl, until recently assistant director of Civil Works, Staffing and Management, Office of the Chief of Engineers, is now Seattle District engineer, U.S. Army Corps of Engineers.

COL Raymond J. Eineigl

A 1953 graduate of the U.S. Military Academy, COL Eineigl has MS degrees in civil engineering from Northwestern University and in administration from George Washington University. His military schooling includes the Army Command and General Staff College and the Industrial College of the Armed Forces.

Among his previous assignments are aide-de-camp to the commander, 25th Infantry Division, to the commander, U.S. Army Pacific, Hawaii, and to the commander, Fort Benning, GA; commander, Engineer Construction Unit, 577th Engineer Battalion, Fort Benning, GA; and assistant professor, U.S. Military Academy.

A registered professional engineer in Pennsylvania, COL Eineigl is a recipient of the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal, Air Medal, and Commendation Medal with OLC.

Conferences & Symposia . . .

Top Defense R&D Leaders Attend AMC Lab Chiefs Parley

Director of Defense Research and Engineering Dr. Malcolm R. Currie and Assistant Secretary of the Army (R&D) Norman R. Augustine, joined by other high-level defense leaders, made their first appearance since appointment before Army R&D leaders as a group at the Materiel Command conference of laboratory commanders and directors.

Materiel Command Commander GEN Henry A. Miley Jr. and AMC Deputy for Laboratories Dr. Robert B. Dillaway had key roles in discussion of problem areas and progress reports related to the "Big Five" materiel objectives and other priority R&D program efforts.

Participating dignitaries included Assistant Secretary of Defense for Installations and Logistics Arthur I. Mendolia, Dr. Hans Mark, director of the NASA-Ames Research Center at Moffett Field, CA, where the conference was held, and Director of Army Research MG Charles D. Daniel Jr., representing Chief of R&D LTG John R. Deane Jr.

GEN Miley and Dr. Dillaway set the tempo of the conference by calling for a candid review and discussion of problem areas, along with a continuing closely coordinated effort at all levels to come up with solutions through cooperative integrated effort—including direct resort to him and members of his command group as necessary. Dr. Dillaway also reviewed a new concept for "Job Analysis, Performance and Placement (JAPER)."

Host to the meeting was the Army Air Mobility R&D Laboratory and its director, Paul F. Yaggy. Program arrangements were made by AMC Assistant Deputy for Laboratories Norman L. Klein. Yaggy discussed developmental advances of U.S. Army aviation since 1945.

Dr. Mark joined with Yaggy in explaining that the arrangement whereby the Army aviation R&D program is advanced by sharing facilities of the NASA-Ames Research Center is unique—a pioneering effort benefitting the Department of Defense and U.S. taxpayers.

The arrangement, effected by a NASA-Army agreement in 1969, makes available to the Army facilities that would otherwise cost many millions of dollars for the Army to construct and operate. When the agreement was signed, it was estimated that the cost to the Army of constructing comparably satisfactory facilities for aviation R&D would be in excess of $100 million.

Equally important is that the agreement permits NASA and the Army to pursue research of mutual interest—such as aircraft aerodynamics, componentry, composite materials and design—thereby minimizing duplication of effort.

Yaggy commented at the recent laboratory chiefs conference: "This not only conserves the resources of both agencies in the performance of research of common interest; it also provides the Army with direct access to the professional expertise of NASA for applications to specific Army aviation requirements."

Involved in the arrangement, in a way similarly beneficial to both NASA and the Army, are the other directorates of the U.S. Army Air Mobility Laboratory. They are: Langley Directorate at the NASA-Langley Research Center, Hampton, VA, the NASA-Lewis Research Center, Cleveland, OH, and the Eustis Directorate, a redesignation of the former U.S. Army Aviation Materiel Laboratories, Fort Eustis, VA.

Dr. Mark called the NASA-Ames RC's new ILLIAC IV "the world's biggest and fastest computer that can trace the complex airflow patterns for research on STOL (Short Takeoff and Landing) and VTOL (Vertical Takeoff and Landing) aircraft. This computer can predict shock-wave location parametrically—something that the wind tunnels cannot do."

ARMY & NASA LEADERS examine a model of the tilt-rotor research aircraft during AMC Laboratory Commanders' Conference. From left are MG Frank A. Hinrichs, AVSCOM commander; Dr. Hans Mark, NASA-Ames Research Center director; GEN Henry A. Miley Jr., AMC commander; and Paul F. Yaggy, director, Army Air Mobility R&D Laboratory, Moffett Field.

R&D LEADERS confer during AMC Laboratory Commanders' Conference. Seated (l. to r.) are Director of Defense Research and Engineering Dr. Malcolm R. Currie, AMC Commander GEN Henry A. Miley Jr., and Assistant Secretary of the Army for R&D Norman R. Augustine. Standing (l. to r.) are AMC Deputy for Laboratories Dr. Robert B. Dillaway and Assistant Secretary of Defense for Installation and Logistics Arthur I. Mendolia.

Dr. Ronald P. Uhlig, chief of the Army Materiel Command Scientific and Management Information Division, reported on the scientific and engineering computer support activities, including efforts to establish an effective network interfacing all AMC computer capabilities.

Dr. John L. McDaniel, director, Research, Development and Engineering Laboratory, U.S. Army Missile Command, Redstone (AL) Arsenal, outlined the Army development of the laser-guided "smart bomb," used effectively by the U.S. Air Force in Vietnam. He also discussed the TOW missile system.

Dr. Joseph Sperrazza, director, U.S. Army Materiel Systems Analysis Agency, Aberdeen (MD) Proving Ground, discussed wound ballistics. Victor Lindner, Picatinny Arsenal, Dover, NJ, discussed the beehive ammunition, scatterable mines and precision-shaped munitions charges. Technical Director Billy M. Horton of the Harry Diamond Laboratories (HDL), reported on major ongoing efforts and advances of proximity fuzes and important new applications of fluidics technology.

Donald J. Looft, director of the Night Vision Laboratory, Fort Belvoir, VA, described the development of the Night Vision Goggles (AN/PVS-5) and the hand-held laser rangefinder.

Acting Technical Director Terence G. Kirkland, U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA, described advances in the state-of-the-art of camouflage for tanks, helicopters and other Army equipment. John Orth, chief, Electrotechnology Dept., MERDC, discussed Laboratory Project Manager Interface Program.

Dr. Alvin E. Gorum, director of the Army Materials and Mechanics Research Center (AMMRC), Watertown, MA, reported on the research on reinforced graphite and reinforced aluminum and 3-dimensional structures that can be applied to missiles and aircraft armament.

MG John C. Raaen, commander of the Armament Command, and BG John E. Sterling, deputy commander of the Army Troop Support Command, reported on reorganization of these new major commands.

Other military R&D leaders who participated in the meeting included MG George Sammet Jr., AMC deputy commander for Materiel Acquisition; MG Frank A. Hinrichs, commander, U.S. Army Aviation Systems Command (AVSCOM), St. Louis, MO; COL T. R. Hukkala, MERDC commander; COL Richard L. Clarkson, commander, U.S. Army Land Warfare Laboratory (LWL), Aberdeen Proving Ground;

COL Harry L. Corkill Jr., commander, U.S. Army Natick Laboratories (NLABS), MA; COL David W. Einsel, HDL commander, COL Thomas R. Ostrom, deputy director, U.S. Army Ballistic Research Laboratories (BRL), APG; and

COL Elmo L. Bowman, RDE deputy director, U.S. Army Electronics Command (ECOM), Fort Monmouth, NJ; Dr. Frederick W. Schmiedeshoff, research director, Watervliet Arsenal, NY; Dr. Henry R. Velkoff, AMRDL staff scientist; COL J. C. Geary, RDE director, AVSCOM; COL Norman L. Robinson, AMRDL deputy director.

AGU Discusses High-Altitude Research

Results of cooperative high-altitude studies were presented by five research agencies during a Dec. 10–14 meeting of the American Geophysical Union in San Francisco, CA, at a session titled "Aeronomy of the Middle Atmosphere."

The research was conducted at White Sands Missile Range (WSMR), NM, by scientists from the Atmospheric Sciences Laboratory (ASL), the Sandia (Albuquerque) Laboratories, the University of Texas, Penn State University's Ionospheric Laboratory; and the Air Force Cambridge Research Laboratory.

Acquisition of data began in September 1972 when a 38-million-cubic-foot balloon was launched from WSMR with one of the most comprehensive instrumentation payloads ever used within the 40 to 50 kilometer altitude region.

The experiment was designed to measure detailed time and space variations in atmospheric composition and related variations in meteorological parameters of temperature, pressure and density at times of darkness, sunrise and daylight. The sunrise and daylight variations are related to measured ultraviolet solar radiation intensity.

The primary payload for this experiment included an ultraviolet photometer, a cryogenically pumped quadrapole mass spectrometer, a positive-ion sensor, a Lyman alpha lamp for production of nitric-oxide ions, a dual-chamber atmospheric sampler, chemiluminescent ozone sensors, bead-thermistor temperature sensors, thermal-conductivity pressure gauges, a Geiger-tube cosmic-ray detector and aluminum-oxide water-vapor sensors.

A secondary payload consisting of an additional aluminum-oxide water-vapor sensor and a balloon-skin temperature sensor was mounted on the valving plate at the top of the vehicle.

Scientists said all sensing instruments functioned properly to accomplish experimental objectives. Interrelations among the measured solar ultraviolet intensities, atmospheric thermal structure and composition have been studied.

Eight papers presented at the Aeronomy of the Middle Atmosphere session detailing results of the experiment include:

Atmospheric Temperatures Measured Near 48 Kilometers by Balloon-borne Thermistors; Stratospheric Balloon Pressure Measurements and Derived Densities in the 40–48 Kilometer Interval; and

Determination of Neutral Constituent Concentrations in the 45–60 Kilometer Interval With Rocket and Balloon-borne Samplers; Ozone Particle Densities Measured by Chemiluminescent Sensors on a Balloon at 48 Kilometers; Solar Irradience and Ozone Particle Density Observations at 48 Kilometer Balloon Float-Altitude; and

A comparison of Measured and Calculated Ozone Particle Densities During Sunrise at 40–50 Kilometers; Electrical Conductivity Measurements in the Upper Stratosphere; and the Computational Studies of Particle Densities and Rates of Chemical Reactions in the Upper Stratosphere.

This high-altitude experiment, one of three in which ASL has participated, was one of a series of research probes that have been conducted—mainly at WSMR—with either balloon-borne or rocket-borne payloads to study the upper atmosphere in detail.

The latest cooperative balloon experiment in which ASL has participated was the Oct. 20 launch of a 7.7-million-cubic-foot polyethelene balloon from the National Center for Atmospheric Research (NCAR) facility at Palestine, TX.

The objective was to acquire atmospheric data in the 28 kilometer (93.1 thousand feet) region. Reportedly, all instruments functioned properly and telemetered data were received from the time of launch until more than 14 hours later when the balloon and payload passed beyond telemetry range. Results are being evaluated.

Other participants in this project include the Sandia Laboratories, Bell Telephone Laboratories and the Air Force Cambridge Research Laboratories, with contract support from the University of Texas at El Paso, Penn State University, NCAR, and Panametrics, Inc.

Military Theme Review Reports Progress

Information Sciences reports of progress by 17 university researchers and two presentations by Army investigators featured a Dec. 4–6 Military Theme Review at HQ U.S. Army Communications Command (ACC), Fort Huachuca, AZ.

Sponsored by the U.S. Army Research Office (ARO), Durham, NC, on behalf of the Army Chief of Research and Development, the Military Theme Reviews serve to identify research or exploratory development that could contribute to solution of critical Army problems.

ACC Deputy Commander MG John E. Hoover opened the meeting at which Army scientists and chief investigators supported through ARO research grants and contracts reviewed communications theory, computer science and subjects related to the Information Sciences theme.

The two Army technical presentations were titled "ECOM Activities in Information Sciences," coauthored by Drs. Ed Lieblein and Dave Dence, U.S. Army Electronics Command (ECOM), Fort Monmouth, NJ, and "Challenges in Information Sciences at White Sands Missile Range," by Dr. Alton Gilbert.

Research progress reports included five from the University of California at Berkeley, four from the University of Southern California, two from the Georgia Institute of Technology, and one each from the University of California at Los Angeles, Massachusetts Institute of Technology, University of Colorado, North Carolina State, University of Hawaii, and the University of California at Santa Cruz.

Presentations dealt with theories applicable to spread-spectrum satellite communications problems, channel-coding and codewords, signal processing methods, and sequential machines—some of the Information Sciences areas requiring basic research efforts termed of critical importance to military operations.

AMSC Schedules Mathematics Meetings

The U.S. Army Mathematics Steering Committee (AMSC) has scheduled the 1974 Army Numerical Analysis Conference, Feb. 13–14, and the 20th Conference of Army Mathematicians, May 14–16.

Sponsored by the AMSC, the Numerical Analysis Conference will be held at the Frankford Arsenal Laboratories in Philadelphia, PA, to exchange information and discuss mathematical aspects of Army applications of computers.

Three invited speakers will lecture on topics related to the theme: "Are We Making Optimal Use of Computers in Army Research and Development?" Several contributed papers on applications of computers with some mathematical content will be presented.

The 20th Conference of Army Mathematicians at the U.S. Army Natick (MA) Laboratories (NLABS) will feature three guest lecturers, including Prof. Joseph P. LaSalle of Brown University and Prof. Fritz John of the Courant Institute of Mathematical Sciences, New York University, and technical papers presented by Army mathematicians.

Further information on these conferences can be obtained by contacting Dr. Jagdish Chandra, associate director, Mathematics Division, Army Research Office, Box CM, Duke Station, Durham, NC, 27706.

Reader's Guide . . .

Report Stresses Human Factors in Organizations

Components of Organizational Competence: Test of a Conceptual Framework is a new report by the Human Resources Research Organization (HumRRO) describing the exploration of those human factors that impede or enhance military command-and-control activities. The report has been published as TR 73-19.

Because little systematic knowledge has been available about these complex human factors in a military environment, where rapid problem-solving response to unpredictable situations is critical to successful operations, the U.S. Army has supported a research effort by HumRRO titled "Factors in Organizational Effectiveness: (FORGE).

Authors Joseph A. Olmstead, Harold E. Christensen and L. L. Lackey describe the FORGE conceptualization in detail and present results of the study based on organizational relationships.

Ten 12-man groups of Vietnam-experienced infantry officers participated in an 8-hour role simulation of a light infantry battalion engaged in combat operations in Vietnam.

Copies of the report are available from the Human Resources Research Organization, 300 N. Washington St., Alexandria, VA 22314.

EPA Distributes R&D Research Bibliography

A cumulative list of about 400 research reports issued by the Office of Research and Development, U.S. Environmental Protection Agency, from April 1972–June 1973 is now available for public distribution.

The second edition of *Bibliography of R&D Research Reports* is part of a continuing effort to shorten the informational lag in environmental research and to speed application of new technology.

These reports are classified into five major categories consisting of environmental health effects research, environmental protection technology, ecological research, environmental monitoring, and socio-economic environmental studies.

Copies of the bibliography are available from the Publications Staff, Office of Program Management, Office of Research and Development, U.S. Environmental Protection Agency, Washington, DC 20460.

Women in Army Science . . .

ASTM Award for Metals Research

Presentation of the Lundell-Bright Memorial Award for 1973 to Edna F. Jacobson was announced recently by the American Society for Testing and Materials (ASTM) Committee E-3 on Chemical Analysis of Metals.

Miss Edna F. Jacobson

The award honored her for outstanding work in advancement of the chemical analysis of metals as a member of Committee E-3. She works in the Chemical Analysis Branch, Polymers and Chemistry Division, Organic, Materials Laboratory, U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA.

Miss Jacobson was cited for developing methods of analyzing complex materials such as refractory metals, uranium alloys and ceramics; also, for participating in analysis of complex steels, cobalt-base alloys and titanium-base alloys for the National Bureau of Standards.

The award also honors her for developing atomic absorption methods for determining iron in columbium, tantalum, molybdenum and tungsten and a method for measuring copper in iron and steel.

Miss Jacobson attended Boston University and Boston College. She started working for Watertown Arsenal Laboratories (now AMMRC) in 1942 as a technician analyzing steels and nonferrous alloys.

Miss Jacobson has served the ASTM as chairman of the editorial subcommittee of Committee E-3, as a member of its executive committee, and as secretary of E-3. She has been a member of task groups participating in numerous development, testing and standardization programs. Seven methods for testing she has developed appear in the *Annual Book of ASTM Standards.*

Among the honors she has received is the Sustained Superior Performance Award in 1956, the Special Act or Service Award in 1966 and an Outstanding Performance Rating in 1972. She is listed in *Who's Who of American Women, Who's Who in the East,* and *Two Thousand Women of Achievement.*

Miss Jacobson is a member of the American Chemical Society (ACS) and has been active in local affairs of the Analytical Group of the Northeastern Section of ACS. She has also been active as an associate member of the Society for Applied Spectroscopy.

Chemist Analyzes Military Pollutants

Chemical analysis of the types and quantities of pollutants discharged by military installations is a relatively new experience for Gaydie Connolly at the Laboratory Services Directorate, U.S. Army Environmental Hygiene Agency.

Mrs. Gaydie Connolly

Since joining the USAEHA staff at Aberdeen (MD) Proving Ground last year, Mrs. Connolly has been working primarily with water samples brought back by AEHA field engineers investigating military pollution problems in the U.S.

With other members of the laboratory staff, she tests the samples for heavy metals and other forms of industrial pollution. Analysis results are sent to the engineer working on the project for corrective action if pollution standards are exceeded.

Mrs. Connolly had planned to go into nursing when she started college but switched to a career in chemistry. Before coming to work for the Army she was a chemist for commercial companies.

She enjoys working in an Army chemistry laboratory because it is a constant learning experience. Currently stimulating to her is the prospect of working with a mass spectrometer awaiting installation.

The spectrometer will greatly simplify the identification of the composition of substances taken from streams, the surrounding atmosphere or other sources, thus helping determine whether pollution is actually taking place.

Enthusiasm Unlimited . . .

MICOM Metallurgist Terms Job 'Most Interesting'

Enthusiasm for a job after seven years is usually tempered a bit, but the only female metallurgist in the U.S. Army Missile Command still contends, without reservations, that she has the most interesting work among Redstone Arsenal employes.

Rebecca Stokes

Rebecca Stokes reported recently on some of her research when she presented a technical paper, "Mechanical Properties of RMI 38-6-44 Beta Titanium Alloy," at the American Society for Materials Engineering Congress and Metals Show in Chicago. As one of the nation's few women metallurgists, she has presented papers at a number of conferences and symposiums.

"Being a woman in what is normally considered a man's profession has created some interesting experiences," she commented. "I entered a technical paper for presentation at an engineering convention. When I received an acknowledgement, it was sent to Mr. Stokes."

About her assignment in the Ground Equipment and Materials Directorate, she states: "There are so many interesting phases of my work that I never have a chance to become bored."

Some of the fruits of her research in titanium alloys, which began while she was working toward a master's degree at the University of Kentucky, have found applications in the development of the U.S. Army's Armed Reconnaissance Scout Vehicle, she believes. Her bachelor's degree in metallurgy was obtained from the University of Alabama.

Rebecca is the president of the North Alabama Chapter of the American Society for Metals; charter president of the North Alabama Chapter, Federally Employed Women; and a member of the Huntsville Chapter, Society for the Advancement of Material and Processing Engineering.

Feasibility Studies . . .

Physical Scientist Reviews Countermine Concepts

Studying the feasibility of countermine systems concepts is Mrs. Beverly D. Briggs' responsibility as a physical scientist in the Countermine/Counter Intrusion Department, U.S. Army Mobility Equipment Research and Development Center (MERDC), Fort Belvoir, VA.

Mrs. Beverly Briggs

The first woman employed by the MERDC in this research area, she serves as a technical specialist and authority on mathematical modeling and simulation, and as a technical source of information in chemistry and physics applied to CMCI components and systems development.

Mrs. Briggs received a BA degree in chemistry, with a minor in mathematics, from Texas Christian University in 1960. After graduate work at the University of Utah, she entered U.S. Civil Service in 1961 with the Bureau of Mines, working in Helium Operations, in Amarillo, TX, and remained there until she transferred to the MERDC in 1971.

The Countermine/Counter Intrusion Department selected her last spring as its nominee for the Commanding Officer's Technology Award. She was recognized for her achievement in developing several complex computer programs that advanced the state-of-the-art in analytical solutions. She received the Special Act or Service Award in 1973 and was nominated for the AMC System's Analysis Award, and the Federal Women's Award.

Mrs. Briggs keeps up with the latest in her field by attending symposiums and conferences. At the 12th Army Operations Research Symposium at Durham, NC, last October she presented a paper titled "A General Computer Program for Use in Determining Track Width Plow Minefield Effectiveness Criteria."

During the 19th Army Mathematician's Conference in June 1973 she presented "Linear and Nonlinear Least Square Regression Analyses."

Awards . . .

Deputy ASA (R&D) Charles L. Poor honors Dr. McFann.

DISTINGUISHED CIVILIAN SERVICE. *Dr. Howard H. McFann,* director of the Western Division, Human Resources Research Organization (HumRRO), recently received the Decoration for Distinguished Civilian Service. This is the highest public service award presented by the U.S. Army to private citizens who serve the military in an advisory capacity.

Dr. McFann was cited for distinguished service to the Army in the field of training research, particularly for his role in the development of a new basic training program.

EXCEPTIONAL CIVILIAN SERVICE. *Victor Lindner, Allan Nunes-Vais, Albert Roseff* and *Daniel Katz,* all employes of the Ammunition Development and Engineering Directorate, Picatinny Arsenal, Dover, NJ, were recently presented the Decoration for Exceptional Civilian Service.

As recipients of the Army's highest award for civilian employes, Lindner, Nunes-Vais and Roseff were cited for team efforts in directing a large-scale project for the design, development and production of a new family of military antiintrusion devices. Katz was recognized for his leadership in conceiving, designing and developing the XM 205 nonmetallic cartridge case.

MERITORIOUS CIVILIAN SERVICE. *Arnold Novack,* Ammunition Development and Engineering Directorate, Picatinny Arsenal, was a recent recipient of the Meritorious Civilian Service Award (MCSA), the Army's second highest award for civilian employes.

Novack was cited for his outstanding engineering and personal application in an advanced research program for the development of XM727 81mm HEAT/antipersonnel ammunition.

Jerome M. Frankle and *Alexander S. Elder,* U.S. Army Ballistic Research Laboratories, received the MCSA for contributions to the science of interior ballistics of large-caliber and shoulder-fired weapons.

Dr. Rauno A. Lampi and *Frank J. Rubinate,* assigned to the Packaging Division, U.S. Army Natick (MA) Laboratories, were presented the MCSA for their contributions to the development of flexible packaging for thermo-processed foods.

LEGION OF MERIT. *COL Elbert S. Throckmorton,* chief, SAM-D Vulnerability Studies Office, Aberdeen Proving Ground, MD, was awarded the LOM for 1970–73 achievements as director, North American Air Defense Command.

COL Gilbert E. Lilly, U.S. Army Health Services Command, received the LOM for previous service as chief, Maxillofacial Sciences Division and deputy commander, Letterman Army Institute of Research, San Francisco.

Prof. Hartley Receives Wilks Award

Internationally renowned statistician H. O. Hartley, whose rise to fame extended over a 17-year period in England, and since 1953 has continued in the United States as a university professor and consultant, is the 1973 Samuel S. Wilks Memorial Medal Award Recipient.

The award is the highest presented annually by the American Statistical Association and was initiated jointly with the U.S. Army in 1964 to honor statisticians whose contributions to science have coincidentally benefitted the Army, the Department of Defense, and the U.S. Government.

Presentation of the award to H. O. Hartley was a highlight of the recent 19th Conference on the Design of Experiments in Army Research, Development and Testing at HQ U.S. Army Armament Command, Rock Island, IL.

Sponsored by the Army Mathematics Steering Committee on behalf of the Army Chief of Research and Development, the meeting was hosted jointly by HQ ARMCOM and the U.S. Army Management Engineering Training Agency.

Presiding as master of ceremonies, Dr. Frank Grubbs of the Army Ballistic Research Laboratories, Aberdeen (MD) Proving Ground, extolled Prof. Hartley as an educator whose influence has impacted profoundly upon more than 20 of the world's current recognized authorities in statistics and mathematics.

Prof. H. O. Hartley

Possessor of three doctorates—in mathematics from Berlin University in 1936, in statistics from Cambridge in 1940 and in science from the University of London in 1953—Prof. Hartley distinguished himself during World War II in planning and supervising large-scale computational programs. He helped in the preparation of U.S. Air Force in England "bombing tables," and in the analysis of data from operational research at British ordnance factories.

During 1946–53 he lectured in statistics at University College, London, and then came to the U.S. to begin a new career as professor of statistics at Iowa State College in Ames. He was a visiting professor of statistics at Harvard University in the spring quarter of 1961 and in 1963 joined the Texas A&M University staff as professor and chief administrator, Institute of Statistics.

Author of more than 100 technical publications in statistics, he also collaborated with E. S. Pearson in the publication of the *Biometrika Tables for Statisticians, Vol. 1,* and has served frequently as a consultant to U.S. Government agencies.

Among Prof. Hartley's PhD students are such eminent statisticians and mathematicians as K. R. Nair, P. B. Patnaik, S. H. Khamis, G. E. P. Box (1972 Wilks Memorial Medal Award winner), Carl Marshall, Ronald Herd, W. H. Williams and J. N. K. Rao. His professional affiliations include fellowship in the Institute of Mathematical Statistics, American Statistical Association, and Texas Academy of Science.

The Wilks award citation reads: "To H. O. Hartley in acknowledgement of his contributions to the theory of statistical methodologies and his steady and helpful influence in the application of statistics to worldwide problems."

The 1973 Wilks award committee considered a large number of nominees and consisted of Prof. Robert E. Bechhofer, Cornell University; Prof. George Box, University of Wisconsin; Joseph Cameron, National Bureau of Standards; Dr. Fred Frishman, Army Research Office, Durham, NC; Prof. J. Stuart Hunter (chairman), Princeton University; Prof. Oscar Kempthorne, Iowa State University; Dr. Albert Madansky, Market Planning Corp., New York; Dr. William R. Pabst Jr., Washington, DC; MG (USA, Ret.) Leslie E. Simon, Winter Park, FL.

RIBBON BRIDGE DEVELOPMENT TEAM MEMBERS were honored recently with a $5,000 Group Special Act or Service Award for development of the tactical floating bridge at the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, VA. The project was completed in 33 months at a cost of just over $3 million. Deputy Commander BG John E. Sterling (standing left), U.S. Army Troop Support Command, and MERDC Commander COL Tenho R. Hukkala (standing right) made presentations to (seated l. to r.) Peder B. Pedersen, test engineer; Thomas Whelan, technical data package coordinator; John K. Singleton, test officer; John Short, test engineer; Edward J. Schultze, advance site coordinator; James R. Bolton, bridge branch chief; and James M. Winkler and Dan Causey Jr., test engineers. Standing (l. to r.) are Clyde S. Williams, prototype contract administrator; Harold Mohaupt, test photographer; and Ben Spangler, Martin Falk, Lloyd E. Krivanek, and Thomas Melton, test engineers. Not present were Virginius H. Rhodes, team leader (retired); Richard Helmke, chief designer; John Petersen and Robert Smith, engineers.

People in Perspective . . .

Climaxes Five Years of Effort . . . Watervliet Man Pilots Self-Built Plane

William Ziegler and son Scott

Seventy years have passed since the historic flight of the Wright Brothers' pioneering aircraft at Kitty Hawk, NC, but the adventurous spirit can still be found in men like William Ziegler, an employe of Watervliet (NY) Arsenal.

Employed as a technician in the Advanced Mathematics and Mechanics Laboratory, Ziegler climaxed five years of effort when he recently climbed into the cockpit of his homemade airplane. The "Termite" readily took off into the sky, fulfilling an ambition he has held since 1947 when he earned his first pilot's license.

Except for its 50-horsepower engine, the aircraft is made entirely of wood. Weighing 510 pounds, it has a wingspan of 26 feet and an overall length of 15 feet—which required Ziegler to enlarge his garage.

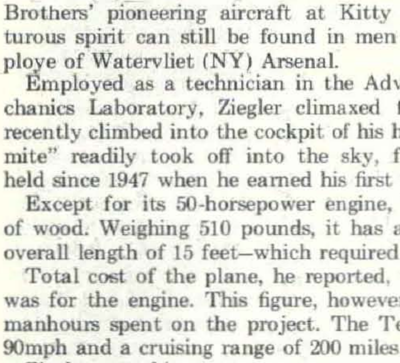
Total cost of the plane, he reported, was only $500, of which $200 was for the engine. This figure, however, does not include the many manhours spent on the project. The Termite has a top air speed of 90mph and a cruising range of 200 miles.

Ziegler says his greatest support came from Scott, his 11-year-old son, who served as a "one-boy rooting section," helped to build the leading edge, painted, and tied knots to secure airframe covering.

Additional assistance came from his colleagues in the 30,000-member nationwide Experimental Aircraft Association. Ziegler gathered parts from other aeronauts, including wing struts from a fellow in Ohio and a carburetor from an Oklahoma birdman.

Although the Termite's maiden flight was brief, Ziegler points out that he plans many more since the craft has proved its air-worthiness in "the greatest thrill of my life!"

Enlisted Man Contributes to Army R&D



PFC David W. Alexander

Excellence of a young scientist's presentation at the International Manpower Institute Symposium in Loughborough, England, testified recently to the role enlisted personnel often play in the U.S. Army research and development programs.

PFC David W. Alexander, assigned to the U.S. Army Natick (MA) Laboratories, presented a research paper on NLABS' program of R&D in microwave sterilization of food. He is a participant in the Army's Scientific and Engineering Program for Enlisted Men.

Titled "Process Parameters for Continuous Microwave Sterilization," the paper describes a mathematical model that permits computer simulation of the microenergy sterilization system.

Designating the relationship of important variables, the model is finding applications in the development of sterilized flexibly packaged field rations and is seen as a "powerful tool" for additional studies.

PFC Alexander has a BS degree in chemical engineering from Virginia Polytechnic Institute, is a recipient of the Commander's Military Award for Science, and has been nominated for the Research Society of America Award.

His prior achievements include coauthorship of a research paper titled "Microwave Processing of Foods, Product Processing and Development," presented at the June 1973 meeting of the Institute of Food Technologists in Miami, FL.

Carries on Historic Name . . . AMC's Priscilla Alden Making Her Mark as GS-15

Priscilla Alden is famed in American history as the *Mayflower* maiden who became the wife of John Alden when he was reportedly sent to woo her as a proxy of Captain Myles Standish, leader of the Plymouth Colony. But one of her tenth-generation direct descendents, bearing the same name, is making her mark in the U.S. Army Materiel Command.

Promotion to GS-15 status, a prestigious grade for male professionals that is much more rare among female employes, came recently to AMC's Priscilla Alden. She was selected to serve as chief of the Programs Branch, Plans and Programs Division, Research Development and Engineering Directorate.

About 10 years have passed since Sally Clements became the first woman at AMC to achieve GS-15 rank. Currently she is the principal assistant, Office of Project Management, reporting directly to MG George Sammet, deputy commander for Materiel Acquisition.

Priscilla Alden's responsibilities as the second female employe of HQ AMC to rise to her new grade involve supervision of the disbursement of about $1.2 billion annually in funds, allocated to AMC's eight commodity commands and five independent laboratories.

With a staff of 18 action officers, she maintains control of the AMC research and development budgetary distribution from program inception to completion, including formulation and preparation of justifications for the defense portion of the President's Budget.

When nominated for the Federal Woman's Award in 1966, Miss Alden was lauded for "a remarkable sense of organization, outstanding administrative ability . . . deep knowledge of her subject."

During a U.S. Government career that began with the Economic Cooperation Administration in 1949 as a commodity industrial analyst, following the phase out of the United Nations Relief and Rehabilitation Administration where she worked as a supply reports officer, Miss Alden has received numerous honors.

UNRRA presented her with a Meritorious Service Award in 1948 and in 1955 the Foreign Operations Administration recognized her with an Outstanding Performance Rating. In addition to the U.S. Army Decoration for Meritorious Civilian Service, the second highest award for civilian employes, and a Sustained Superior Performance Award, she has received annual Outstanding Performance Ratings since 1963.

Graduated with honors from Dean Academy and Junior College in Franklin, MA, she received the 1966 Alumni Award for Distinguished Public Service. In 1940 she earned a bachelor's degree, again with honors, from Duke University where she majored in French and history, and minored in mathematics and fine arts.

When World War II started, she went to work as an assistant to the Duke University curriculum chairman for the Medical School. Toward the end of the war, she came to Washington, DC, for employment as a liaison officer with the French Government, aiding the Free French, in the U.S. Lend Lease Program.

Miss Alden attended elementary schools in Paris and Vienna while living with her widowed mother. In Paris she was stricken with polio. She uses a wheelchair much of the time today, and she has been nominated for AMC handicapped employe of the year honors.

Much of her success she attributes to "good supervisors who have understood" the subtleties of employment factors that have contributed to Women's Lib activities. Life, she feels, has been "evenhanded" with her, in the rewards of her professional career and otherwise. Fluent in French, she also is known as an excellent French cook. Brahms and Beethoven music delights her, she attends numerous social functions, and she loves to travel.

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Development of a Stress Corrosion Test for Armor Alloys

By Daniel Dawson
Army Materials and Mechanics Research Center

Stress corrosion cracking (SCC) is a form of failure in which the combined action of a static stress and a corrosive environment leads to cracking at stress levels which may be far below the yield strength of the material.

High-strength steel, aluminum, and titanium alloys are frequently found to be susceptible to stress corrosion cracking in such commonplace environments as seawater, or even humid air (for certain steel alloys), but only when a crack or a sharp notch is present.

Consequently, the traditional methods for evaluating SCC, using smooth test specimens, have proved inadequate for determining susceptibility in high-strength alloys, including steel armor. This has led to the application of fracture mechanics analysis to the design of precracked stress-corrosion specimens.

In practice, these SCC specimens are similar to the precracked specimens used for fracture toughness testing. For high-strength materials, fracture toughness (K_{Ic}) frequently supplants yield strength as the critical material property in many design applications.

Similarly, the threshold stress intensity for stress corrosion (K_{Iscc}) is the critical measure of environmental susceptibility in these alloys. The stress intensity (K) is a function of applied stress and crack geometry, shown by fracture mechanics analysis to represent the state of stress at the tip of a sharp crack under conditions of limited plasticity, such as occurs in materials with a high yield strength.

Crack-like flaws cannot be entirely eliminated from practical engineering structures. High-strength alloys are designed to be used at high operating stresses. Since they often have low resistance to SCC, the crack tip stress intensity for these preexisting flaws may exceed K_{Iscc} under normal operating conditions.

An index of relative SCC susceptibility for different alloys may be obtained from the ratio K_{Iscc}/K_{Ic}, where a value approaching 1.0 would indicate immunity. As this implies, there is no correlation between fracture toughness measured in air and resistance to stress corrosion cracking in a corrosive environment.

Some steel alloys have a susceptibility ratio as low as 0.15 in distilled water, which could easily result in service failures for these alloys under normal operating stresses and service environments.

Armor alloys used in Army weapons systems have not generally been used in load-bearing applications, and stress corrosion cracking has not been viewed as a major problem. However, several factors have recently led to the development of a SCC test for these alloys.

First, residual processing stresses in armored structures can often be high enough to propagate stress corrosion cracks in alloys with poor resistance to SCC, even in the absence of significant design stresses. This is thought to be the cause of several suspected stress-corrosion failures in armored personnel carriers.

While the cracking failure of nonstructural armor is certainly undesirable, it does not have a major potential for catastrophic failure of the entire weapons system, with attendant risk of loss of crew.

A more serious danger may be present in the recent decision to use armor as an integral load-bearing element of aircraft structures. Stress-corrosion failure of this structural armor could cause complete loss of both aircraft and crew.

Development of a stress-corrosion test for evaluating armor alloys entailed several major considerations. The specimen that provided the optimum solution, shown in Figure 1, is a wedge-loaded double cantilever beam (DCB) type, adapted from a specimen developed by Armco Steel for plane-stress testing of thin sheet.

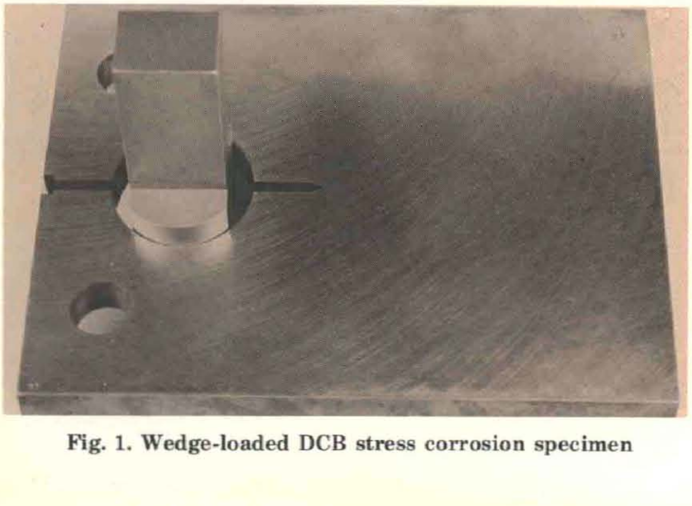

Fig. 1. Wedge-loaded DCB stress corrosion specimen

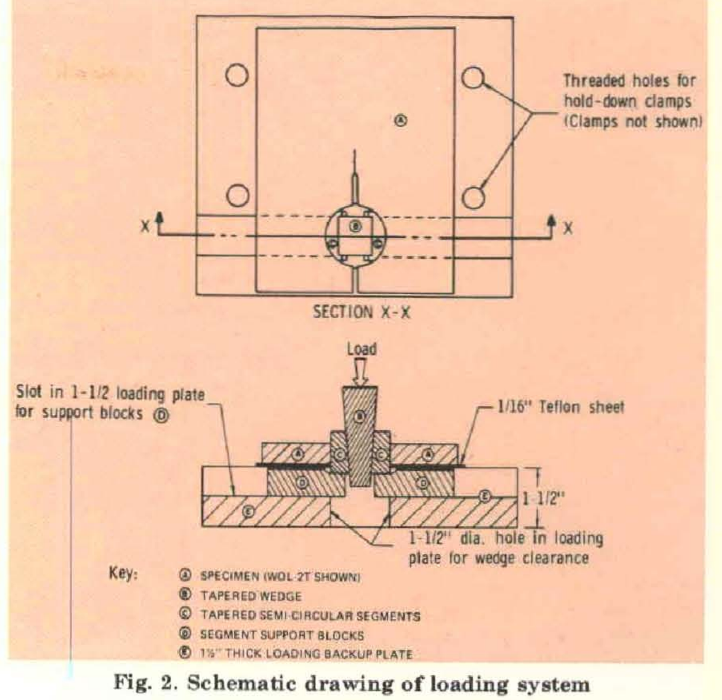

Fig. 2. Schematic drawing of loading system

A schematic of the wedge loading system is shown in Figure 2. A tapered wedge is driven between two matching tapered segments, forcing open the preexisting fatigue crack in the specimen. Stress intensity at the crack tip is calculated from a functional relationship of the form:

$$K_I = \frac{EV}{\sqrt{a}} f\left(\frac{a}{w}\right)$$

Where: E = elastic modulus
V = crack opening displacement produced by wedge loading
a = crack length
$f\left(\frac{a}{w}\right)$ = geometrical factor related to crack length and specimen

If the initial stress intensity applied by wedge loading is greater than the stress-corrosion threshold, the crack will grow—f(a/w) decreases with increasing crack length, and V is fixed, so K will decrease. The crack will stop growing when K falls to the SCC threshold. After measuring the final crack length, K_{Iscc} can thus be calculated.

The wedge-loaded DCB specimen has several distinct advantages over other possible specimen configurations:

- Armor alloys are extremely hard, so it is difficult if not impossible to fabricate specimens using conventional machining techniques. The DCB specimen can be produced by grinding and EDM alone.
- The wedge-loading system can be applied to a wide range of armor plate thicknesses, from thin sheet to plate over ¾" thick.
- The specimen is self-loaded, so the assembly of the specimen, the wedge, and the segments can be removed from the loading fixture and placed as a unit in the test environment. This eliminates the need for expensive loading equipment and fixtures, except for initial loading.
- For a crack-arrest SCC specimen, such as the wedge-loaded DCB, a single specimen is sufficient to determine K_{Iscc}. Other types may require multiple specimens.

The wedge-loaded DCB specimen used to evaluate high-hardness steel armor revealed extremely poor resistance to SCC. Currently, other types such as dual-hardness and gradient steel armor are undergoing tests to determine suitability for either load-bearing or unstressed applications. This specimen can also be used for stress corrosion testing of other alloys, including aluminum and titanium.

The results which have been obtained with the DCB stress corrosion specimen have shown that this system is uniquely suited to the case of armor alloys. The results also show that SCC may impose severe limitations on the utilization of armor alloys. Stress corrosion testing is recommended for all armor alloys; for structural applications it should be mandatory, since catastrophic failure risk is much greater.