ARMY RESEARCH AND DEVELOPMENT

MONTHLY NEWSMAGAZINE OF THE OFFICE OF THE CHIEF, RESEARCH AND DEVELOPMENT
Vol. 8, No. 4 April 1967 • HEADQUARTERS, DEPARTMENT OF THE ARMY • Washington, D.C.

Army Outlines RDT&E Objectives in Proposals to Congress

Based on presentations by Chief of Research and Development Lt Gen Austin W. Betts at recent hearings before the Appropriations Committees of the Senate and House, Congress is reviewing the Army's RDT&E budgetary proposals – an FY 1968 program for $1,571.0 million. An FY 1967 Supplemental Request of $40 million has been approved.

The Supplemental contains fund requirements for projects oriented to the specific needs of U.S. Army forces in Southeast Asia.

As in past years, the FY 1968 research, development, test and evaluation request contains funds to continue efforts begun in prior years, initiate new work, conduct the required level of basic and applied research to provide a technological base for future programs, and support requirements in Southeast Asia.

The Congress initially appropriated $1,528.7 million for FY 1967, as contrasted with a budget request of $1,518.9. To the appropriation has been added nearly $28

(continued on page 2)

Army Orders Design Of Advanced Aircraft

Two advanced concepts in the U.S. Army's search for an aircraft with superior vertical lift-hover characteristics and forward speeds upwards of 300 miles an hour have been approved for further effort.

Contracts of $1.9 million each were awarded Mar. 24 to Bell Helicopter Co. and Lockheed Aircraft Corp. for analytical effort and component testing, a major step in the Army Composite Research Aircraft Program.

Program engineers are hopeful that within the next few months allotted for Bell and Lockheed to engineer the details of their concepts, and to produce and test small-scale models, sufficient data will be compiled to establish a firm technological base for flight test vehicles of one concept or the other. The "next generation" concepts, termed "revolutionary advances in rotary-wing technology," were approved early this year for further contract work.

When selection is made, the follow-on program will encompass the design, component test, fabrication, instrumentation, and ground and flight tests of full-scale aircraft.

The contracting agency is the Army Aviation Materiel Laboratories (AVLABS),

(Continued on page 3)

ASAP to Review R&D For Night Operations

Research and development for "Military Operations at Night or Under Conditions of Fog and Smoke" will be reviewed by the Army Scientific Advisory Panel, May 14-16, at HQ U.S. Army Electronics Command, Fort Monmouth, N.J.

Host for the annual joint member-consultant meeting of ASAP is Maj Gen William B. Latta, CG of the Electronics Command. His deputy for science and chief scientist, Dr. Hans K. Ziegler, is project officer for the full-scale discussion of capabilities and objectives for improving effectiveness of limited visibility operations. Twenty-two ASAP members and 43 consultants have been invited to participate.

The ASAP winter meeting at the U.S. Army Natick (Mass.) Laboratories examined research to ease the combat soldier's load in battle, the natural and battlefield environments imposed by machines and military hardware, and the adaptability of troops to climatic extremes and hostile environments.

Australia Hosts TTCP For Infrared Review

State-of-the art of infrared (IR) research and development was reviewed during an Apr. 10-14 meeting of the four nations of The Technical Cooperation Program (TTCP) hosted by Australia.

TTCP Subgroup J Australian national leader, Dr. John L. Farrands, of the Defense Standards Laboratory at Melbourne, was the principal Australian Scientist at the ninth conference of the IR specialists.

Business meetings and discussions of working panel reports were held in Adelaide and Melbourne. Visits were made to the Weapons Research Establishment at Adelaide and the Defense Standards Laboratory at Melbourne.

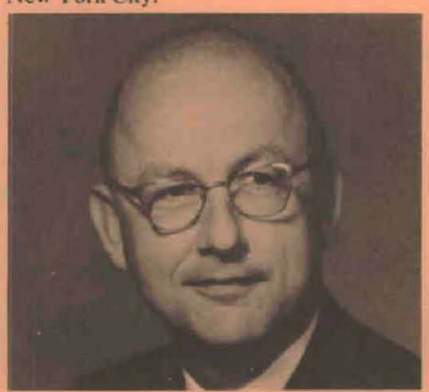
(Continued on page 5)

Dean Fadum, Dr. Krebs Accept JSHS Speaker Bids

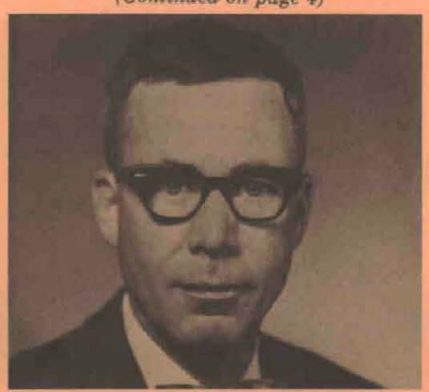
Two more distinguished scientists have accepted invitations to address the Fifth National Junior Science and Humanities Symposium (JSHS), Apr. 20-22, at the U.S. Military Academy and HQ United Nations, New York City.

Dr. Ralph E. Fadum, dean of the School of Engineering, North Carolina State University, Raleigh, and Dr. Robert W. Krebs, research coordinator, Esso Research and Engineering Co., Linden, N.J., will be

(Continued on page 4)



Dr. Robert W. Krebs



Dr. Ralph E. Fadum

Featured in This Issue . . .

Army R&D Newsmagazine

Vol. 8, No. 4 April 1967

Editor . . . . . Clarence T. Smith
Associate Editor . . . . George J. Makuta
Assistant Editor . . . . . Read Wynn

Published monthly by the Army Research Office, Office of the Chief of Research and Development, Department of the Army, Washington, D.C. 20310, in coordination with the Technical and Industrial Liaison Office, OCRD. Grateful acknowledgment is made for the valuable assistance of Technical Liaison Offices within the U.S. Army Materiel Command, U.S. Continental Army Command, Office of the Chief of Engineers, and Office of The Surgeon General. Publication is authorized by AR 310-1, as extended by the Army Publications Board on Sept. 15, 1964.

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

Picture Credits: Unless otherwise indicated, all illustrations are by the U.S. Army.

Submission of Material: All articles submitted for publication must be channeled through the technical liaison or public information officer at installation or command level.

By-lined Articles: Primary responsibility for opinions of by-lined authors rests with them; their views do not necessarily reflect the official policy or position of the Department of the Army.

DISTRIBUTION is based on requirements submitted on DA Form 12-4. Army agency requirements must be mailed to the U.S. Army AG Publications Center, 2800 Eastern Boulevard, Baltimore, Md. 21220.

Distribution on an individual name basis is restricted to members of the U.S. Army Atomic Energy and R&D Officer Special Career Programs. Members of the U.S. Army Reserve R&D Unit Program receive distribution by bulk lot sent to their individual units. Otherwise, distribution is made only to the Army installation, office or organizational element to which the requester is assigned.

CHANGES OF ADDRESS for AE and R&D Officer Special Career Program enrollees should be addressed to: Specialist Branch, OPXC, Department of the Army, Stop 106 Washington, D.C. 20315. Reserve R&D Unit members should contact: Special Assistant for Reserve Affairs, OCRD, Department of the Army, Washington, D.C. 20310.

OTHER GOVERNMENT AGENCIES' requirements should be submitted directly to the Army Research Office, OCRD, Department of the Army, Washington, D.C. 20310, ATTN: Scientific and Technical Information Division.

ALL NON-U.S. GOVERNMENT agencies, firms and organizations must obtain this publication through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Single copies sell for 20 cents. Subscription rates (12 issues annually) are: Domestic, APO and FPO addresses, $2.25; Foreign, $3.00

Army Outlines RDT&E Objectives to Congress

By Lawrence Cohen
Deputy Chief, Programs and Budget Division
Office of the Chief of Research and Development

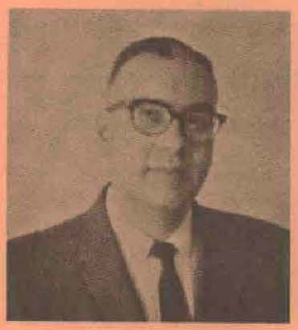
(Continued from page 1)

million from the Office of the Secretary of Defense (OSD) Emergency Fund. Plus the Supplemental, this brings the FY 1967 fund availability to $1,596.7 million.

All of the Emergency Funds received have been for Southeast Asia requirements, as is the $40.0 million FY 1967 Supplemental.

For FY 1968, a proposed program of $1.571 billion requires new obligation authority of $1.539 billion augmented by carrying forward $32 million of FY 1967 and prior year unobligated balances.

Table 1 is a comparison of the FY 1967 program, including the Supplemental, and the FY 1968 planned program, shown by budget activity. Budget activities are essentially commodity/industry-oriented and are the basis on which Congress appropriates funds. The line titled unobligated balances represents a financing mechanism.



Lawrence Cohen

TABLE 1
Summary by Budget Activity
($ In Millions)

Budget Program	FY 1967	FY 1968
Military Sciences	160.5	165.4
Aircraft	113.6	115.7
Missiles	722.5	706.2
Military Astronautics	14.0	11.1
Ships and Small Craft	.9	.9
Ordnance and Combat Vehicles	196.2	183.6
Other Equipment	307.2	309.3
Programwide Management and Support	78.3	78.8
Program Total	1593.2	1571.0
Unobligated Balance	3.5	−32.0
Appropriations	$1596.7	$1539.0

The FY 1967 amount represents a statistically derived amount anticipated to be surplus in FY 1967, due to establishment of an average civilian employe grade and salary level lower than the one utilized in preparing the FY 1967 column of the FY 1968 budget. Since this amount was included in the appropriations, it was placed in reserve for application to programs of future years.

Based on prior experience and the expected rate of obligation of funds, OSD concluded that during FY 1968 about $32 million would be recouped from prior-year programs. This is due to changes in requirements, price revisions, contract cancellations and limitations, renegotiations, firming up of estimates and so on.

The pie chart (Fig. 1) reflects four major program segments. The largest (39%) is National programs—NIKE-X, and its associated test site at Kwajalein, White Sands Missile Range, ground environment elements of the DoD Communications Satellite Program and project DESERET.

Scientific research and the development of technology directed toward future systems calls for 19.3% and 7.7% is devoted to testing and facility operations. This leaves 34% for Army development programs, where the bulk of our future hardware rests and from which funds to meet additional Vietnam requirements must be provided. This funding increases the impact on those longer-term development efforts directly associated with the land combat mission of the Army.

In Table 2, the revised FY 1967 program and the proposed FY 1968 program are expressed in terms of Program Categories. These categories represent, in a simplified way, the steps through which ideas are turned into useful military hardware.

TABLE 2
Summary by Program Category
($ In Millions)

	FY 1967	FY 1968
Research	86.2	87.3
Exploratory Development	227.6	216.3
Advanced Development	183.8	217.9
Engineering Development	608.0	575.9
Management and Support	269.1	268.8
Operational Systems Development	218.5	204.8
TOTAL	1593.2	1571.0

The development process for materiel is coordinated closely with Army operational requirements. The nature of the threat the Army faces and the operational characteristics of materiel necessary to meet the threat determine the focus of the RDT&E program.

Some of the more important operational

(Continued on page 30)

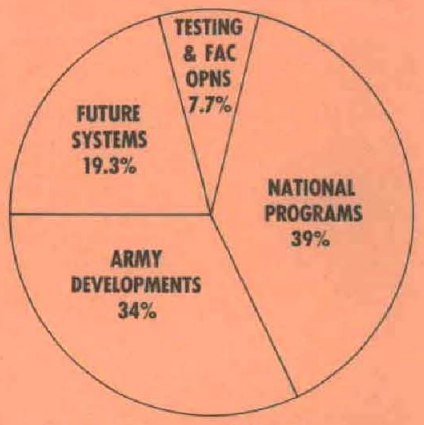


Figure 1. Army R&D Program

Army Awards 2 Contracts for Design of Advanced Aircraft

(Continued from page 1)

Fort Eustis, Va. The program is monitored at Department of the Army level by the Air Mobility Division, Office of the Chief of Research and Development, Washington, D.C.

Objective of the composite research aircraft program, a part of the Army's Advanced High-Speed Rotary-Wing Aircraft Project, is to combine into one aircraft the good vertical takeoff and landing (VTOL) capabilities of the helicopter and the efficient high-speed characteristics of the fixed-wing aircraft.

Aviation experts have long recognized that the low disc-loading of the helicopter marks it as the most efficient hovering vehicle in the VTOL category and that the simple fixed-wing aircraft has the most efficient lift-producing system in cruise flight.

In order to accomplish higher speeds with such an aircraft, the rotor drag must be reduced or eliminated for cruise flight. The concepts by Bell and Lockheed involve unloading or altering the mode of operation of the low-speed lifting rotors or prop-rotors to minimize high-speed drag. In the high-speed flight mode, the lift is transferred to conventional, lift-producing airplane-type surfaces and the low-speed lifting rotor is stopped and stowed (Lockheed concept) or tilted (Bell).

Bell tilting prop-rotor concept. The proposed Bell Composite Research Aircraft is essentially a high-wing airplane with a tilting prop-rotor mounted on each wing tip. Power supplied by two T64 engines operates two 3-bladed prop-rotors, each measuring 36.5 feet in diameter. Each engine, transmission and prop-rotor is combined in a power package which rotates as a unit during conversion.

Lockheed stopped/stowed rotor concept. This composite research aircraft uses a stopped, folded and stowed main rotor, two wing-mounted propellers and a conventional antitorque tail rotor. Power is generated by two engines mounted in nacelles under the wings to turn propellers with shafting to the rotor transmission. The 3-bladed "rigid" rotor is stopped and the blades are folded, trailed aft in a horizontal position and then retracted into the top of the fuselage during conventional wing-supported flight.

Army aeronautical experts are optimistic about the current project, based on successes in advancing, in similar fashion, the state-of-the art in rotary-wing aircraft. Results of earlier research helicopter programs have confirmed the feasibility of compound helicopters with speeds in excess of 200 miles an hour and led to the current development of the Advanced Aerial Fire Support System (AAFSS).

The U.S. Army's quest for versatile rotary-wing aircraft may be said to have begun in the Army Air Corps a quarter-century ago. The first concept of the helicopter is credited to Leonardo da Vinci and his "aerial-screw machine" toward the close of the Renaissance four centuries ago.

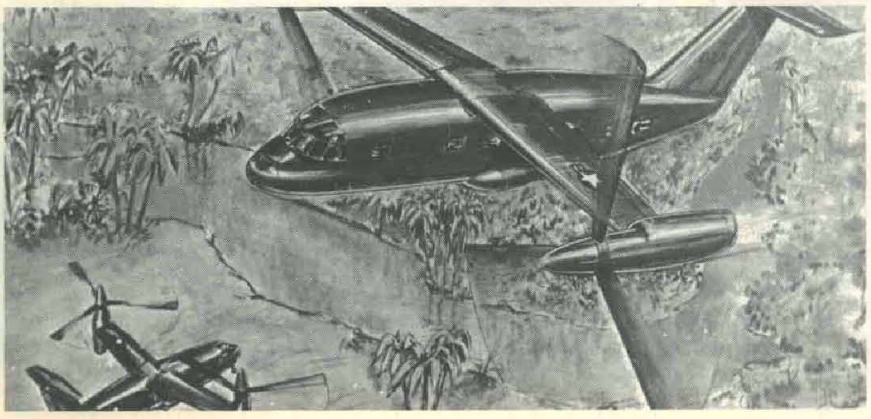
Through the decades, various descriptive names have emerged, such as helicoplane, helicogyre, helicopter, gyroplane, gyrodyne, autogyro, aerogyro, rotodyne, convertible airplane, convertoplane, convertible helicopter, pure helicopter and compound helicopter.

The two new concepts accepted for intensive research and development by the Army are more aptly placed in the convertible helicopter category. The developmental project parallels a sister Army R&D program, the vertical short takeoff and landing (V/STOL) aircraft.

If development of the Bell or Lockheed "convertible" is as successful as anticipated, engineers foresee a VTOL/V/STOL advance that could be adjudged a major aeronautical achievement of this decade.

STOPPED/STOWED ROTOR concept by Lockheed Aircraft Corp. is shown here in "before" and "after" stages. Model at left shows full extent of the main rotor and the antitorque tail rotor. In the artist's concept (above), the rotor is folded back in the upper aircraft; in the foreground, main rotor has been retracted into the fuselage.

TILTING PROP-ROTORS form the basic concept of a fast VTOL aircraft envisioned by Bell Helicopter Co. Shown in Bell photo (right) is a model with the tilting prop-rotors at the in-between position. Artist's version (below) shows the aircraft in forward motion, while the craft on the ground has prop-rotors in vertical-lift position.



Reactor Group Gets New Chief

Col Robert L. Ednie, former commander of the 92d Engineer Construction Battalion, Fort Bragg, N.C., is the new director and commander of the U.S. Army Engineer Reactor Group, Fort Belvoir, Va.

His duties include serving as director of the Army Nuclear Power Program and special assistant for nuclear power to the Chief of Engineers.

A graduate of Louisiana State University, Col Ednie served from 1962 to 1964 as inspector general for the Department of the Army's Nuclear Power Reactor Program.

JSHS Program Pioneer Added to Advisory Council

Duke University's nationally known professor of science education, Dr. Sherwood Githens Jr., who helped organize the first Army Junior Science and Humanities Symposium (JSHS) in 1958, is a newly appointed member of the JSHS Advisory Council.

Dr. Githens is renowned as the innovator of the revolutionary "Quantitative Physical Science System" being tested at 35 high schools in 11 states. The system provides motivated learning-by-doing experience for students with a wide range of intellectual capacities, instead of "losing the excitement of science in a maze of words."

Created when the Army's JSHS Program became nationwide in scope in 1961, the JSHS Advisory Council, now headed by Dr. Ernst Weber of Polytechnic Institute of Brooklyn, N.Y., assists the Assistant Secretary of the Army (R&D) and the Army Chief of Research and Development in establishing guidelines and objectives for the program.

Since it was launched as an experiment in stimulating interest in junior science at Durham, N.C., under sponsorship of what is now named the Army Research Office-Durham (ARO-D), the JSHS Program has expanded to an annual level of 23 regional symposia throughout the United States.

The Fifth National JSHS, which will draw about 235 selected science students and teachers to the U.S. Military Academy and United Nations Headquarters in New York City, Apr. 20-22, will be marked by addresses by several of the nation's leading educators.

Dr. Githens is backed for his new duties on the JSHS Advisory Council by continuous service since 1958 as Duke adviser to the JSHS Program. Last year, the Durham (N.C.) County Board of Education voted him a measure of immortality by naming a new structure the Sherwood Githens Junior High School, for having "done so much for Durham County as a teacher."

During 1959-1962, when Dr. Githens was deputy chief scientist at the U.S. Army Research Office-Durham, he taught physics on his own time without compensation at Durham's Southern High School.

Since joining the Duke faculty in 1962, he has served in various civic roles, including guest teacher at nearby public schools. He is regional counselor for high school physics in North Carolina for the American Institute of Physics and is also chairman of the North Carolina Committee on High School Physics.

Dr. Githens received an AB degree in mathematics from Bucknell University in 1931 and MA and PhD degrees in physics from the University of North Carolina in 1933 and 1936. In 1933-1934, he did graduate work at Princeton University and was assistant professor at Wake Forest (N.C.) College, 1936-1941.

He was an Army Air Corps technical instructor at Chanute Field, Ill., and Sheppard Field, Tex., early in World War II. After the war he was a lecturer in electronics at Harvard University, a physicist at the Johns Hopkins Applied Physics Laboratory and chairman, Department of Physics, Baylor University, before he joined the staff of the Army Research Office-Durham.

Dr. Sherwood Githens Jr.

Appointments to the Army JSHS Advisory Council are approved at Department of Defense level and the Assistant Secretary of the Army (R&D). Chief of Research and Development Lt Gen Austin W. Betts extended the invitation to Dr. Githens.

Other members are J. Harold Browne, national director of exploring, Boy Scouts of America HQ, New Brunswick, N.J.; S. C. Donnelly, director, Greensboro and Burlington (N.C.) Shops, Western Electric Co.; Dr. Ralph Gibson, director, Applied Physics Laboratory, Johns Hopkins University, Silver Spring, Md.; George F. Leist (Col, USA, Ret.) Owens-Illinois Co., Toledo, Ohio; and

Dr. Harry L. Levy, administrative vice-chancellor, City University of New York; Dr. George R. Seidel, education manager, E. I. DuPont de Nemours and Co., Wilmington, Del.; and Dr. M. H. Trytten, director, Office of Scientific Personnel, National Academy of Sciences, Washington, D.C. Mrs. Grace Boddie of ARO-D is executive secretary.

Military members of the council are Col Charles D. Y. Ostrom Jr., Director of Army Research, Office of the Chief of Research and Development, and Lt Col Donovan F. Burton, who on July 11 will become commanding officer of ARO-D.

Dean Fadum, Dr. Krebs Accept JSHS Speaker Bids

(Continued from page 1)

among the main speakers.

As announced in March, Dr. Margaret Mead, curator of ethnology, American Museum of Natural History, and adjunct professor of anthropology, Columbia University, will give a keynote address on the humanities. Dr. Paul R. Elliott, assistant professor of zoology, University of Florida, and Dr. Frederick C. Steward, professor of botany, Cornell University, also accepted invitations last month.

DEAN FADUM, head of the North Carolina State University engineering school since 1962, is vice chairman of the Army Scientific Advisory Panel (ASAP). He has held numerous national and state advisory positions, including membership on the Advisory Panel for Engineering, National Science Foundation and the Advisory Panel on General Sciences, Office of the Assistant Secretary of Defense (Research and Engineering) from 1954-1958.

He received MS and PhD degrees in engineering at the University of Illinois and Harvard University, and holds an honorary doctorate from Purdue University.

DR. KREBS has been research coordinator of elastomers and coatings at Esso since 1962 and served as director of the Chemical Research Division, Esso Research and Engineering Co., 1957-1962. He joined Esso Laboratories, Standard Oil Co. of Louisiana, as a chemical engineer, rising to assistant director in 1947 and associate director in 1955.

He received BS, MS and PhD degrees in chemical engineering from the University of Illinois in 1933, 1935 and 1937.

Report Covers Army Special Aircraft Design

Army progress in designing special aircraft was reported at the International Congress on Subsonic Aeronautics conducted this month by the New York Academy of Sciences.

Paul J. Carpenter, U.S. Army Aviation Materiel Laboratories, Fort Eustis, Va., presented a paper titled "Design Trends in Future Helicopters, Compounds and Composite Aircraft." It was one of 35 papers on the program.

Major topics included aerodynamics of fixed-wing aircraft, rotary wings, thermodynamics and aerodynamics of propulsion, boundary layer, transport role of subsonic aviation, V/STOL, facilities and techniques.

The Congress was cosponsored by the American Institute of Aeronautics and Astronautics, Aeronautical Society of India, Associazione Italiana di Aerotecnica, Association Belge des Ingenieurs et Techniciens de l'Aeronautique et de l'Astronautique, Canadian Aeronautics and Space Institute, Institute of Fluid Mechanics of the Academy of the Socialist Republic of Romania, The Royal Aeronautical Society, The Royal Aeronautical Society (Australian Division), The Swedish Society of Aeronautics and the Yugoslav Society of Mechanics.

Cosponsored Line Islands Satellite Experiment Collects Weather Data

Hovering in synchronous orbit 22,300 miles above the equatorial Pacific Ocean, the new Applications Technology Satellite (ATS-1) brings a new dimension to one of the most comprehensive tropical research programs ever devised.

Called the Line Islands Experiment, field operations are on three of the islands south of Hawaii—Palmyra, Fanning and Christmas. Involved are meteorological experts of the sponsors, National Science Foundation(NSF) and the National Center for Atmospheric Research (NCAR). Assisting directly are the Environmental Science Services Administration (ESSA), universities affiliated with NCAR and federal agencies, including the Department of Defense.

The project is the first step of a long-range tropical research program enhanced by the ATS satellite launched into its "stationary" position last December. Another ATS launching is scheduled in June and it is anticipated that similar observations will be made in the Barbados area in 1968 and Marshall Islands in 1969. Similar projects are planned within 5 to 10 years.

The Line Islands Experiment from Feb. 15 to Apr. 15 is being assisted on each of the islands by Army enlisted specialists from the Army Electronics Command Meteorological Support Company, Fort Huachuca, Ariz., and the Meteorological Team at Yuma (Ariz.) Proving Ground.

The small Army meteorological groups, making surface observations and taking wind measurements aloft, are complementing the three U.S. Air Force-manned rawinsonde stations on the islands.

The program is attempting to fill "serious gaps" in the knowledge of tropical meteorology. Considered a key region in attempting to understand the global behavior of the atmosphere, the tropical zone is one of the least adequately observed regions of the earth.

Water forms the greatest percentage of the tropical areas of the world, limiting orthodox methods for making meteorological observations. Circulation of the water changes as trade wind belts shift across the geographic equator, making accurate, consistent readings difficult.

Meteorologists consider the multiagency experiment of vital import to tropical environmental research. Scientific objectives are a detailed investigation and description of meteorological events in and near the equatorial trough zone, or intertropical convergence zone.

Intensive weather observations, including soundings of the upper atmosphere, are being made from ground stations, a shipboard station and from research and reconnaissance aircraft.

Conventional observations, coupled with those made by the polar-orbiting ESSA satellite and the National Aeronautics and Space Administration's NIMBUS, will be used to evaluate photographs taken by the ATS. Weather radar on Palmyra Island records precipitation and storm developments and an Automatic Picture Taking (APT) ground station on Palmyra receives pictures from the satellites.

The ESSA research ship, *Surveyor I*, the Woods Hole (Mass.) Oceanographic Institution's research aircraft C-54Q and the NCAR Queen Air meteorological aircraft are serving the Line Islands Experiment, Christmas Island is used for landings.

Research projects conducted by scientists of NCAR and some of its affiliated universities include:

- A study of tropical disturbances by Edward Zipser, NCAR scientific coordinator, and Henry van de Boogaard, NCAR.
- Effectiveness of the synchronous satellite as a meteorological instrument and a study of cloud motions and development by a University of Wisconsin team and a group from St. Louis University.
- Another group from the University of Wisconsin is studying temperatures of the sea surface using the Queen Air.
- An investigation of large-scale meteorological phenomena of the equatorial trough zone, using satellite data, is being carried out by meteorologist Aylmer Thompson of Texas A&M University.
- Studies embracing many aspects of tropical weather, including the development of convective clouds and radiometric measurements, are being made from the Woods Hole aircraft.
- Tropical dynamics and the effects of atolls are being investigated by scientists from the University of Hawaii.
- The U.S. Army will study small-scale circulations in the Line Islands area and corresponding boundary layer energy exchanges at the surface-air interface.

Australia Hosts TTCP For Infrared Review

(Continued from page 1)

Representing the U.S. Army were Dr. Werner K. Weihe of the Engineer Research and Development Laboratories, Fort Belvoir, Va., executive member and U.S. national leader of Subgroup J; Dr. Robert B. Watson, alternate Army member, Physical and Engineering Sciences Division, Army Research Office, Arlington, Va.; Col F. J. Nemethy, chief, Special Warfare Division, Office of the Chief of Research and Development, Department of the Army; and Benjamin Goldberg, also of Fort Belvoir, chairman of the working panel on night vision.

U.S. Navy representatives were Frank Jablonski of the Office of the Chief of Naval Operations, alternate Navy member; and Dr. Edward Dayhoff of the Naval Ordnance Laboratory, White Oak, Md., U.S. national leader of the working panel on lasers.

Representing the U.S. Air Force were Subgroup J member, Maj John H. Jacobsmeyer Jr., HQ USAF, Washington, D.C.; and L. H. Meuser of Wright Patterson Air Force Base, Ohio, alternate member and chairman of the air-to-surface surveillance working panel.

Objectives of the TTCP include formulation of proposals to obtain maximum employment of each nation's resources, and maintenance of a continuing exchange of information related to military research and development. Monitored by each of the quadripartite nation's defense establishments, TTCP reviews through specialized subgroups the R&D objectives and progress of the armed forces.

Australia joined the U.S.-Canada-Great Britain tripartite organization in 1965, and has been a member since 1963 of the ABCA Armies Standardization Program. This complements the TTCP exchange of information involving military services of each participating country.

Reserve Unit Schedules Nuclear Science Meet

The seventh annual Army nuclear science seminar sponsored by the 3252d U.S. Army Reserve Unit at Oak Ridge, Tenn., is scheduled July 16-29.

The purpose is to provide Reservists and Regular Army, Air Force and Navy personnel engaged in research and development an opportunity to receive current data in nuclear science and related fields.

The Atomic Energy Commission (AEC) and its Oak Ridge contractors, the Union Carbide Corp., the University of Tennessee and the Oak Ridge Associated Universities, will support the seminar.

Lt Gen A. W. Betts, Chief of Research and Development, and his Assistant for Reserve Affairs, Lt Col Loren R. Lester, are scheduled for addresses.

The tentative list of speakers includes A. K. Bissell, mayor of the City of Oak Ridge; S. R. Sapirie, manager, Oak Ridge Operations Office, AEC; and Dr. C. E. Larson, president, Nuclear Division of Union Carbide Corp.

Other Oak Ridge speakers on the program are Dr. A. M. Weinberg, director, Oak Ridge National Laboratory; Robert Jordan, superintendent, Oak Ridge Gaseous Diffusion Plant, Nuclear Division, Union Carbide Corp.; and Roger F. Hibbs, superintendent, Electromagnetic Separation Plant (Y-12), Nuclear Division, Union Carbide Corp.

James W. Sterling, Research Plans Office, Army Research Office, OCRD, will discuss "Technological Forecasting," and Col John W. Burfening, commander of the Institute of Nuclear Studies, U.S. Army Combat Developments Command, will furnish a team to speak on "Army Nuclear Weapons Effects."

Picatinny Applies Fluidics to Timers

Feasibility of applying fluidic (flueric) controls to a timer having no moving mechanical parts is demonstrated in an experimental device on which scientists at Picatinny Arsenal, Dover, N.J., have been working since 1963.

Army researchers are of the opinion that such a timer would have wide application in the design of Army weapons systems because of its simplicity. An estimate is that potential unit cost of mass production may be as low as $5.00. The device also is smaller in size than comparable timers now in use.

Fluidics (the new term for the rapidly developing family of fluid amplifier control devices) involves the flow properties of a gas or liquid through a combination of orifices and passageways for precise control.

Components such as oscillators, frequency dividers, binary counting and other digital-type logic elements can be actuated by a high-pressure gas supply in the fluidic timer (see figures 1 and 2). The oscillator sends pressure pulses through a 5-stage frequency divider which affects the oscillator frequency by a factor of 2^5.

The output from the frequency divider is connected to 12 presetable counter stages to provide the timing function by counting the pressure pulses. The setting card presets a binary number into the 12 binary counter stages so that the output is always that from the last counter stage of the timer.

Flueric buffer amplifiers are used between all stages of the divider and counter elements to maintain appropriate pressure levels throughout the system. The timer is presettable by prepunched cards in increments of 0.1 second between 2 and 200 seconds.

Picatinny researchers have designed and built two miniaturized flueric timers, having 0.009-inch orifices. The timer is initiated at the instant that a stop watch is started by means of a connecting flexible tube from the watch to the oscillator of the timer.

The output (2 psig) of the last counter stage of the timer is connected by flexible tubing to the escapement mechanism of the stop watch so that when the output from the timer occurs, the escapement mechanism of the watch is locked, thereby stopping the watch. In this manner, it is possible to compare, in real time, the timing action of the fluid timer against the timing function of the stop watch.

The fluidic timer has been tested in the laboratory by using electronic counters for accurate monitoring of its performance. Accuracy of the timer is within approximately 0.5 percent of the preset time at constant temperature, with a pressure supply variation from 1.8 psig to 20 psig.

Accuracy of the timer is approximately ± 7 percent of the preset time with temperature variations from -65°F. to +165°F. for the same pressure variation.

Presetable in 0.1-second increments, the counter will provide a maximum timed delay up to 280 seconds. The prototype flueric timer is one-half cubic inch in volume, excluding the pneumatic power supply. A device to provide a 100-second timing in a tactical weapon application would require a pressurized gas supply, without regulator, measuring about five cubic inches.

Construction of the timer involves a simple stacking of metal laminations, held mechanically by a set of tension fasteners. Laminations are 0.002 and 0.004-inch in thickness, acid-etched to required configurations.

Picatinny researchers are encouraged by the performance of the prototype. Problems to be solved before a practical application can be made in an Army weapon system are:

- To design and build a small, simple digital-to-binary continuous-setting mechanism to eliminate individual setting tabs for each time setting.
- To design temperature compensation into the timer so that better accuracy than ± 7.5 percent of the preset time can be achieved over temperature variation from -65°F. to +165°F.
- To optimize design of the gas supply.

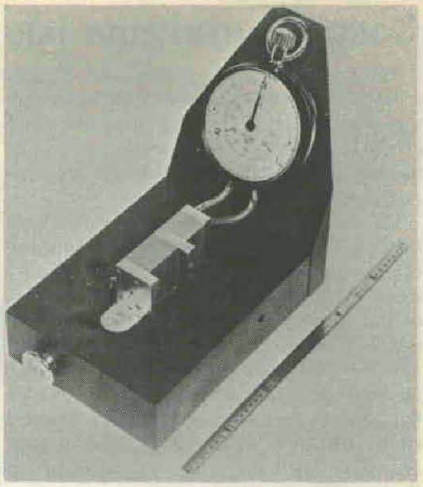
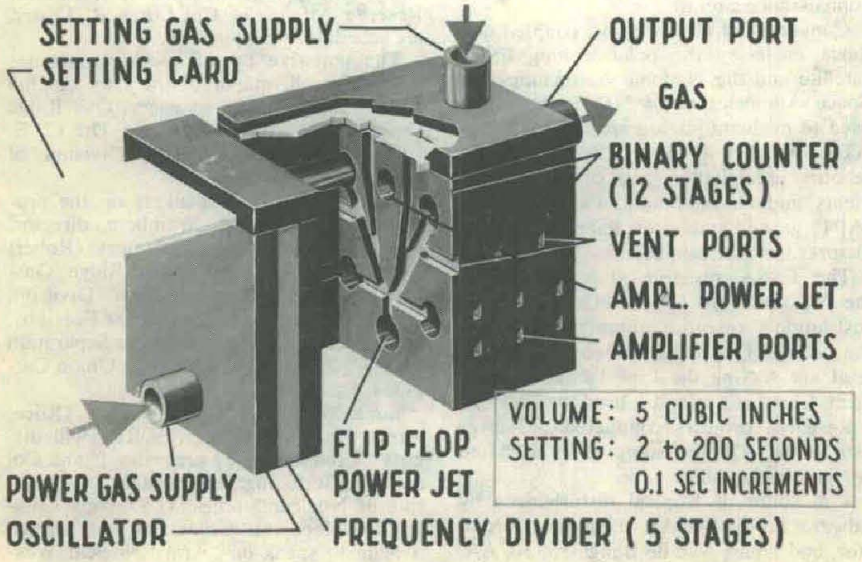


Figure 2. Fluid Timer



ADI Calls for Tech Papers For Conference, Oct. 22-26

Papers on "Levels of Interaction Between Man and Information" are being sought by the American Documentation Institute for presentation at its annual convention, Oct. 22-26, in New York City.

Documents should report on significant techniques, trends and achievements related to the creator, user, handler and packager of information.

"Creator" includes the creative writer, the scientist, the graphic artist, the editor and the publisher. "User" concerns those using information in the business world, man/machine interface, psychology and information, and language and information.

The "handler and packager" topic includes traditional and new methods of organizing and storing information, wares of information services, and information sharing.

Selected papers will be printed and distributed at the convention. Authors will be grouped by topic for panel discussions and allowed to give a 10-minute precis of the papers, which should not exceed 2,000 words. Anyone intending to submit a paper should notify the program chairman by June 1. Papers must be submitted by July 1.

A reply form may be obtained from Paul Fasana, program chairman, ADI 1967 Annual Convention, Columbia University, The Libraries, New York, N.Y. 10027.

Fluidics Hailed as Next Big Payoff of Army R&D to Nation

Beneficial impact of Army R&D upon the civilian economy has accounted for new products that have added many billions of dollars annually to manufacturing output, and another big payoff is reported on the brink.

Seven years ago, in 1960, a press conference was called at the Army's Diamond Ordnance Fuze Laboratories (renamed the Harry Diamond Laboratories in 1962) to announce that the famed Army research establishment in Washington, D.C., had developed the principles of fluid amplification for controls without moving parts.

The discovery—recognized even then as having potentially worldwide industrial importance—was attributed to Billy M. Horton, now the technical director of HDL, coworker Raymond W. Warren and Dr. Romald E. Bowles, who since has founded his own industrial consulting firm.

The trio was selected recently for the John Scott Award, climaxing a long series of honors in recognition of their achievement. The award dates back to 1816 and is reserved for epochal contributions to science. Among recipients are such immortals as Mme. Curie, Edison and Marconi.

Principles of fluid amplification controls (now grouped in the coverall classification of fluidics to apply to fluid-actuated systems as well as to the pure fluid systems without moving parts) have been applied by Army scientists to an experimental artificial heart pump, computers, missile guidance and other materiel items.

Potentialities of fluidics are pointed out in a "special report" in the Feb. 13, 1967, edition of *Product Engineering*, which states in part:

"The fluid amplifier stands today where the transitor stood 10 years ago: It is versatile, functional, and promising—and not very well understood except by the specialists. The parallel is stressed by the fact that the fluid amplifier has been called a fluidic transistor . . .

HEART PUMP, which assists or supplements actions of human organs during surgery, exemplifies highly efficient and compact systems operating on principles of fluid amplification for control system without moving parts.

FLUID AMPLIFIED missile pitch control system, operating with no moving parts, is shown by Shirley McClain.

"Fluidic devices haven't yet captured any major commercial market, yet companies annually are spending millions of dollars on fluidic R&D. A Harvard Business School study predicts commercial markets worth hundreds of millions in the 1970s. . . ."

Among advantages cited in *Product Engineering* as accounting for the great increase of industrial interest is that "Neither heat, nor steam, nor oil, nor dust can spoil fluidic operation. A well-chosen fluidic device can tolerate almost any environmental abuse. You can make amplifiers out of almost any material, can stack them like pancakes to eliminate interconnecting tubing, and can mount them anywhere. . . ."

Envisioned applications of fluidics (somewhat fancifully termed "fluid dynamics" in the early stages of development for various uses) comprise a long list in the *Product Engineering* article. Potential uses include "temperature, pressure and speed controls on gas turbines; proximity sensors of all kinds; counting and timing circuits for missiles and projectiles; and

"Process controls where electricity is not allowed; boot-strap flow instruments that use the process fluid itself; diversion valves for process fluids, cryogenic fuels and hot metal vapors; respiratory instruments; artificial organs, using body fluids; and

"Sequencing controls for machines and processes where conventional electromechanical controls cannot be used, cannot stand up under abuse, or are not reliable enough; short-time controls for projectiles or mobile machines in which a bottle of air or gas is the only supply; and

"Washing machines; flight controls for aircraft; stabilization controls for vehicles, steering and inertial controls for missiles and rockets; and proportional amplifiers for process and air-conditioning controls."

Provided the potential applications of fluidics materialize as anticipated by industrial organizations spending millions of dollars on developmental effort, the impact of the Army R&D discovery upon the civilian economy will add significantly to an impressive record.

Among the major contributions which may be cited—many of which were detailed in a 72-page third anniversary edition of the *Army R&D Newsmagazine* devoted to the theme of byproduct benefits of Army R&D (Volume 5, No. 1, 1964)—are such pioneering efforts as the following:

Manhattan Project. This Army effort in developing the atomic bomb led to the peaceful use of atomic energy for power plants, worldwide interest in irradiation preservation of food, and the latest concept of atomic-powered spaceships and large-scale detonations for huge excavation projects—such as a sea-level canal proposed across the Isthmus of Panama.

Computer Development. When the Army awarded a World War II contract for computer development, to meet a mounting requirement for rapid processing of logistical and ballistics data, the foundation was laid for the growth of today's multibillion-dollar computer industry.

Microminiaturization. Discoveries of Army researchers leading to development of printed circuits and microminiaturization of components helped to revolutionize the

(Continued on page 8)

Fluidics Hailed as R&D Payoff to Nation

(Continued from page 7)

radio, TV, computer systems, and many associated fields of communication. Army scientists developed radar and early radio tubes; they pioneered in space communications, bouncing the first signal off the moon, and developing the first communications satellites, the COURIER and ADVENT.

Unconventional Power Sources. Because of problems of logistics involved in fuel transportation to remote areas for generating electrical power, the Army has long been deeply interested in development of unconventional power sources.

With the support of the Advanced Research Projects Agency (ARPA), the Army was a pace-setter in Department of Defense fuel-call developmental activities in recent years. The Army also has developed long-life, high-powered, lighter-weight batteries for many special purposes. Research in both of these areas bears also upon the current major effort to develop electrically propelled vehicles to help minimize the air pollution problem.

Another area of pioneering effort by the Army has been in development of gas turbines for electric power plants—again geared to the military requirement for lighter-weight equipment for field use. Some gas turbines under development are less than one-fourth the size and weight of diesel engine systems of comparable capacity. They also have the advantage of "clean" exhaust products.

Solar power cells developed by the Army contributed to the success of the NASA man-in-space project. Because of many specialized requirements for this type of power, the Army is still conducting extensive research.

Vacuum-Spray Can. Few men in the United States (and in many other countries) have not touched their fingers more or less often to a vacuum-spray can of one type or another—paint, shaving lather, room deoderants, insecticides, starch, window cleaners, to list only a few. Even Milady's annual investment in hair sprays is a sizeable national economy item.

Altogether, the spray-can industry contributes to the gross national product some $300 million annually. How did it originate? From a search by Army chemists for a simple way to spray insecticides, primarly as an aid to malaria control, for the relief of troops in the southwest Pacific during World War II.

Pest Control. Many of the poisons developed by the Army in research to develop a capability for and a defense against chemical-biological-radiological warfare have found important byproduct applications for civilian use to control rodents and insect pests. Knowledge gained through such research has contributed to measures for control of various fungi, viruses and insects destructive to crops, ornamental shrubbery, trees and—more important—to protection of public health.

Medical Research. No other area of Army R&D effort affects the welfare of the multitudes as meaningfully, day in, day out, year after year, as the ceaseless search of the U.S. Army Medical Service Corps for new or improved ways of protecting the health of military forces.

In its concern for knowledge of how to cope with diseases in any part of the world where U.S. soldiers may be stationed, the Army has accounted for many hundreds of dramatic, life-saving innovations. Among the most notable contributions are treatment and control of yellow fever, typhoid fever, malaria, smallpox, dengue fever, plague and cholera.

The Brooke Army Medical Center at Fort Sam Houston, Tex., is known throughout the world for the results of research and development activities for the treatment of badly burned patients—an area of effort particularly important in national civilian disasters. Knowledge acquired by this institution has proved of vast benefit in the U.S. and many foreign nations.

Any civilian amputee has a better chance of learning to live a normal life again because of the truly pioneering R&D work of the U.S. Army Prosthetics Laboratory at the Forest Glen (Md.) annex of Walter Reed Army Institute of Research.

The Army's concern in prosthetics research was in developing artificial limbs to rehabilitate combat amputees, but the many devices that have resulted—including a new electrically controlled hand that provides precise control of finger movement—are equally useful for the civilian population.

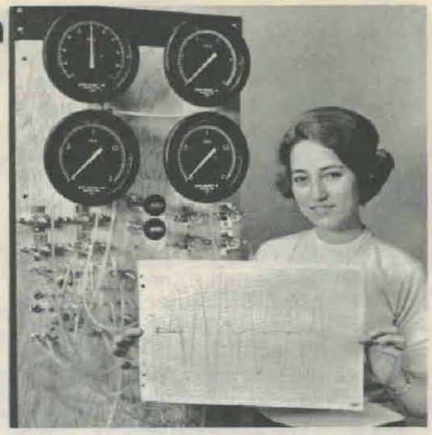
Development of equipment that will enable the U.S. Army to provide the best possible medical care under field conditions is the mission of the Army Medical Equipment Laboratory, Fort Totten, N.Y.

Some of this equipment serves equally well in coping with such major disasters as floods, hurricanes, tornadoes, earthquakes and fires or blasts that sweep or raze large areas.

The Army's recently developed jet injector, capable of immunizing 800 patients an hour, has found emergency use in several countries. A portable lightweight field X-ray machine and a field anesthesia machine are other recent products of Army R&D.

Germ warfare has deeply disturbing possibilities. In preparing to cope with this threat by learning how to take prompt and effective control measures, the Army has come up with new knowledge that is finding civilian peacetime applications. For example, Army scientists developed a single toxoid to protect humans against all five types of food poisoning under the general heading of botulism.

The U.S. Army also has contributed greatly to control of two of the most deadly cattle diseases. Dr. George C. Wright, an Army chemist at Fort Detrick, Md., earned the Exceptional Civilian Service Award for developing a vaccine against anthrax. Working with researchers of the U.S. Department of Agriculture and Canadian investigators, the U.S. Army helped to develop a vaccine against rinderpest.



HDL staff member Judy Lipnick displays graphic solution of differential equation solved by pneumatic analog computer (background) operating on fluid amplification control principles.

Mouth-to-mouth (oral) resuscitation is now the accepted standard method used by the American Red Cross and is widely used throughout the world. This method, combining the head-tilt technique, originated through U.S. Army studies of various methods.

Research with deadly diseases is risky business, imposing a requirement for stringent control and protective measures. Many basic contributions to the development and acceptance of safety cabinets as standard equipment in biological operations have resulted from work originally done at the U.S. Army Biological Laboratories (since redesignated) at Fort Detrick, Md.

Modular system cabinets developed by the Army for special operations, such as exposure and surveillance of experimental animals, and for large-scale microbiological plating and counting, are now commercially available through seven U.S. manufacturers.

Food preservation techniques, including better methods of packaging, have long been under intensive study by the U.S. Army, both through quick-freeze dehydration and through ionizing irradiation.

Dehydrated food developed by the U.S. Army Natick (Mass.) Laboratories, and now produced by industry, include salad items such as tuna, potatoes, salmon and chicken; also, fruits in cereals, meat balls and components of a Long-Range Patrol Ration now available to campers.

Several items preserved by ionizing irradiation at the Natick Laboratories have been approved by the U.S. Food and Drug Administration, and others are pending.

Proving useful to the Agency for International Development, the Food for Peace Organization and other civilian agencies concerned with economical development of

food resources, and with deficiency diseases in various under-developed countries of the world, is a series of Army publications titled, "The Ecology of Malnutrition." These reports cover wide-ranging U.S. Army studies of the world food problem.

Army Corps of Engineers R&D. Development of national resources for the public good has been a U.S. Army Corps of Engineers responsibility since the early days of American history.

The Corps is engaged in a civil works program currently funded at more than $1 billion annually, involving flood control, irrigation and hydroelectric power dams, developing and maintaining public waterways and harbors, measures to control beach erosion, bridge construction, and many other projects.

Efforts of the U.S. Army Corps of Engineers in research and development to improve the strength of concrete under various types of environmental stresses—linked to the need for military operations in any terrain or climate—have provided results of almost incalculable benefit to the civilian economy.

Army engineers did the trail-blazing in studies of use of atomic blasts for large-scale excavation projects. Currently the Army is assisting the U.S. Atomic Energy Commission in Project Plowshare, a study of the feasibility of using atomic blasts for construction such as might be involved in construction of a sea-level canal across the Isthmus of Panama or other major dams.

Pollution of the nation's navigable waters from industrial waste is an area of major concern to the Corps of Engineers. Current studies are dealing with measures for improved control of all types of pollution.

An area of international interest in which the U.S. Army Corps of Engineers must be recognized among the early large-scale investigators is in the development of plants capable of converting sea water to fresh water at feasibly economical cost. The role of the Corps was acclaimed by U.S. Secretary of the Interior Stewart Udall at the 1966 international conference on this problem in Washington, D.C.

The Corps also has worldwide responsibility for topographic and geodetic maps needed by Department of Defense agencies. Except for classified material, this worldwide library of information is available to U.S. industry and the public. The Corps also is charged with protection of wild life, management of timber resources, and aid in developing park and recreation areas.

MILITARY ORIENTED PROGRAM. Any extended discussion of the many results and the dollar value of Army research and development, insofar as impact upon the civilian economy is concerned, logically may be expected to raise a question or two regarding primary objectives of the R&D program.

From an Army viewpoint, the answer is clear. Army R&D efforts are, by basic intent, oriented to military requirements—immediate, short-range or as envisioned far in the future. Critics who say there is under Army sponsorship "no *pure research*"—that is, research rather vaguely directed to new knowledge—are striking accurately at a necessary fundamental management principle.

Basic to the Army R&D Program is a recognized responsibility to taxpayers to invest money as wisely as fully knowledgeable judgment permits—admittedly at times, however, on a carefully calculated gamble on a "big payoff" that would result from a needed breakthrough in technology.

Recognition that there is a critical need for greatly expanded knowledge in a specific scientific field, as it may be related to desirable advanced technology for weapons system development, explains the "occasionally adventurous investment." These high-risk enterprises may at times miss the target, but they also have produced many of the dramatically significant breakthroughs of vast impact.

Because of the diversity of military requirements, Army R&D must be concerned with investigations into all the major scientific disciplines and most of the subfields. The program is both broad and deep, conducted at Army in-house laboratories and through industrial and academic institutions under contracts and grants.

Results maintain military supremacy; they also produce byproduct benefits, only a few of which have been mentioned in this article, that are tremendously important to health, welfare and economy of the nation.

WRGH Buys $100,000 Cancer Unit

Installation of a $100,000 "fail-safe" teletherapy unit in the Radiation Therapy Section of Walter Reed General Hospital, Washington, D.C., has increased the number of cancer patients that can be treated daily by 20 percent. The Theratron 80, a type of Cobalt 60 machine, is considered the most advanced of its kind for the treatment of cancer.

R&D Officials Discuss U.S. Army CRREL Expansion

REPRESENTATIVES of the Office, Chief of R&D (OCRD), and the U.S. Army Materiel Command's Office of the Deputy for Research and Laboratories (DORL), scan photo mosaic during recent staff visit to the U.S. Army Cold Regions Research and Engineering Laboratory (USA CRREL), Hanover, N.H. Taking part in discussions of CRREL capabilities and plans to expand in cold regions research of concern to the Army are (from left) W. K. Boyd, chief engineer, CRREL; Lt Col Daniel J. Walsh, research planning officer, OCRD; Lt Col Robert H. Hurst, chief, Research Plans Office, OCRD; Dr. Geoffrey Ballard, DORL; Dr. Leonard Wilson, chief, Environmental Sciences Division, OCRD; Dr. Andrew Assur, chief scientist, CRREL; Dr. Robert E. Frost, chief, Photographic Interpretation Research Division, CRREL; and (partially out of view) W. R. Floyd, chief, Liaison and Technical Publications Branch, CRREL. Also visiting USA CRREL for assistance in solution of scientific and engineering problems related to U.S. Air Force cold regions responsibilities was Col Bernt Balchen, USAF, Ret. (pictured at right). Col Balchen's career includes the distinction of being the first pilot to fly over the South Pole while serving as chief pilot for Admiral Richard E. Byrd on his Antarctic expedition (1928-30), and of taking part in numerous rescue operations in Arctic in World War II.

Panel Reviews Vehicle Research to Alleviate Air Pollution

State-of-the-art technological capability for development of electrically powered vehicles and modification of internal combustion engines to alleviate air pollution is being reviewed by the Department of Commerce.

A 16-member Panel on Electrically Powered Vehicles is surveying government and industrial research and development programs to determine feasibility of producing propulsion systems to minimize exhaust products which contribute to the rapidly increasing U.S. problem of air pollution.

An initial meeting was held Feb. 17-18 at the Department of Commerce. Representatives of government and major industrial firms presented their programs to the panel of high-level scientists, educational leaders and industrialists.

Dr. Richard S. Morse, formerly the first Assistant Secretary of the Army (R&D) after serving as Director of Army Research and Development, is a panel member. Dr. Morse is now with the Alfred P. Sloan School of Management of the Massachusetts Institute of Technology. Other members:

Dr. Edwin A. Gee, E. I. DuPont de Nemours & Co.; Dr. Manfred Altman, University of Pennsylvania; Dr. Edward Blum, Woodrow Wilson School of Public and International Affairs, Princeton University; Dr. Rolf Eliassen, Stanford University; and Dr. James W. Ford, Ford Motor Co.; Dr. Everett Gorin, Consolidation Coal Co., Library, Pa.; Dr. Carl E. Heath, ESSO Research and Engineering Co., Government Research Laboratory, Camden, N.J.; Dr. Seymour W. Herwald, Westinghouse Electric Corp.; and

Dr. Edward O. Johnson, RCA Laboratories; Dr. Peter Kryopoulos, General Motors Technical Center; Mr. Alan C. Loofbourrow, Chrysler Corp.; Dr. Robert C. Shair, Gulton Industries, Metuchen, N.J.; Dr. Philip Sporn, American Electric Power Co.; Dr. Charles W. Tobias, University of California; and Dr. Myron Tribus, Dartmouth College.

Terence G. Kirkland, chief of the Power Technology Laboratory, U.S. Army Engineer Research and Development Laboratories (USAERDL), Fort Belvoir, Va., made the Department of Defense presentation to the panel.

Army representatives present included Dr. Sidney J. Magram, Office of the Chief of Research and Development; Ralph Hopkins, USAERDL; Marshall Aiken, U.S. Army Materiel Command; and Wayne Anderson, U.S. Army Tank-Automotive Command, Warren, Mich.

The Department of Commerce gave a

ECOM Testing Portable Hydrocarbon Fuel Cell

Successful operation of a 500-watt portable fuel cell, believed the first in the U.S. to use a standard hydrocarbon fuel, was announced recently by the U.S. Army Electronics Command (ECOM), Fort Monmouth, N.J.

Exploratory tests of the 83-pound model power plant have produced electricity "up to five or six times" more efficiently than a conventional engine-driven generator of comparable capacity.

Designed primarily for forward-area radars, radios and other electronic combat equipment, the new unit has the inherent silent-power characteristic of earlier fuel-cell systems.

The compact reactor reforms a kerosene-type fuel, such as the hydrocarbon used in jet-engine testing, into carbon dioxide and pure hydrogen. The hydrogen is fed with oxygen from the air into a fuel-cell assembly to produce a steady output of 500 watts for nearly six hours. It can be refueled without stopping.

FUEL CELL POWER PLANT produces electricity five or six times more efficiently than an engine-driven generator. The reactor, left, converts a kerosene-type fuel into carbon dioxide and pure hydrogen. The hydrogen is fed into the fuel assembly along with air to produce a steady 500 watts. Project engineer Stephen Bartosh sets controls.

Engineers report the fuel-cell power plant has a 30 percent energy conversion efficiency. Conventional gasoline engine-driven generators widely used in the field have 5 to 10 percent efficiency.

In tests conducted by ECOM, the unit has produced from 50 to 350 watts over a range of 33 to 28.9 volts for 450 hours at temperatures of 60 to 80 degrees Fahrenheit in relative humidity up to 100 percent.

The fuel cell project is being conducted by the ECOM Electronic Components Laboratory. Developmental work has been done under contract with Pratt and Whitney Division of United Aircraft Corp.

A 12-pound exploratory fuel cell which uses liquid hydrazine (a nitrogen-hydrogen compound) and oxygen from the air was produced for ECOM last year by Monsanto Chemical Corp. It produces up to 60 watts.

The 500-watt system has a fuel-cell assembly with a dry weight of 41 pounds and a hydrogen reactor weighing 42 pounds. The two cases measure slightly more than 2½ cubic feet. Fuel, priced about the same as gasoline, is fed into the reactor at a rate of one part to 3½ parts of water. The 7.2-pound combination produces sufficient hydrogen to generate the peak flow of electricity for six hours.

A small quantity of fuel is used to start the reactor. Heat for the self-sustaining process is provided by burning some of the hydrogen and waste gases produced during the conversion. The main flow of hydrogen feeds through a flexible line to the fuel-cell assembly for conversion into electric power.

ECOM plans to evaluate the hydrocarbon fuel cell with electronic field equipment during the next year. Additional exploratory models incorporating wider fuel capabilities also will be tested.

Since large-scale military and industrial developmental effort began some 10 years ago, fuel cells have rated high as a potential forward-area power source because of silent generation of electricity, few moving parts and capability of operation without attention except for refueling.

Army Chief Scientist Lasser Slates Report on Lasers

Army Chief Scientist Dr. Marvin E. Lasser will deliver an invited paper for the Army at the Third Classified Department of Defense Conference on Laser Technology, Apr. 18-20, at the U.S. Naval Air Station, Pensacola, Fla.

Dr. Lasser will discuss "The Status and the Future of the Army Laser Program."

Some 500 representatives of the military services, government laboratories, universities and industry are expected to attend to participate in the exchange of information. About 45 papers will be delivered on the state-of-the-art of various types of laser systems and equipments—solid and gas lasers, reconnaissance systems, optical surveillance radars, laser rangefinder systems, target designator, terminal guidance and other applications to military problems.

Sponsored by the Army, Navy, Air Force and the DoD Advanced Research Projects Agency (ARPA), the conference is being arranged by the Boston (Mass.) Branch of the Office of Naval Research (ONR). Thomas B. Dowd of ONR is executive secretary. The last DoD laser meeting was held in April 1965 in Chicago, Ill.

Program chairman Dr. C. Martin Stickley, U.S. Air Force Cambridge Research Laboratories, Mass., is being assisted at Military Department level by Dr. Robert B. Watson, U.S. Army Research Office, Office of the Chief of Research and Development; Dr. Francis T. Byrne of ONR; and Maj John M. MacCallum Jr., HQ U.S. Air Force.

briefing on its activities and interests in development of electrically powered vehicles and modified internal combustion engines. Briefings were given also by the National Aeronautics and Space Administration, Post Office Department, Bureau of Public Roads, Department of Housing and Urban Development, Institute for Defense Analyses, Massachusetts Institute of Technology, Ford Motor Co., ESSO Research Corp., Chrysler Motors Corp., General Motors Corp., and General Atomics.

Two bills directly related to the Department of Commerce panel review have been introduced to the 90th Congress. The S.451 (Muskie, Gruening, Magnuson) amendment to the Clean Air Act proposes an "investigation and study to determine means of propelling vehicles so as not to contribute to air pollution." The bill was referred to the Committee on Public Works.

The S.453 (Magnuson and Muskie) Bill, referred to the Committee on Commerce, proposes authorization of "a program of research, development, and demonstration projects for electrically powered vehicles."

U.S. Transportation Secretary Allan S. Boyd commented on the proposed legislation at the Senate hearing, saying that "research on electric vehicles is first and foremost a responsibility of private industry."

In discouraging favorable action on the two bills, under which the government could spend $15.5 million on R&D, he said he planned to initiate a series of comprehensive system studies to evaluate the long-term impacts of alternative vehicle systems upon the nation's transportation system.

The Department of Commerce panel studying problems of air pollution control as related to vehicles and other gasoline or diesel fuel power systems for industrial use was established late in 1966. Based on findings, it will recommend R&D roles for government and industry in development of electrically powered vehicles and improved internal combustion engines.

The U.S. Army has long had a continuing interest in electric propulsion of certain types of vehicles and in fuel-cell or gasoline-turbine generation of electricity for a number of reasons. Primarily, the reasons are related to logistical and field army operational problems, mainly in remote areas.

Electric power supplied by lightweight long-life batteries and new fuel cells being developed offer the advantages of efficient prime energy conversion, silent operation and elimination of waste materials easily detectable by the enemy.

Army engineers investigating the problem point out also that electric-power drive systems provide better control than is currently possible with other types of drive systems. The Army has a growing requirement for substantial amounts of on-board (mounted on vehicles) electric power for weapons, communications and surveillance systems.

Much of the Department of Defense R&D effort in electrical propulsion of military vehicles has been conducted by the Army. Work is centered at the U.S. Army Tank-Automotive Command, Warren, Mich., and the U.S. Army Engineer R&D Laboratories, Fort Belvoir, Va.

In presenting significant accomplishments resulting from the Department of Defense program to the Panel, Kirkland described present and planned programs in the three major functions of an electrical propulsion system—the power plant, the power-conditioning equipment, and the drive units.

Potential applications of both rotating and unconventional electrical-power sources were outlined. These include compression-ignition and spark-ignition engine generators, hybrid-engine generators, turbine generators, Stirling and Rankine cycle generators, fuel cells, batteries, and hybrid power plants consisting of combinations of the individual sources.

Major Army effort is directed to fuel-cell development. Kirkland pointed out, however, that fuel cells present problem areas that will require a costly and long-term development program.

Among the fuel-cell systems he discussed are those employing hydrogen, hydrazine, ammonia alcohol and hydrocarbon fuels. The problems become more difficult as the ease of hydrogen release decreases—pure hydrogen systems being the least complex and most advanced in development and the liquid hydrocarbon systems being the most complex and least advanced.

In discussing R&D progress of the Defense Department in "power conditioning" within the past few years, Kirkland described this effort as the total of operations performed to modify and control output from the plant to the input of the electric-drive motors.

Recent advances have provided for a more detailed understanding of the functions and circuit behavior in the power-conditioning area and have greatly increased the power level, he said. Continued effort is aimed at improvements in rectifier control and operational cost reductions.

Both wheeled and tracked test-bed vehicles are being used to establish component and system design procedures and processes to meet required performance parameters of electric propulsion systems.

One of the most advanced of these test-beds—the M-37, ¾-ton Mark I fuel-cell truck—was displayed Mar. 13 at the U.S. Capitol in connection with the hearings conducted by Senate Commerce and Public Works committees. The M-37 cell operates on hydrazine-hydrate fuel and air, and serves as the prime propulsion power for an electric-drive system. As the first of its kind, it is indicative of the systems that are ultimately envisioned with fuel cells.

The Department of Defense plans to continue present programs and expand other efforts in such areas as mathematical modeling and computer simulation, Kirkland said. Planned are vehicular concept design studies, feasibility studies of acyclic devices, and an advanced concept of a fuel-cell research vehicle.

Microminiaturization of electronic components, further improvements in power plant performance, and reduction of bulk and weight in the power plant, conditioning equipment and drive units are among program objectives.

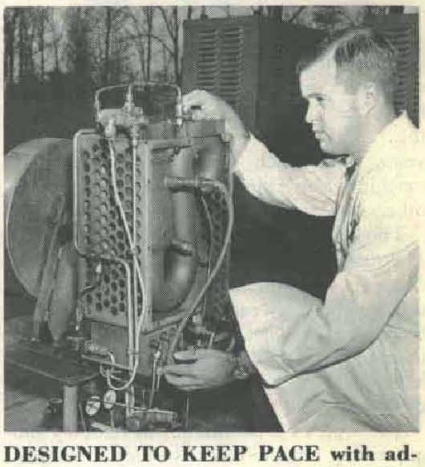
R&D on novel power sources will continue and be integrated into the vehicle-propulsion programs if and when practicable. The Defense Department also is evaluating the feasibility of electric power for a self-propelled howitzer and for an amphibian, as well as planning for electric drives on materials-handling equipment and for a missile carrier.

DSA (I&L) Port Is Speaker

Deputy Assistant Secretary of the Army (Installations and Logistics) A. Tyler Port spoke on "Procurement Under Emergency Conditions," as featured speaker at an Apr. 6 meeting at Edgewood (Md.) Arsenal.

The Chemical Section of the Chemical-Biological-Nuclear Division of the American Ordnance Association sponsored the scientific session.

ERDL Testing Turbine Starter



DESIGNED TO KEEP PACE with advances that have decreased weight but increased starting power requirements of gas-turbine power plants, the pulse-jet starter (shown above) for a 300-hp. gas turbine is being tested at the U.S. Army Engineer R&D Laboratories (USAERDL), Fort Belvoir, Va. The unit weighs 60 percent less than the electric starter and batteries now used. Unlike electric or hydraulic systems, its available power increases with decreasing temperature. It will operate at -65°F, without the use of heat or other starting aids. The experimental starting system burns all gas turbine fuels including gasoline, JP and diesel. Developed by Rocketdyne Division, North American Aviation, Inc., the system is being studied at USAERDL with a view of making it lighter, smaller, quieter.

Army CDC Maintenance Agency Accents New Ideas

Far-out thinking is the vogue rather than the exception these days, as manifested constantly in the fantastic fabrications for TV, radio and general advertising, but ventures deep into the "wild blue yonder" of ideas are almost routine in the U.S. Army Combat Developments Command.

Take, for example, some of the work of the USACDC Maintenance Agency. Imagine a soldier on a hilly outpost in "Fantasmagoria" needing a new component for his computerized battlefield scanner. The stage is set. What does he do?

Would you believe that he conjures up a "telepathic requisition" and that, in minutes, the supply section of his direct support maintenance agency has the required part on the way by supply rocket?

Fantastic? Perhaps for the present—but 10, 15, 20 years from now? Not for those who are taking the imaginatively creative approach to problems at the USACDC Maintenance Agency at Aberdeen Proving Grounds, Md.!

New ideas at the Maintenance Agency are a basic stock in trade. No matter how fanciful the ideas may seem, they cannot be lightly disregarded or discarded. The watchword is not new; in fact it's aeons old —"The fantasies of today may prove the realities of the future."

Try to laugh that off and you may be gently reminded that Leonardo da Vinci, for example, conceived many ideas for military hardware that were viewed as fantastic at the time but proved workable almost 500 years later—such concepts as the flying machine, a machine gun, a tank, and many others.

Those who read the go-go gospel at the Maintenance Agency will tell you, with the candor of complete conviction, that "the the time lag between ideas and reality must be compressed." That is scarcely a new theme in Army R&D; in fact, it's downright hackneyed—but, nevertheless, nothing to be downgraded by Agency personnel.

The Agency is continually developing and improving maintenance service organizations and doctrine for future time periods. Its aim: Provide and continually update full, efficient, effective, and economical maintenance support for materiel of combat and supporting units of the Army.

This is a process of continuous evolution and refinement in response to changes in the composition, operating procedures, and equipment of Army forces. In addition the Agency, through its maintenance engineers, keeps track of equipment in its design and development stages, to improve reliability and reduce maintenance requirements.

While the "crystal ball" is a symbolic and necessary "tool of the trade," the Maintenance Agency does not spend all its time peering into possible products a decade or more ahead.

"Future" organizations, doctrine, and equipment must be built on the realities of the present. Current problems must be solved; lessons must be learned for experiences of the past. Thus, Agency personnel talk.

Looking to the 1980s and beyond, they still stay deeply engrossed in analyzing present-day maintenance organizations, problems and equipment—current and projected requirements for Army materiel, maintenance support, trends in technology and scientific breakthroughs that may permit revolutionary, beneficial improvements.

Ideas, the principal products of the Agency, are translated into studies, tables of organization and equipment, field manuals, and documents indicating the need for development of new types of materiel and service procedures. Hopefully, the Agency is looking to an era when vehicles will be practically maintenance-free and powered by fuel cells or solar energy; when computers will be used to diagnose all equipment malfunctions; and when air-cushion vehicles will be practical and commonplace.

The business vocabulary of the Agency includes such terms as "Army-90," "Maintenance-85," and "Maintenance-75." These titles identify projects for specified time periods in the future such as 1990-1985-1975. To this lexicon are added such terms as "multi-purpose test and diagnostic equipment," "computerized maintenance management," "automatic checkout" and "aerial movement of maintenance teams."

All of these terms are indicative of the Agency's persistent and continuing efforts to evaluate, reevaluate and keep improving the Army's equipment and the maintenance services by which this equipment is kept in a state of combat readiness.

With accuracy, it might be said that the Agency is an organization that concerns itself with the realities of today and prospects for the future to determine what Army equipment, maintenance requirements, and maintenance service procedures will be like next year and 20 years from now.

Again you are reminded that the USACDC Maintenance Agency deals in ideas—ideas that may seem far-fetched now, like a tank that requires no maintenance, but ideas that may be entirely practical 10 to 20 years from now.

SecDef Orders Inactivation Of Army Davy Crockett Units

Inactivation of Davy Crockett units from U.S. Army nuclear-capable 155mm howitzer units has been directed by the Secretary of Defense, effective June 30. Only those Davy Crockett units required to support airborne or airmobile divisions, or units that do not have organic 155 mm howitzer units, will be retained.

Due to improvements and refinements which have increased the effectiveness of the nuclear round for the 155 mm howitzer, it can meet Army requirements for a light, mobile rapid-response weapon capable of delivering low-yield nuclear firepower close-in to friendly troops.

The 155 mm howitzer, with its greater range, has less vulnerability to enemy counterfire and greater tactical capability than the Davy Crockett. Flexibility is improved because it can provide either conventional or nuclear firepower.

ASAP Names 3 Senior Consultants

Dr. William Shockley, Dr. Harold C. Weber and Dr. William Martin were designated recently as senior consultants to the Army Scientific Advisory Panel. Other ASAP members who have achieved the status of senior consultants are Dr. Charles C. Lauritsen and Dean Morrough P. O'Brien.

BRL Expects Computer 200 Times Faster Than Ordvac I

ORDVAC II, a solid-state digital computer designed to be 200 times faster than the ORDVAC I it will replace at the U.S. Army Ballistic Research Laboratories, Aberdeen (Md.) Proving Ground, is expected to become operational in November. ORDVAC I has been in service since 1952.

Used in conjunction with BRLESC (Ballistic Research Laboratories Electronic Scientific Computer), ORDVAC II will provide more economical and efficient operation and far greater workload capabilities for solving scientific problems of the labs.

The new integrated-circuit computer will employ 68 binary bits per word and four parity bits. Operation time for addition will vary between 100 and 400 nanoseconds; average time for multiplication will be six microseconds.

ORDVAC II will provide more memory and decision-making cells and other components in less space than ORDVAC I. Together, the new computer and BRLESC will use a 96,000-word memory with many variations. Each computer will have a maximal capacity of 96,000 words.

While the obsolescent ORDVAC I is limited to 80-column cards for both input and output, its successor will be capable of handling both cards and up to 16 tape units. The ORDVAC II card reader will process 1,500 cards per minute, and the printer 1,000 lines per minute.

ORDVAC II will handle numbers as large as 16×16^{126} and as small as 16×16^{-127} which is approximately 16 times larger than the number-handling capability of ORDVAC I.

The primary machine language will continue to be FORAST (Formula and Assembly Translator), developed at USABRL and particularly efficient in the coding of scientific problems.

The integrated circuits for ORDVAC II have been produced under contract. Logic design, back-panel wiring and assembly of the computer is being completed at BRL.

4015th R&D Unit Sets Example in Science Fair Support

Something for other U.S. Army Reserve Research and Development Units to try to surpass in the way of excellence, with respect to active support of the Army junior science program, has been presented by the 4015th USAR R&D Unit at Austin, Tex.

Chief of Research and Development Lt Gen Austin W. Betts was favorably impressed by a handsome brochure prepared by the 4015th Unit and submitted through Lt Col Loren R. Lester, OCRD Assistant for Reserve Affairs.

The brochure showed how members of the 4015th participated in support of the 11th Annual Mathematics Science Fair, Mar. 1-3, at Sidney Lanier High School in Austin, serving as judges and providing assistance in various other ways.

Under a policy initiated by the Chief of Research and Development in 1963, USAR R&D Units throughout the United States have been encouraged to help promote and assist local and regional high school science fairs as part of the Army's support of the annual International Science Fair (ISF).

Under this program, members of about 70 USAR R&D Units are encouraged to provide career guidance counseling, serve as judges, help promote local and regional high school science fairs and provide other assistance as requested by the fair officials.

Certificates of Achievement in recognition of outstanding science exhibits are presented to students selected by the USAR R&D Unit judges. The certificates are signed by the Chief of Research and Development and by Edward G. Sherburne Jr., director of Science Service, a nonprofit organization of scientific leaders who promote the International Science Fair.

In the 11th Annual Mathematics Science Fair, the 4015th Unit judges selected Brian Lebowitz and Dominique Emerson for top honors, with Joan Gardner as alternate. The two winners were rewarded with a trip by military aircraft to visit HQ of the U.S. Army Air Defense Command, Colorado Springs, Colo. Arrangements for the visit were made by the members of the 4015th.

Brian's award winning exhibit was titled "An Arbitrary Geometric System." He hopes to begin his work toward an advanced degree at Princeton University with a major

Brian Lebowitz

USAR 4015th R&D Unit judges view "A Bioelectrogenic System" exhibit at 11th Annual Mathematics Science Fair, Austin, Tex. From the left are Maj Herbert F. Schwartz, Capt Thomas E. Wiley Jr., Capt Bill M. Clayton, Lt Col W. E. Barron, 1st Lt L. F. Gusman Jr., Lt Col Earnest F. Gloyna and Lt Col Kinch C. Knolle.

Dominique Emerson

in mathematics.

Dominique was recognized for an exhibit on "Mechanical Inversion." Interested in metallurgy and aeronautical engineering, she is applying for entry to Massachusetts Institute of Technology to pursue her goal of a PhD degree in engineering. She plans to enter the mathematics and engineering categories of the Science Fair in her senior year.

Army Certificates of Achievement were presented to each of seven participants in botany, zoology, medicine, chemistry, environmental science, physics, and mathematics areas of research.

Judges of the 11th Annual Austin Area Math-Science Fair included chairman, Maj Herbert F. Schwartz, assistant professor of pharmaceutical chemistry, University of Texas (UT); Lt Col Bill E. Barron, professor of education, UT; Lt Col Kinch C. Knolle, serologist, Texas State Health Department; Lt Col Earnest Gloyna, professor of civil engineering, UT.

Also, Lt A. Gordon Everett, UT graduate student; Capt Bill M. Clayton, UT graduate student; Lt B. K. Cooper, electronics engineer, Kaman Instruments; Lt Larry F. Guseman, research mathematician, NASA/MSC; Capt Tom E. Wiley, real estate broker; and Lt Col Tom H. Taylor, division director, Texas Highway Department.

Comprised of Reservists with academic training or experience in research and development, the 4015th R&D Unit is commanded by Col Roger Q. Spencer. "The International Science Fair," he said "has been very effective in stimulating the interest of young people in the field of science and technology."

Army, Interior Award Contract For Seawater Distillery Design

Under a jointly financed contract, the Army and the Department of the Interior are cooperating in development of a mobile seawater distillation unit with a 3,000-gallon an hour capacity.

The unit will incorporate a new scale-prevention technique, to permit extended operation without shutdown for de-scaling, developed by the U.S. Army Engineer R&D Laboratories (USAERDL) at Fort Belvoir, Va. It will be available for emergency civilian use as well as military applications.

Now in the design phase, the new trailer-mounted unit will produce at least 3,000 gallons of safe drinking water per hour from all types of salt or brackish water sources, or from fresh water contaminated with chemical, biological and radiological substances.

USAERDL and the Department of Interior's Office of Saline Water have awarded a $60,000 contract to AiResearch Manufacturing Division of the Garrett Corp. for a 6-month design study.

The contract calls for plans for a unit mounted on a semitrailer not more than 40 feet long and 8 feet wide. Maximum use must be made of standard military components, and weight will not exceed 40,000 pounds.

Services Studying Canadian V/STOL

Canada's CL-84 twin-engined, tilt-wing, utility vertical and short takeoff and landing (V/STOL) aircraft will soon be evaluated in Montreal by a U.S. tri-Service team of pilots and engineers.

The purpose of this evaluation is to determine the potential of the aircraft in a number of utility roles among the Services.

Since the first prototype was completed in December 1964, the aircraft has progressed into the flight test phase and successfully demonstrated all phases of flight including vertical, conventional and transition from one phase to another. "Multi-mission possibilities" include air rescue, utility and troop transport, armed helicopter escort, surveillance-reconnaissance and air evacuation.

Being developed under a joint Canadair (a division of the U.S. firm of General Dynamics) and Canadian government program, the CL-84 tilt-wing is one of a number of VTOL concepts under examination by the Services.

Heading the evaluation team is Lt Col Lavern R. Riesterer, chief of Flight Research at the U.S. Army Aviation Materiel Laboratories (AVLABS), Fort Eustis, Va.

Lt Cmdr William Davies, U.S. Navy; Maj Gay Jones, U.S. Air Force; and Maj Robert Chubboy, U.S. Army, of the Tri-Service V/STOL Test Team, Edwards Air Force Base, Calif., will fly the CL-84 during the evaluation. Other members of the team are AVLABS project engineer, Richard Adams, and AVLABS experimental test pilot, Maj Thomas C. West.

For vertical takeoff, the CL-84's stubby wing with engines and propellers is tilted into a vertical position by a hydraulic screw. The thrust of the twin propellers lifts the aircraft vertically with longitudinal pitch control provided by an interconnected tail propeller.

Once aloft, the wing is rotated to the zero degree position for forward flight. In cruising flight, the CL-84 looks much the same as a conventional aircraft except for the V/STOL characteristics of short wing span, oversized propellers and stowed tail rotor.

Reportedly, the CL-84 can cruise at speeds up to 350 m.p.h., "far in excess of a helicopter with equal engine power." Two 1,400 hp. Lycoming turboshaft engines provide the power for the 14-foot fiber-glass propeller blades.

For short takeoff, the CL-84 wing is tilted to about 45 degrees. This enables the aircraft to clear a 50-foot obstacle with a takeoff run of "less than 200 feet" by combining the lift components of propeller thrust and flap-deflected slipstream. In the STOL configuration, the aircraft can carry approximately 75 percent more payload than in vertical takeoff.

Dean Everill Appointed To AWC Advisory Group

The U.S. Army Weapons Advisory Group met recently at HQ Army Weapons Command, Rock Island, Ill., with Dr. William L. Everitt, dean of engineering at the University of Illinois, attending for the first time as a new member.

The 9-man group meets at the call of Brig Gen William J. Durrenberger, Army Weapons Command CG, to advise him on policies that may achieve a more effective research and engineering program.

Chairman of the Weapons Advisory Group is Martin Goland, president of the Southwest Research Institute. Other members are Dr. (Maj Gen, USA, Ret.) Chester W. Clark, vice president for research at the Research Triangle Institute, Durham, N.C.; James A. Reid, manager of research for the Phillips Petroleum Co.; James C. Zeder, retired vice president and director of Chrysler Corp.;

Dr. Arthur A. Burr, dean, School of Engineering at Rennselaer Polytechnic Institute; Errol J. Gay, a technical consultant, Detroit, Mich.; Dr. Maurice J. Zucrow, emeritus professor of mechanical engineering at Purdue University; and Dr. George A. Hawkins, dean of engineering at Purdue University.

HumRRO Tapes Course in Basic Vietnamese

(Vietnamese music for 15 or 20 seconds, gradually fading out and voice coming in.)

"You are about to embark on a language course very unlike any you may have taken before. . . ."

So begins the taped introduction to a short programed course in practical Vietnamese, designed and tested by the Human Resources Research Office (HumRRO) of George Washington University, Washington, D.C.

Sixty-three 5-inch reels of magnetic tape and three printed speaking tests comprise the course, requiring only a tape recorder and power source for utilization.

As an experiment in developing a self-instructional method in Vietnamese relevant to job requirements, the course was designed particularly for U.S. Military Assistance Training Advisers (MATA).

In consideration of the five functions of the U.S. adviser in Vietnam—rapport establishment, advising, assisting, interpreter control and survival—the course was limited to understanding and speaking skills, at a basic proficiency level, and job relevant content.

HumRRO's technical report on the project noted that "successful relationships between the adviser and indigenous Vietnamese personnel . . . depend largely on the amount of *rapport* that can be generated between the American and the Vietnamese in face-to-face contacts. . . . Demonstrated willingness to speak their language, however imperfectly, may be expected to contribute to such rapport."

Selected from Vietnamese phrases considered critical by U.S. returnees from Vietnam, the course content is concentrated on queries, social amenities, advisory terms and imperatives.

Nineteen MATA officers served as students in the MALT (Military Assistance Language Training) program in lieu of receiving MATA classroom instruction. With students proceeding at their own rate, time required for completion ranged from 45 to 150 hours.

Proficiency of students completing the programed course was comparable with that of their control counterparts receiving classroom instruction. Mean comprehension and speaking test scores for MALT students were, respectively, 90 percent and 73 percent of the maximum possible scores. Preparation for subsequent training in Vietnamese was as good as that of the control group. Attitude toward the course was generally favorable.

With the exception of tests and instructions, training consisted of audiolingual practice. Students read Vietnamese sentences or translations into the tape recorder and listened for confirmation. No printed textbook was used. Use of tapes provided for accurate perception of the rises and falls of pitch which indicate differences in meanings in Vietnamese, a tonal language.

Additional information on the construction and evaluation of the course may be obtained from the Research Information Coordinator, Human Resources Research Office, 300 North Washington Street, Alexandria, Va. 22314.

Vela IV Launch to Add 2 'Eyes in Sky'

Launch IV of the nuclear-test-detecting Vela satellite research program, conducted by the Department of Defense Advanced Research Projects Agency (ARPA), is expected to put two more electronic packages into orbit Apr. 19.

Project Vela is the ARPA code word for the overall program of detecting nuclear blasts above or beneath the earth's surface.

The "eyes in the sky" are scheduled to be thrust into a 60,000 nautical mile circular orbit by a Titan III rocket from a Cape Kennedy pad to join the half-dozen orbiting Vela experimental satellites. They include the original pair launched Oct. 16, 1963—the oldest continuously operating U.S. spacecraft still providing useful data.

Vela launches II and III, each with a pair of solar-powered 20-sided supersensitive satellites, were made in July 1964 and July 1965. Launch V is scheduled some time during 1968.

Launch IV Vela satellites are slightly larger than the 4-foot diameter of their predecessors and have 26 sides. Optical and electromagnetic pulse instruments, as well as other components, are more advanced. They will determine the capability for detecting nuclear explosions down to the earth's surface as well as in outer space and high in the earth's atmosphere.

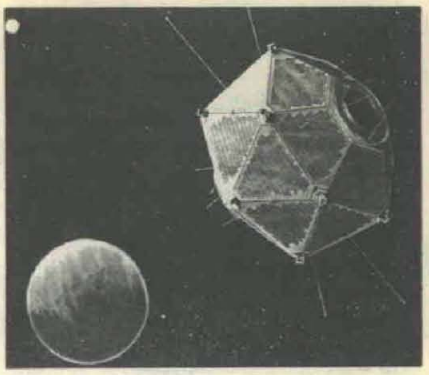
Research and development of Vela satellite instrumentation is done by the Los Alamos (N.Mex.) Scientific Laboratory of the University of California and Sandia, Albuquerque, N. Mex., under contract with the U.S. Atomic Energy Commission. The Space Systems Division of the U.S. Air Force Systems Command is responsible for developing and launching satellites for ARPA.

Highly sensitive instrumentation was included in Vela satellites 5 and 6 of Launch III. It included radiation detectors for space tests plus the first experimental optical and electromagnetic pulse detectors. These were to determine the possibilities of detecting nuclear tests near the earth.

The presently orbiting instrument packages represent the most sophisticated of the ARPA research and development programs for nuclear detection.

Project Vela evolved partly from the Geneva Nuclear Test Ban negotiations between the United States, the Soviet Union and Great Britain, when it was decided that the U.S. should have a means of monitoring nuclear explosions throughout the globe. Launch I of the Vela satellite program occurred some three months after the Test Ban Treaty was signed in 1963.

The satellite coverage of the earth is obtained by putting two vehicles in orbit at the same time 180 degrees apart. The six units "at work" since October 1963 have transmitted more than 400 billion bits of data to tracking stations.



VELA satellite (artist's concept) orbiting Earth at 60,000 nautical miles.

USAEPG Consolidating Tests in New Chambers

Installation of some $250,000 worth of environmental testing equipment is expected to begin in July at the U.S. Army Electronics Proving Ground (USAEPG), Fort Huachuca, Ariz.

Fourteen stages of environmental, vibration and shock-testing of Army materiel will be possible in December, when the new Environmental Test Facility is scheduled for completion. Presently equipment must be shipped elsewhere for the phases of environmental testing. The new facility is expected to pay for itself in travel and shipping cost savings.

The 4-foot chambers will be equipped to subject electronics gear to a wide range of heat and cold, salt fog, fungus and conditions of varying humidity, as well as shock and vibration.

Two small environmental test chambers, used for calibrating meteorological instruments by the Electronic Command's Meteorological Support Activity at Fort Huachuca, are the only other such chambers at the post.

The Instrumentation and Range Development office of USAEPG designed the Facility and estimates that the chambers will accommodate approximately 85 percent of the equipment slated for testing.

HumRRO Adds 2 Training Studies to FY 67 Workload

Studies of methods of adjusting Army training to individual differences and developing an instructional program in training technology are projects added recently to the FY 1967 work program of the Human Resources Research Office (HumRRO), George Washington University.

As an Army contract agency, HumRRO is seeking ways to select and organize training and to improve training methods to achieve more effective learning at all aptitude levels. Special emphasis is being given to the problems of the slower learners.

Sponsored by the Office of the Chief of Research and Development, the first project is being performed by HumRRO Division No. 3. The second project is sponsored by the Office of the Deputy Chief of Staff for Personnel, Department of the Army, and the U.S. Continental Army Command.

The present Army training system determines aptitude largely in terms of establishing prerequisites for courses or of providing remedial training. Studies show that intelligence differences "sometimes interact with learning procedures."

HumRRO researchers will conduct small-scale studies on training and media to determine the feasibility of modifying instruction according to the individual characteristics of the learner. They will study first the combat and support fields where training requirements are concentrated—especially where low-aptitude soldiers are assigned.

Researchers will work with the concept of "time-to-criterion" (TTC), or the score one achieves in a fixed period of time as opposed to how long it takes to attain a fixed score. Sufficient time is alloted in present practice to pass all but the very slowest. This "locks" the faster student to the slower rate, and sometimes to a less efficient instructional method.

Representative learning tasks will be examined for differences in TTC for different levels of aptitude, relations between TTC in one learning task and another, predictability of TTC and extent to which it can be used to predict achievement in military occupation specialty instructional units.

While the laboratory work is being performed, studies will be conducted in the Army Training Centers to gain experience in operation contexts.

HumRRO's second new project is the development of an instructional program on training technology and training management, with particular attention to advances and new concepts.

The hundreds of Army training programs, with their frequent demands for new courses or the updating of existing ones, need as many career people as possible trained in the techniques of training. If a course in this field existed, it could be made available through several Army programs.

In response to a request from the U.S. Army Armor School, HumRRO's Division No. 2 will design a course in curriculum engineering that provides the student with practical exercises in the determination of job duties, development of achievement tests, and construction of a training program.

Students will practice procurement and management of training resources and the evaluation of training operations. They will also be taught new concepts in the field.

After three trial runs at the Armor School, the course will be submitted to the Department of the Army during the first half of FY 1969 for Army-wide adoption.

CWAS Encourages High-Risk Contracts

A rating system designed to encourage defense contractors to accept high-risk contracts and motivate prudent management decisions was adopted recently by the Department of Defense.

Titled "Contractor Weighted Average Share," the CWAS system was designed by an Armed Services Procurement Regulation subcommittee chaired by Lloyd Mitchell, a contract price analyst in the Directorate of Procurement and Production, U.S. Army Materiel Command.

In developing the concept, the subcommittee worked with a panel from the Defense Industry Advisory Council. Mitchell also chaired a committee responsible for briefing defense contract personnel on the system.

As stated in Defense Procurement Circular No. 50, CWAS is based on the premise that "good management by industry, properly motivated to cost consciousness, can accomplish much more effective control of costs than can detailed review, control, and overhead by government personnel."

The CWAS principle "recognizes that a contractor who accepts higher risk contracts has a greater financial motivation to exercise prudent business judgment in the performance of such contracts."

Initially the system is being used to determine "reasonableness" of a contractor's indirect costs. Eventually it is envisioned for use in eliminating government administrative controls over qualifying companies. It will not be used as a basis for contracts.

On a voluntary basis, contractors will compute their rating by multiplying the dollar costs of each type of government contract held during the fiscal year by the percentage factor assigned that type, and dividing by the total dollar costs.

If, for example, half a contractor's work is on cost-plus-fixed-fee contracts (percentage factor of 0) and half is firm-fixed-price—competitive (factor of 100), his rating is 50.

An initial threshold of 65 has been adopted, with a "discretion band" of 50-64. At 65, a contractor has two dollars at issue for every government dollar. Thirty-five or more points of the overall rating of a firm must come from competitive firm fixed-price contracts and commercial sales.

Ratings are beginning to come in to the Defense Contract Administrative Regions, which maintain registers of CWAS ratings in each area. A master register is kept in Washington.

CWAS applies only to indirect costs. Audits will still be performed to assure that costs have been properly incurred, are in proper accounts, and are allowable.

Research Grants Total $6.3 Million Armywide

More than $6.3 million in individual research grants were awarded in 1966 by the Department of the Army to 189 institutions for 292 projects.

Statistics are taken from the annual report of the U.S. Army Research Office (USARO), Arlington, Va., titled "Grants for Basic Scientific Research and Transfer of Title to Government Equipment."

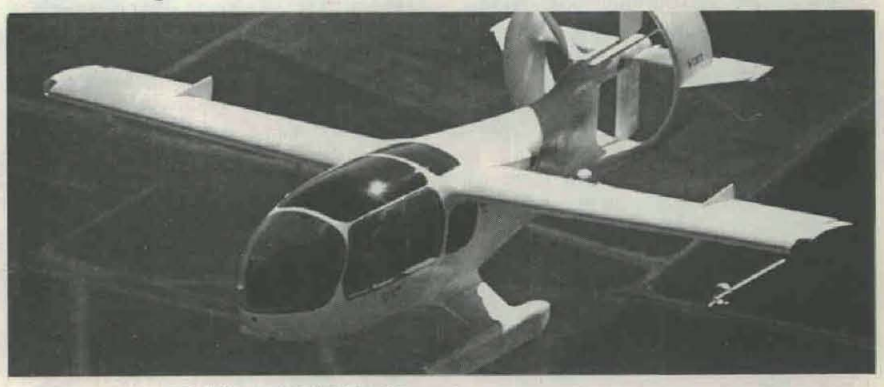
Prepared by the Research Contracts and Grants Branch, Research Programs Office, the report was submitted recently to the Assistant Secretary of Defense (Comptroller) as required by Public Law 85-934.

In 1965, 271 grants to 171 institutions totaled $9.65 million. Title transfer of equipment under grants totaled $387,000 in 1966 and $3.75 million in 1965. Under contracts, $151,000 in equipment was transferred in 1966 as compared with $202,984 in 1965.

The report includes the research grant activities of the U.S. Army Research Office, Durham, N.C.; U.S. Army Research and Development Group, Far East; U.S. Army R&D Group, Latin America; U.S. Army Materiel Command; and the U.S. Army Medical R&D Command, Office of The Surgeon General.

No grants were awarded during this reporting period by the U.S. Army R&D Group, Europe, and the Army Corps of Engineers. The statistics do not include the grants for the Army In-House Laboratories Independent Research (ILIR) Program, currently funded at about $10.2 million annually.

University Tests STOL Aircraft Developed for Army



XV-11A (MARVEL) fiber-glass research aircraft

MARVEL is the fortuitous acronym for a second-generation short-takeoff-and-landing research aircraft designed by Mississippi State University (MSU) to achieve high lift by a distributed-suction boundary-layer-controlled wing.

MARVEL stands for Mississippi Aerophysics Research Vehicle Extended Latitude. The XV-11A vehicle with variable-camber wing also is demonstrating the feasibility of polyester-reinforced fiber-glass aircraft construction, under a contract with the U.S. Army Aviation Materiel Laboratories (AVLABS), Fort Eustis, Va.

Based on findings in tests to date, fiber-glass construction is considered to have excellent possibilities when complex aerodynamically smooth curvatures, free of joints and protuberances, are desired.

The XV-11A was flown some 35 hours in early tests, primarily in aerodynamic research of the shrouded propeller, the boundary-layer control system, and for evaluation of general handling characteristics.

Mississippi State University will end Phase I of a research program with the aircraft in November and Phase II will begin with a 6-month series of flight tests.

MARVELETTE, the first-generation research aircraft, was called the XAZ-1, and it led to construction of the MARVEL beginning Nov. 1, 1964. Completed about a year later, the MARVEL started a 6-month flight-test program Dec. 1, 1965.

The XV-11A is the result of cumulative research in high-lift boundary-layer control, propeller-thrust augmentation and low-drag geometric boundary-layer control.

Except for the landing gear and ducting, fiber-glass components of the aircraft were manufactured by a private contractor and assembled by the MSU Aerophysics Department.

MARVEL is propelled by a 250-horsepower Allison T-63 gasoline engine which drives the tail-mounted 2-blade propeller with an electrically actuated pitch control developed by MSU. The propeller has reverse-pitch capability and provides adequate control power even at very slow air speeds.

Maximum predicted speed of the XV-11A is 200 m.p.h. It is 23 feet, 3 inches long with a wing span of 26 feet, 2.5 inches. Maximum takeoff weight is 2,600 pounds. The 4-wheel "pantabase" landing gear permits takeoff and landing in soft or muddy terrain.

Each wing of the MARVEL acts as a single plenum chamber and the two wings are connected to the suction source by a common duct. Air flow from perforations in the upper surface passes through the wing to the common duct at the "root" and is guided through a 90-degree turn into the engine compressor.

Army Contracts Total $278,362,221

Seventy-seven contracts and modifications of $1 million or more each for research, development, test and evaluation and for procurement of materiel, totaling $278,362,221, were awarded by the Department of the Army since the March edition of this publication.

A $61,445,723 definitization of a previously awarded contract with Philco-Ford is for Shillelagh missiles and guidance and control components.

Two contracts totaling $14,596,918 with Bell Helicopter Co. are for UH-1 aircraft gear box and transmission assemblies. General Motors Corp. won six contracts, increments and definitizations totaling $12,436,050 for radios, trucks and transmission assemblies for diesel engines for tanks.

Two modifications totaling $12,035,582 with the U.S. Rubber Co. are for explosives, ammunition and tires. The Pacific Car and Foundry Co. will provide 1½-ton cargo carriers for $8,671,249.

Three contracts totaling $8,385,664 will purchase tractor and tank trucks from the Ford Motor Co. Honeywell, Inc., will provide fuzes for $8,260,538. The Holston Defense Corp. of Eastman Kodak received a $7,933,451 modification for explosives and operations and maintenance activities.

AVCO Corp. was awarded two contracts totaling $7,679,769 for T-53 turbine engine housing assemblies for UH-1 aircraft and product support and improvement services for the engines during 1967.

A $7,400,000 definitization with Boeing Co. is for the CH-47A helicopter configuration 1A and II product improvement program. TRW Inc. received two contracts totaling $7,156,402 for electronic equipment and a classified project.

Two contracts totaling $7,013,589 with the Institute for Defense Analyses are for extended research for the Director of Defense Research and Engineering, Advanced Research Projects Agency and the Weapons System Evaluation Group of the Joint Chiefs of Staff.

Amron Corp. gained a $6,914,194 contract for 20mm brass cartridge cases and Martin-Marietta Corp. will provide metal canister parts on modifications totaling $6,448,654.

Grumman Aircraft Corp. will provide services and supplies for $5,665,000 to fabricate avionic retrofit kits for OV-1A aircraft and for modernization of OV-1B and OV-1C aircraft.

Philco Corp. received a $5 million modification for classified electronic equipment and Muncie Steelworks a $4,512,105 definitization for nozzle and fine assemblies for 2.75-inch rockets.

General purpose radio receivers will be purchased from the Electronics Assistance Corp. for $4,482,073. Chrysler Motors will supply trucks for $4,463,449, and the Union Carbide Corp. will furnish BA-801/PRC and BA-279/U batteries for $4,032,485.

FMC Corp. gained a $3,918,380 modification for M113A1 armored personnel carriers and M548 cargo carriers. Harvey Aluminum Sales, Inc., won a $3,502,451 modification for ammunition. Chamberlain Corp. will provide metal parts for 155mm projectiles on a $3,007,300 modification.

The Atlantic Research Corp. will provide XM22E2 mines for $3 million. For $2,860,000 United Aircraft Corp. will furnish JFTD Space 12A-4A turbine-engine assemblies for the CH-54 aircraft. Day and Zimmerman received a $2,564,352 modification for medium-caliber ammunition.

For $2,554,765 Johnson Corp., Bellevue, Ohio, will provide ¾-ton truck chasses and trailers. The General Steel and Tank Co. won a $2,516,898 contract for 60,000-gallon capacity fuel supply system.

Flinchbaugh Products, Inc., will supply metal parts for 152mm projectiles for $2,510,016, and ITT Gilfillan, Inc., won a $2,382,500 modification for omni-directional mortar locating radar systems. Raytheon Co. will provide fuzes for the 750-pound bomb and maintenance and modification of special tooling and test equipment to support the Hawk missile system at a cost of $2,379,784.

Stanford Research Institute received a $2,363,355 contract to continue research in civil defense. Metal parts for 4.2-inch cartridges will be supplied by Kollsman Instrument Corp. for $2,337,400.

H. O. Boehme, Inc., obtained a $2,186,531 contract for teletypewriter sets and related equipment. Mason and Hanger, Silas Mason Co., Inc., will get $2,158,370 for medium-caliber ammunition and the Olin Mathieson Chemical Corp., $2,156,296 for propellants and operations and maintenance activities.

Radio sets (AN/ARC-102) with ancillary items will be purchased from the Collins Radio Co. on a $2,102,752 modification. The Dirilyte Co. of America will receive $1,927,728 for fin blades for 2.75-inch rockets and the E. I. Dupont de Nemours and Co., $1,919,700 for explosives.

Bomb parts from ACF Industries will cost $1,887,619, from Batesville Manufacturing Co., $1,885,873, and from Scovill Manufacturing Co., $1,866,817.

KDI Corp. is to receive $1,849,220 for rocket fuze parts, Continental Motors Corp., $1,647,750 for truck engines, and the Viz Manufacturing Co., $1,616,668 for AN/AMT-4D and AN/AMT-12 radiosonde sets.

Bendix Corp. will supply landing gears for OV-1 aircraft for $1,497,996, General Electric Co., 20mm automatic guns for $1,475,000, and Atlas Corp. and H. C. Smith Construction Co. (Global Associates) will provide 31 months of logistics support at Kwajalein Test Site for $1,352,378.

Other contracts: Stevens Manufacturing Co., $1,287,127 for 7½-ton semitrailers; Bell and Howell Co., $1,280,276 parts for 81mm illuminating shell time fuzes, Baifield Industries, Inc., $1,239,000 for trucks;

University of Illinois, $1,200,000 for 12 months research in pure and applied electronic science; Servel, Inc., $1,172,928 for radio batteries;

Thermo King Corp., $1,103,233 for air conditioners in trailers; Aeronca, Inc., $1,073,266 for XM3 mine dispenser parts; G. G. Greene Enterprises, $1,032,897 for 5.56mm 10-round clips and magazine fillers; Zenith Radio Corp., $1,012,700 for SM429 fuzes for the 2.75-inch rocket.

Redstone Tests TOW In Helicopter Firings

TOW missile reflects sunlight as it streaks toward a target more than a mile away during XM-26 missile tests.

Engineering development tests of the XM-26 airborne TOW antitank guided missile system started recently with successful firings from Army UH-1B helicopters at Redstone Arsenal, Ala.

The XM-26 heavy-armament subsystem for aircraft is being developed as a replacement for the M-22 subsystem now deployed with U.S. Army troops in Vietnam. The M-22 employs SS-11 French-developed wire-guided missiles.

To provide greater accuracy for helicopter-mounted missile systems, Hughes Aircraft Co. (TOW prime contractor) developed a stabilized sight that allows the runner to hold a bead on the target even while the pilot maneuvers to evade groundfire.

Initial firings conducted by the Hughes Co. were supported by the U.S. Army Missile Command Test and Reliability Evaluation Laboratory. Col Cyril D. Sterner, commodity manager for Land Combat Systems, directs the XM-26 program for the Missile Command. Col Nelson Lindstrand Jr. is project manager for all aircraft weaponization at the Army Materiel Command in Washington, D.C.

Technical supervision of the program is under the Small Rockets and Aircraft Armaments Branch, Research and Development Directorate, Missile Command, Redstone Arsenal.

Col C. J. Canella

Lt Col J. N. Chapman

Lt Col T. U. Greer

Lt. Col M. J. Krupinsky

8 New Personnel Assigned to OCRD

New assignees to the Office of the Chief of Research and Development, Department of the Army, Washington, D.C., include seven officers and a civilian.

COL CANELLA (Charles J.) recently returned from assignment in Vietnam, is the chief of Social Science Research Division, USARO. He served from July 1956 to July 1959 in the USARO Human Factors Research Division.

In Vietnam, Col Canella was senior adviser, Quang Trung Training Center and later CO, Pleiku Subarea Command and 45th General Support Group. He was deputy director, Department of Joint, Combined and Special Operations, Army Command and General Staff College, Fort Leavenworth, Kans. (1964-1966), and CO, Support Command, 1st Infantry Division, Fort Riley, Kans. (1963-1964).

A 1941 graduate of the U.S. Military Academy, he received an MS in psychology from Tulane University in 1956. He is a graduate of the Infantry School, Command and General Staff College and Army War College.

He wears the Legion of Merit, Bronze Star Medal with cluster, Army Commendation Medal with cluster and the Combat Infantry Badge.

LT COL CHAPMAN (James N.), named Outstanding Young Engineer of the Year by the District of Columbia Council of Engineers and Architects in 1962, is on six months temporary duty with the Nike-X and Space Division. His permanent assignment is chief, Willow Run Office, Combat Surveillance and Target Acquisition Lab., Army Electronics Command.

His last permanent assignment was with the Eighth Army Signal Section, Korea (1962-63), following duty as an electronic engineer with the Office of the Chief Signal Officer, Department of the Army.

Col Chapman holds a BS degree in electrical engineering from the University of Illinois (1950) and an MSE degree from the University of Michigan (1959). He has attended the Command and General Staff College and holds the Army Commendation Medal.

LT COL GREER (Thomas U.), a 1950 graduate of the U.S. Military Academy (USMA), comes to the Combat Materiel Division from the 25th Infantry Division, Vietnam, where he served as the G-3.

He has served as commanding officer, 1st Battalion, 5th (M) Infantry, 25th Division, in Hawaii and Vietnam. Other assignments include G-3, Plans, U.S. Army, Pacific, Fort Shafter, Hawaii, and associate professor, Department of Mechanics, USMA.

Col Greer received an MS degree in theoretical and applied mechanics from the University of Illinois. He has attended the Command and General Staff College and Armed Forces Staff College.

Among his awards are the Silver Star, Bronze Star with "V" Device and Oak Leaf Cluster, the Legion of Merit, the Air Medal with four Oak Leaf Clusters, and the Vietnamese Gallantry Cross with Silver Star and Oak Leaf Cluster.

LT COL KRUPINSKY (Marvin J.), currently assigned to the Management Analysis Branch, Review and Analysis Division, was graduated from the USMA with a BS degree in 1951. He received an MS degree in civil engineering from the Massachusetts Institute of Technology (1955), and an MS in mathematics from Rensselaer Polytechnic Institute (1960). He has completed the associate course at the Command and General Staff College.

Col Krupinsky was an operations staff officer in Vietnam (J-3 Section, MACV) during 1966, following four years as a mathematics instructor at the USMA. He served three years in Alaska as an engineer staff officer with the U.S. Army, Alaska, and the U.S. Army Security Agency. He has the Bronze Star and Legion of Merit.

LT COL ROGERS (David B.) came to the Plans Branch, Nike-X System Office (NXSO), from the Army Materiel Command, where he was plans staff officer with the NXSO cadre since 1965. His previous assignment was with the System Developments Office, North American Air Defense Command.

A 1949 graduate of the USMA, he has attended the Command and General Staff College, taught electronics at Fort Bliss, Tex., and served in Korea and Germany. He holds the U.S. Army Commendation Medal and the Joint Service Commendation Medal.

LT COL TEAGUE (Jerry L.) comes to the Plans Division from the Army Concept Team in Vietnam, following assignments with the 2d Infantry Division as executive officer of the 2d Aviation Battalion and as commander and executive officer of the 2d Engineer Battalion.

A Senior Army Aviator, he was aviation staff adviser to the superintendent, and commanding officer, 2d Aviation Detachment, at the USMA. He also served in engineer and aviation assignments in Germany and in Korea.

Col Teague holds a BS degree in mechanical engineering from Louisiana State University (1950) and has attended the Armed Forces Staff College and the Command and General Staff College. He has received the Air Medal with four Oak Leaf Clusters and the Bronze Star with Oak Leaf Cluster.

CAPT MANDERVILLE (Bernard P.

Lt Col D. B. Rogers

Lt Col J. L. Teague

Capt B. P. Manderville Jr.

Jr.), staff officer in the Physical and Engineering Sciences Division, Army Research Office, holds BAE and MS degrees in aeronautical engineering (1959, 1963) from Rensselaer Polytechnic Institute.

Until recently he was technical intelligence officer (J-2), Military Assistance Command, Vietnam. Other assignments include R&D coordinator for the Small Rockets and Aircraft Armament Branch, Directorate of Research and Development, U.S. Army Missile Command, Redstone Arsenal, Ala., and three years in Hawaii as an artillery and ordnance officer with the 25th Infantry Division.

He has completed the special Intelligence Staff Officer Course and the Ordnance Career Course, and holds the Army Commendation Medal and the Joint Services Commendation Medal.

BROWN (R. Peyton), general engineer in the Plans Division, Nike-X System Office, holds a BS degree in industrial engineering from the Georgia Institute of Technology (1954) and an MBA degree in business administration from Georgia State College (1960).

From 1965 to 1967 he worked on the Nike-X project manager's staff at HQ, U.S. Army Materiel Command, and did research on guided missiles at the U.S. Army Missile Command from 1962 to 1965. His experience includes surveys and construction design and inspection for the General Services Administration, production planning for Procter and Gamble, and research analysis for Scottdale Mills.

ECOM Soliciting Papers For Wire, Cable Conclave

Technical papers are being solicited for presentation at the 16th Annual Wire and Cable Symposium, under the auspices of industry and the U.S. Army Electronics Command, Fort Monmouth, N.J.

As the leading event of its kind, the symposium is expected to attract more than 1,000 manufacturers, scientists and engineers to Atlantic City, N.J., Nov. 29-Dec. 1.

Requested papers include reports on the latest developments in cable design and application; cable materials (conductors and insulations); process, manufacture and installation techniques; testing and reliability; cable interconnection and connective devices; special cable requirements for advance equipment, and performance and field experience.

The newest and most novel features of the subject matter should be included in a summary of at least 500 words, along with a tentative title, authors and coauthors.

Ten copies of the proposed papers should be received not later than May 12 for evaluation by the committee. Authors will receive notice of acceptance by June 15.

All correspondence should be addressed to: Jack Spergel, cochairman, Wire and Cable Symposium, U.S. Army Electronics Command, Fort Monmouth, N.J., ATTN: AMSEL-KL-EE.

Book Tells of Panama Ectoparasites

Five Army medical researchers are authors or coauthors of chapters in *Ectoparasites of Panama*, an 861-page book published recently under a grant from the U.S. Army Medical Research and Development Command.

Lt Col Vernon S. Tipton, PhD, Army Medical Service (AMEDS), formerly assigned to the Office of the Chief Surgeon, U.S. Army Caribbean and now stationed with the 406th U.S. Army Medical Laboratory in Japan, edited the volume with Dr. Rupert L. Wenzel, curator, Division of Insects, Field Museum of Natural History, Chicago, Ill.

Other Army contributors are Dr. K. C. Emerson, Assistant for Research, Office of the Assistant Secretary of the Army (R&D); Lt Col Robert M. Altman, PhD, AMEDS, chief, Environmental Branch and Charles M. Keenan, supervisory biologist, Environmental Health Branch, Office of the Chief Surgeon, U.S. Army Caribbean (now entomology consultant, Office of The Surgeon General).

Lt Col Harold D. Newson, PhD, AMEDS, chief, Entomology Branch, Preventive Medicine Division, Office of The Surgeon General, wrote the foreword.

With Col Altman and Keenan, Col Tipton coauthored "Mites of the Subfamily Laelaptinae in Panama (Acarina: Laelaptidae)." He also coauthored "The Ticks of Panama (Acarina: Ixodoidea)"; "The Fleas (Siphonaptera) of Panama"; "The Streblid Batflies of Panama (Diptera: Streblidae)"; and "Some Relationships Between Mammal Hosts and Their Ectoparasites."

Dr. Emerson, working as a research associate, U.S. National Museum, Smithsonian Institution, Washington, D.C., contributed a chapter on "Mallophaga of the Mammals of Panama."

Other contributors are representative of the National Institutes of Health Rocky Mountain Laboratory, the Gorgas Memorial Laboratory, the Smithsonian Institution, the Field Museum of Natural History, the University of California and South American laboratories.

In the course of the survey, 360 species of blood-sucking ectoparasites representing over 120 genera were collected. Of these, 15 genera and over 115 species were new.

Scientists have been interested in malaria, yellow fever and other arthropod-borne diseases ever since they presented difficulties during the building of the Panama Canal.

"The climate, geological history, and varied physiography of Panama have combined to produce varied environments having a rather rich ectoparasite fauna in which unique and complex host-parasite relationships have developed," Newson states.

In the introduction, Dr. Graham B. Fairchild, Medical Entomologist, Gorgas Memorial Laboratory, Panama, notes that "the fauna of Panama is of special interest, because the isthmian region is the only dryland bridge between North and South America. Knowledge of the present Panama fauna is of great importance in understanding the movements and distribution of the animals of both continents.

"Furthermore, the relatively small land area, with its great diversity of habitats and climatic zones, contains an unusually rich fauna of manageable size."

Dr. Fairchild believes the book, although primarily taxonomic in purpose, should prove useful "not only to those engaged in studies of zoonoses in this area, but also those with broader zoological interests."

Col Elliott Heads Edwards AFB Aviation Test Activity

Col John W. Elliott's promotion to that rank followed closely his recent assignment as commander of the U.S. Army Aviation Test Activity at Edwards Air Force Base, Calif. He was deputy CO, U.S. Army Aviation Materiel Laboratories, Fort Eustis, Va.

Among his key assignments have been: deputy chief of staff, U.S. Army Aviation Materiel Command (1963-65); commander, 71st Transportation Battalion, Transport Aircraft in Korea (1962-63); flight test pilot and assistant chief of Flight Operations, National Aviation Facilities Experimental Center, Federal Aviation Agency (1958-62).

Col John W. Elliott

Col Elliott has been qualified in 57 types of aircraft—4-engine, turboprop, jet and rotary-wing—and is a master aviator with a special instrument card.

He received a bachelor of fine arts degree in music from Oklahoma State University in 1938, did graduate work at the University of Oklahoma, and is a graduate from the Command and General Staff College (1963) and the Associate Transportation Officer Advanced Course (1958).

Col Elliott entered the service in 1942 and was assigned to the Air Transport Command. He made 11 crossings of the Pacific and participated in the invasions of the Philippines and Okinawa and the air offensive against Japan, and has been honored with 12 awards and decorations.

Natick Laboratories Report Covers Research in Progress

Technical abstracts of basic and applied research tasks in progress during 1966 at the Pioneering Research Division (PRD) of the U.S. Army Natick (Mass.) Laboratories are presented in a 135-page annual report.

The 88 abstracts cover the fields of enzymes, spores, microbiology, proteins, theoretical biology, entomology, sensory physiology, polymers, photo and radiation chemistry, analytical chemistry, food chemistry, chemical synthesis, energy transfer, radiation physics, experimental psychology, psychophysiology, and insect and rodent control.

As described in the report, the PRD activities in biology are oriented primarily toward the problem arising from the depredations of micro-organisms, insects and rodents on organic materials. Emphasis is on the development of basic information and principles for extrapolation to potential preventive measures, although applied research is performed.

Specific areas of investigation in microbiology are the taxonomy of relevant fungi, the characterization and isolation of enzymes, metabolism of spores, and the interactions of microbial and environmental factors in deteriorative processes.

Applied biological studies pertaining to deterioration involve the natural resistance of new materials and the development of protective measures. Entomological basic research is concerned mainly with increasing knowledge of reproductive and behavioral mechanisms, sensory physiology and nutrition.

The PRD program in chemistry deals with chemical systems basic to food, clothing, detergents and packaging, It involves both synthesis and natural product isolation and identification.

Physical chemical studies provide a theoretical and experimental basis for better understanding of the kinetics and reaction pathways of organic compounds when exposed to stresses. Molecular systems studies range from simple gaseous molecules to complex synthetic and natural polymers. Research also seeks improved methods of analysis for solution of problems in chemistry and biology.

Physics laboratories investigations probe the properties of known and new materials under radiation and thermal and mechanical stress. Development of materials capable of withstanding recognized extreme environmental and stress-imposed conditions has been far short of known and anticipated requirements, the report states.

The behavioral sciences program provides for human factors evaluation of all items developed at Natick, including analysis of man-equipment compatibility and food-acceptance testing.

Applied studies of human factors are directed to long-term needs of the Natick Laboratories product divisions. Included is work in anthropometry, psychoacoustics, stress and performance in relation to potential development of clothing and equipment, psychophysical scaling, development of new food-acceptance techniques and studies of human sensation in taste, olfaction, and flavor affecting appetite.

"Major (human factors) emphasis in basic research," the report states, "is on electrophysiological studies of sensory coding, information processing, and psychophysical and behavioral work on the regulation of food and water intake."

Spores Study Seeks Ways to Curb Material Spoilage

Prevention of microbiological degradation of food and other material through improved treatment processes is the goal of bacteriologists investigating the physiology of *Bacillus megaterium* spores at the U.S. Army Natick (Mass.) Laboratories. Broadened knowledge of how to reconstitute biologicals also is envisioned.

Prime investigators are Drs. Hillel S. Levinson and Peter K. Holmes and Mrs. Mildred T. Hyatt of the Pioneering Research Division. Their studies are concerned with developing methods that will overcome the high resistance of bacterial spores to heat, radiation and disinfectants.

Bacillus megaterium spores are rod-shaped and are dormant until placed in an activating environment. When activated spores are incubated with solutions of certain chemicals (e.g., glucose), they germinate—begin to develop into vegetative cells. One of the first events to occur during germination, researchers report, is loss of resistance to physical or chemical stresses.

Although one of the best-known treatments is "heat activation," spores in aqueous suspension are not killed by heating at sublethal temperatures (65° C., 10 minutes). But they do become increasingly susceptible to germination in glucose.

The Natick investigators have recently demonstrated an analogous activation of dried (lyophilized) spores as a result of exposing them to water vapor at room temperature.

Dry spores were exposed to atmospheres maintained at relative humidities at 75 and 90 percent, with temperature controlled at 30° C. so that no condensation of water on the spores could occur, and then suspended in a glucose solution. They germinated faster and to a greater extent than spores which had been suspended in water and then placed in a glucose solution without prior exposure to water vapor.

The investigators also have shown that spores are activated for germination as a result of treatment with aqueous (but not absolute) ethanol for short periods (5 minutes).

Researchers hypothesize that these activation treatments (sub-lethal heat, water vapor and aqueous ethanol) permit water molecules to reach a specific sport site where hydration is essential for functioning of germination agents.

Gaseous or hot water, or water containing ethanol, may penetrate to such sites, whereas, water at room temperature cannot. This may be due to the reduced surface tension of water in the activation treatments or to alteration of the aggregation characteristics of water, with the altered form being more capable of reaching the important hydration sites.

GE Gets Nike-X Radar Contract

Design and development of a new Perimeter Acquisition Radar (PAR) will be performed by the General Electric Co., Syracuse, N.Y., under a subcontract carrying an initial funding of $1,000,000. Additional amounts will be negotiated.

The new phased-array radar will be a major subsystem of the Nike-X Missile Defense System and is expected to increase significantly the range at which targets can be detected.

CRREL Hosts Meeting On Meteorological R&D

U.S. ARMY CRREL (Cold Regions Research and Engineering Laboratory) leaders hosted the recent 15th annual meeting of the U.S. Army Meteorological R&D Coordinating Committee. Presentations by representatives of 21 Army agencies included research observations of snow, ice and permafrost conditions throughout North America; micrometeorological requirements in Antarctica and Southeast Asia; forecasting of monsoon rains; use of rockets for atmospheric studies in Panama; and Arctic cold-fog studies and meterological tools. Principal participants (front, l. to r.) included John A. Copeland, committee chairman and chief, Environmental Sciences Division, U.S. Army Materiel Command (AMC); James A. Bender, chief, Research Division, CRREL; (rear) W. Keith Boyd, chief engineer, and Dr. Andrew Assur, chief scientist, CRREL; and Elmer F. Clark, Environmental Sciences Division, AMC, executive secretary of committee.

30 Army Suggesters Make Honor Roll

Honor roll listing of "Economy Champions" announced by the U.S. Civil Service Commission for February, under a new 6-month Incentive Awards Program promotional effort, includes 30 Army employees out of a total of 80 winners for all government agencies.

Army award recipients shared a total of $18,305 for cost-reduction suggestions, estimated as productive of first-year savings of $2,896,810. Seven winners each received cash awards of $1,000 or more. To qualify for the honor roll, a suggestion must yield a first-year saving of $10,000 or more.

All of the CSC honor roll employees had previously received the cash awards from their agencies. The Economy Champion designation does not carry an additional cash award.

Purpose of the CSC promotional program is to give additional distinction and prestige to employees who make significant contributions to the goal of holding down expenditures; also, to give added emphasis to agency activities that encourage employee effort to find new ways to do their jobs more efficiently or at less cost.

The suggestion saving the Army the largest amount was made by two employees of the Satellite Communications Agency at Fort Monmouth, N.J. William W. Deckert and Frank N. Wilcox shared $1,500 for a recommendation to utilize modified Advent satellite tracking, telemetry, and command equipment to implement the Data Acquisition and Processing System program. In testing the military communications satellite systems, this saved $1,429,770 in procurement costs.

The largest individual award went to Malcolm G. Anding. Employed as a research hydraulic engineer with the Vicksburg (Miss.) District of the Corps of Engineers, he received $1,420 for a suggestion to use control gates on weir passes of navigation dams, thereby saving $366,000.

For suggesting a way to modify transponder sets to insure reliability in signaling emergencies during military flights, Joseph L. Srebro, an electronic technician with the Tobyhana (Pa.) Army Depot, received $1,155. Savings were estimated at $100,994.

Charles J. Poss, a supervisory inventory management specialist with the Army Mobility Equipment Command, St. Louis, Mo., suggested that a power unit generator be issued with a carrying case only, rather than with both carrying case and bag. Elimination of 582 bags from the inventory resulted in savings of $90,792 and won Poss $1,105.

Suggested use of grid-rolled pit-run gravel instead of the conventional stabilized aggregate for the base course on public-use roads at reservoirs saved the Army $123,809 and won $1,000 for Doss D. Neely, a highway engineer with the Corps of Engineers in Tulsa, Okla.

Edward Ruby, a foreman with the Red River Army Depot, Texarkana, Tex., received $1,000 for a suggestion to reclaim T-96 track pins for use on the T-97 track rebuild program instead of purchasing new pins. The estimated saving was $225,536.

Economy Champions at the Atlanta (Ga.) Army Depot are Walter J. Cook, $795, and Hiram D. Acree, $775. At the Army Armor Center, Fort Knox, Ky., Alfred J. McIntyre won $970; George W. Leonard, $655; James G. Crutcher and Hendrick A. Ray shared $570; and 1st Lt James B. Adams, Marilynn A. Hudgins, M/Sgt James E. Petitt and Sgt John G. Moran, Sr., shared $780.

Robert J. Hall of the Army Aviation Materiel Command, St. Louis, Mo., received $630. At Edgewood (Md.) Arsenal, A. Radford Baker won $860; Watson E. Myers, $580; Evans F. Bowersox, $555; and Paul A. Holcomb and Norman C. Moore shared $800.

Winners at the U.S. Army Electronics Command, Fort Monmouth, are Albert Wiener, $830; Robert W. Lantz, $540; Irvine E. Tilton, $500; and Lewis J. Birt and CWO William E. Hardy sharing $505. At the Red River Army Depot, Vernon D. May and David B. Thompson shared $780.

Engineer Labs Assume 'Mechanical Muscles' Project

Mechanical muscles in an exoskeletal structure that provides man with the strength to lift 1,500 pounds with ease are undergoing research and development at the U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

Project "Hardiman," under contract with the General Electric Research and Development Center, Schenectady, N.Y., recently was transferred to ERDL from the U.S. Army Natick (Mass.) Laboratories, where feasibility studies were conducted. Alexander Levin is project engineer.

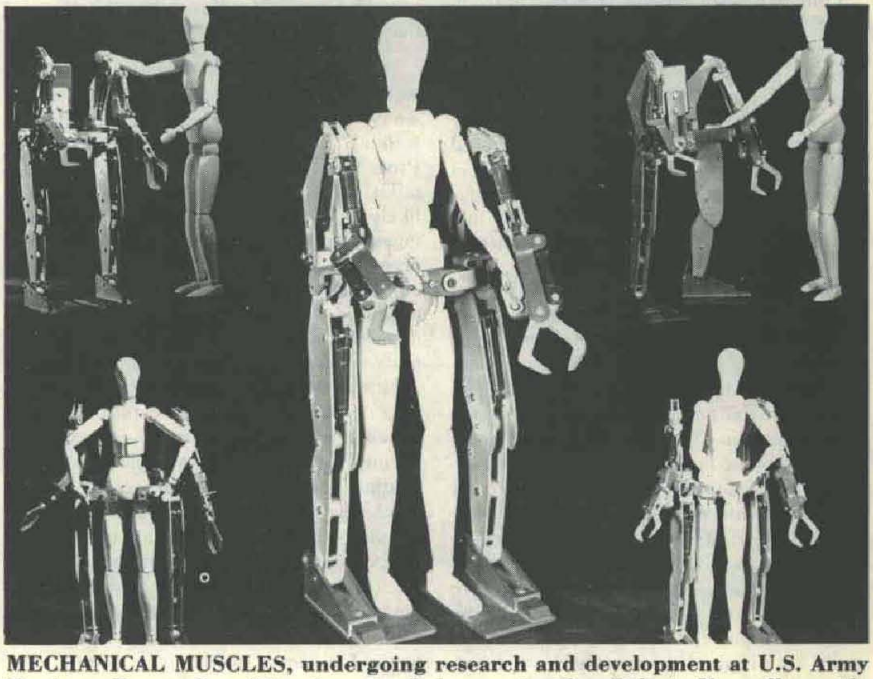
Hardiman is supported jointly by the Army Materiel Command and the Office of Naval Research. General Electric is scheduled to deliver a research prototype unit in 1968 for machine and human factor design studies at ERDL.

The metal structure of Hardiman would be of the general human configuration "worn" by a soldier. He would "drive" the skeleton, making it mimic and amplify his movements, by manipulating hydromechanical circuitry.

Operating on an advanced system of sensors, levers, actuators, control linkages and servomechanisms, the device reportedly will give the operator enough extra "muscle" control to lift, lower and walk with 1,500 pounds under field conditions.

Combining the operator's dexterity and versatility with the machine's size and strength, Hardiman could be expected to perform load-lifting tasks in warehouse and factory operations, bomb loading and underwater salvage.

Described as a "powered exoskeleton" by its developers, Hardiman will be attached to the operator at the feet, forearms and waist. Although the prototype will be connected to a separate power supply by flexible hydraulic lines, it is anticipated that later models will use self-contained power.



MECHANICAL MUSCLES, undergoing research and development at U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va., will provide man with strength to lift 1,500 pounds by using "force feedback" controls.

Walking Machine Studies

By Ronald A. Liston

The author has been selected for a Secretary of the Army Research and Study (SARS) Fellowship (see story on page 29). Originally published in the March-April 1967 issue of The Military Engineer, *this article is copyrighted by the Society of American Military Engineers and is reprinted by permission. The "Quadruped" is being developed under joint Advanced Research Projects Agency and U.S. Army sponsorship by contract with General Electric Co.*

Ground mobility has ever been and still is one of the most serious military problems to be solved. Many types of machines have been developed and improved since the first mechanization of the Army, but so far there are no ground vehicles which are not burdens to the soldier as soon as he is forced to take his vehicle off the road.

Under "ideal" off-the-road conditions a vehicle can only travel at about 10 miles an hour. When forced to operate under cover, speed is necessarily severely reduced. And it is apparent that there are no ground vehicles which can chase fleeing guerrillas, or negotiate boggy canals, or cope with the off-the-road environment with the efficiency of a human being.

It would seem reasonable to demand that any vehicle intended for counterinsurgency, remote areas, or antiguerrilla operations should be able to go where a man can go, and with greater efficiency. In attempting to improve travel over natural terrain, it is essential that the engineer explore all ideas and possibilities that may occur to him.

Long ago, man became committed to the wheel for land transport, and improvement in speed and efficiency has closely matched the development of roads as running surfaces suited to the requirements of the wheel. When the ability of wheeled vehicles to operate in unmodified terrain is compared to the mobility produced by nature, it is found that animals can move at speeds several times greater than man's product. Thus in some terrain, a $50 horse can outperform a $225,000 tank.

The mobility counterparts in the air and on the sea have followed nature's guide rather closely in their development. Thus, airplanes are bird-like and high-performance underwater seacraft are fish-like, and in these media nature has been outstripped in performance by man's machines. This is far from true on natural terrain.

If, as is observed, animals can move off the road with considerably greater ease than a vehicle, it seems logical to conclude that a vehicle which is based on the wheel may not be the proper vehicle form. Nature has not evolved an organism based on the wheel or even remotely resembling one. It might be surmised that nature did not produce wheel mobility simply because a system of levers was a superior locomotion system for movement on natural terrain.

ADVANTAGES. There are several aspects of a walking machine or similar vehicle which are inherently superior to those of wheeled devices. First, when operating on terrain having a rough surface, the walking device may select the point on which it will place its foot and thus, in effect, move over smooth terrain while the wheeled or tracked vehicle is forced to move over each point in its path.

A second advantage of the walking-type vehicle is that it is more efficient than either a wheeled or tracked vehicle when traversing soft soil. The losses associated with a walking machine can be attributed to the friction in the various joints, to the lifting of the center of gravity with each step, and to the acceleration of the legs. (There are, of course, mechanical losses associated with the drive system which are independent of the type of vehicle. In the case of the walking machine, a hydraulic drive system is proposed and this is admittedly inefficient.)

When moving in deformable soil, the feet of the walking machine will sink into the ground and the losses will increase because of the additional motion of the center of gravity. A similar situation occurs when a man or animal walks in soft soil.

The off-the-road efficiency of wheeled or tracked vehicles is less than that of a walking machine because these vehicles are in continuous contact with the soil. If a wheeled vehicle is to move 1,000 feet through soft soil, it produces a continuous 1,000-foot rut by compacting the soil. Since soil compaction is the primary source of motion resistance, the continuous motion accounts for greater losses than the step motion of the walking machine.

DESIGN. In 1954, a series of studies was begun of vehicles based on nature, which led to the building of a prototype walking machine. The first study, with Prof. Bernhard of Rutgers University, established the levered vehicle form most likely to fit the needs of the military. Walking, running, trotting, galloping, leaping, and creeping devices were examined. It was concluded that a grasshopper-like design appeared to be the most appropriate of the devices studied, based on mechanical feasibility and operational ability.

However, the leaping machine had a serious drawback. In nature, leaping creatures usually have a means of maintaining control during flight to permit the selection of the landing point. The grasshopper has wings to change his direction; the kangaroo uses his tail. A leaping vehicle could be designed to provide in-flight correction, but it would be too complex to be practicable; hence, despite the comparatively slow speed of the walking-type machine, a contract was let to the University of Michigan to produce a mechanism which would provide optimum walking efficiency.

Prototype of "walking truck."

The work undertaken by Prof. Shigley was the development of a linkage that would provide straight-line motion of the foot and reduce inertia forces to a minimum, and the establishment of the operating requirements or characteristics of a walking machine. The requirements specified were:

1. The machine must have a uniform velocity while the feet are in contact with the ground.
2. The stride must be long in relation to the physical dimensions of the machine to achieve adequate speeds.
3. The height and length of the stride must be controllable by the operator.
4. The height of the step should be large compared with the dimensions of the machine.
5. The feet should have a high stride-to-return-time ratio.
6. A mechanism integral to the legs must be provided for steering the vehicle.
7. The vehicle must be able to move forward and in reverse.
8. The inertia forces and torques must be balanced.
9. The energy lost in lifting the foot should be recoverable in lowering the foot.
10. The height of the body of the machine above the ground should be controllable by the operator.

Animals fulfill all these requirements except numbers five and nine.

Numerous investigations led to the selection of a hydraulically controlled walking machine with a pantograph-like mechanism. Before this choice was made, a walking machine with mechanical linkages that would fulfill most of the listed requirements was developed and a model was constructed.

A prime source of trouble with this device was a set of noncircular gears which were used to reduce the inertia forces in the legs. By using noncircular gears, the drive system, instead of the legs, was accelerated and decelerated. This reduced the problem of inertia forces but posed the new problems of forming the gears and of keeping all gear teeth attached to the gear body.

Although this design appeared to be the

most effective that conventional linkages could produce, it had the disadvantages of nonuniform rotation of the crank mechanism through the noncircular gearing arrangement, unbalance of the inertia forces, lack of control of vehicle height, and the ability to achieve only very low vehicle speeds (5 m.p.h.).

The mechanical linkage machine was abandoned and investigation of the hydraulic-mechanical system was continued. Most of the disadvantages of the mechanical system were eliminated by the hydraulically operated pantograph linkage. The resulting design was a 16-legged machine with gangs of four legs mounted at each corner of the vehicle.

Operating at 20 miles per hour, the inertia forces were within tolerable limits. However, the requirements were approached from the viewpoint of mechanisms and the critical requirement that the vehicle should be controllable by an average human being was overlooked.

At this point, if this 16-legged device were picking its way across a piece of rough off-the-road terrain, the operator could, perhaps, drive each gang of four legs as a single leg but, even so, he would face the awesome task of attempting to step over a tree stump, for example, without upsetting the machine.

It was obvious that control required a sensing and computing system as efficient as that of a horse. Thus, the solution of the mechanical problems would be of no avail without a simple means of control.

CONTROL. The type of control system that appears practical for a walking machine is based on the force feedback principle. Man controls his physical actions through several senses but his primary control mechanism is responsive to forces and force differentials. Although he makes extensive use of the visual sense, it is used primarily for positioning.

For example, in picking up a block of lead, the visual sense controls the placing of the hands, but the process of picking up the block is totally force-responsive and the visual sense gives no guidance whatever, since it cannot distinguish variation in density. A lead-coated piece of balsa would produce the same visual response as a piece of lead of similar dimensions.

Total miscues from visual control are often experienced when one expects something to weigh much less or much more than it actually does, and the force feedback response corrects the error. On the other hand, it is difficult to even imagine a miscue from the physical force feedback system. A force miscue is not possible because the force is based on gravity or acceleration.

A force feedback control system has been developed by the General Electric Co. to a high degree of reliability, and has been applied to a class of devices known as Cybernetic Anthropomorphous Machines (CAMS).

The "Handyman" remote manipulator is an example of a CAM and was the inspiration for the proposed walking machine. The manipulator is operated by means of an electronically counterweighted harness fitted over the arms of the operator. The manipulator exactly mimics the movement of the operator's arms and hands, and the forces resulting from its movements are fed back to the operator.

If the manipulator arm strikes a solid object, the operator feels the identical force situation of striking a solid object with his arm (although, of course, he does not receive the normal touch response to surface temperature or texture). If the operator attempts to pick up an object with the manipulator, he feels a force signal when the manipulator hand closes on the object, when the object is picked up, and when the object is replaced.

As far as force signals are concerned, the man and the machine are the same. The man does not have to learn how to make the machine perform a task; he must learn how to perform the task and his action is duplicated by the machine.

The practicality of the CAM lies partly with the ability of the human to operate with distorted references. As an example, if one attempts to walk along a designated path while looking through the wrong end of binoculars, he is likely to become unsteady but, after a little practice, equilibrium is regained and walking becomes relatively normal, even though references are severely distorted.

Experience with manipulative CAMS has led to the idea of a vehicle in which the operator has his legs in a manipulator so that when he takes a step, the machine will do the same. Thus the gait of the machine as well as its balance could be governed by the natural gait and balance of the human operator.

A feasibility study of a walking machine using the force feedback control system and the establishment of design criteria for such a machine are now under way.

The human factors appeared at first to be a more significant problem than the design of the machine. The effect of placing the operator at a height several times greater than normal raised questions concerning his inertia-sensitive response system, but this has been found to present no trouble.

The second concern was over the problem of static balance. The human factors

(Continued on page 24)

97 15-Ton Amphibious Cargo Craft Slated for Delivery

Confirmatory testing of the LARC XV, middleweight of the Army-developed trio of huge amphibious cargo craft, has been completed. Production models will begin entering the supply system between July and September.

Final testing was performed recently in a cold chamber at Eglin Air Force Base, Fla., where a LARC XV was subjected to minus 25 degrees F. to check starting capabilities and other systems.

Under contract with the U.S. Army Materiel Command, Freuhof Corp. will produce 97 of the 45-foot, 15-ton lighters. LARC is the acronym for Lighter, Amphibious, Resupply, Cargo.

Like the 5-ton LARC V, the 15-ton amphibian is constructed of welded aluminum. It is driven by twin 300-horsepower diesel engines. A single engine of the same power drives the LARC V. Both lighters have 4-wheel drive and a single marine screw.

The LARC LX is a steel-body 60-ton member of the family powered by four 165-horsepower diesels. For land travel, one diesel engine drives each wheel; in the water, two engines power each of the twin screws.

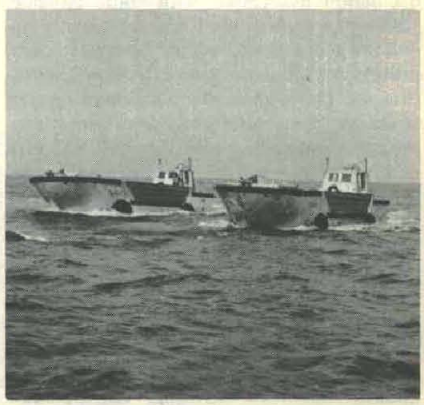
LARCs XV and LX have hydraulic bow ramps to facilitate loading and unloading. The 62-foot LARC LX and the LARC V are deployed in "significant numbers" at off-loading points on the coast of South Vietnam.

LARC V, a standard Army item since mid-1960, is used also by the U.S. Navy. The Federal Republic of Germany and Australia together have purchased approximately 400.

The 60-ton LARC, a standard item since 1954, has been manufactured primarily on the west coast of the United States by the Pacific Car and Foundry Co., Treadwell Construction Co. and Western Gear Corp. Peterson Builders of Sturgeon Bay, Wis., is a new producer.

Because of the lighter's width and overall size it cannot be moved by rail or highway. The LARCs completed by Peterson Builders are moved with auxiliary outboard engines from Sturgeon Bay to Virginia via the intracoastal waterway.

To test the work of the new builder, an Army crew of four from the U.S. Army General Equipment Test Activity, Fort Lee, Va., "sailed" a LARC LX 1,700 miles in a 2-week voyage from Lake Michigan to Fort Story Va.



LARC XVs wade through light surf under simulated conditions of landing military supplies from offshore ships.

Walking Machine Studies

(Continued from page 23)

study concluded that the most difficult phase of walking is not in stepping but in standing still. This conclusion is verified by observing an infant learning to walk. A small child can stand so long as he has something to lean on. He can walk (in fact negotiate a semicontrolled fall) from one support to another. But he cannot walk efficiently until he has conquered the balance problem. Once this has been accomplished, there is literally no stopping him.

Based on the results of the initial study, a biped vehicle form was built with a balance test rig that would permit investigation of the static balance problem and tests of a proposed control system. The control system was to be fully hydraulic and required the development of a servo-valve that would be rugged, cheap and adequately sensitive.

The rig (that was developed) works very satisfactorily. The device has two degrees of freedom in one plane, rotation of the ankle joint and rotation of the hip joint. In order to balance the rig, the operator is placed in the harness and stands still. And that is all there is to it. As long as he stands still and maintains his balance, the machine follows.

If the operator attempts to "balance" the rig by conscious manipulation, he will find himself in trouble. Balance is achieved by an unconscious response to force feedback signals. If these same signals are responded to in the balance test rig, the rig is balanced. The learning time to balance the machine has not exceeded 15 minutes with any subject and usually requires only two or three minutes.

As with the static balance, the inertia response system presented no problem in operation. Operators were fully able to oscillate the rig within fixed limits without losing balance while keeping their eyes closed. The inertia response system is apparently sensitive to relatively high acceleration rates which lie outside the range of oscillation associated with static balance.

Upon completion of the tests with the balance test rig, work could be started on a prototype walking machine. The only question was the form of the machine to be constructed. Two different ideas were proposed: a biped that was a true CAM or a quadruped that would require some special training of the operator.

The quadruped was selected because it appeared to be more useful and because the operator training turned out to be much simpler than had been anticipated. The front legs of the machine will be controlled by the operator's arms and the rear legs by his legs, which will move the machine by a motion similar to crawling. The operator will be placed in the harness at an angle to the verticle so that all "legs" will receive a force feedback signal.

The proposed quadruped will operate at a speed of approximately 5 m.p.h. and will carry a payload of 500 pounds. The proposed dimensions are: 10 feet high, 10 feet long, and 3½ feet wide. The speed of the quadruped machine will be limited by the ability of the operator, who can increase speed by attempting to "trot" or "pace." It should, however, require considerable skill for the operator to develop a gallop.

The walking machine is not viewed as the future means of land transportation. Although the cost will be modest, the vehicle will not be able to compete with wheeled vehicles under most circumstances. It is expected to compete with helicopters for high-density cargo transport which requires movement over extremely rough terrain independent of weather conditions.

The walking machine will cost about one-tenth the price of an equivalent helicopter and will not require a highly trained operator. The walking machine and the force feedback control system developed for the vehicle represent a significant breakthrough in off-the-road locomotion that will permit access to a major portion of terrain denied to conventional vehicle forms. But the walking machine is not going to make the wheel extinct.

Article Fires Rivalry for Youngest PhD Honor

No one rightfully can say "young doctors are a dime a dozen," but . . . !

The February 1967 issue of the Army R&D Newsmagazine noted that Dr. Ann Lowe (now Dr. Ann Baker), Behavioral Sciences Division, Army Research Office, was the youngest woman with a PhD degree in the Department of the Army.

Until Dec. 18, she also was the youngest doctor in the Office, Chief of Research Development (OCRD). Then 1st Lt Anthony J. Graffeo, holder of a PhD degree from the University of Houston and three months younger than Dr. Baker, was assigned to the Physical and Engineering Sciences Division.

Newsmagazine articles on Drs. Baker and Graffeo have prompted two officers to set forth their candidacy for the unofficial title of youngest doctor in the Department of the Army.

Capt. Roger A. Lucheta, U.S. Army Airborne, Electronics and Special Warfare Board, Fort Bragg, N.C., sent a letter saying he was born Nov. 26, 1940, and entered the Army Feb. 12, 1966, with a ScD degree in mechanical engineering from M.I.T.

He has completed the Ordnance Officers Basic Course and the Army Airborne Course at Fort Benning, Ga., and was stationed at Aberdeen Proving Ground (APG) before his present assignment.

Capt Lucheta's claim was duly recognized by the editorial staff, but, as ever, "Fame is fleeting." Capt Michael J. Ram, HQ 610th Maintenance Battalion (DS), APO San Francisco, Calif., 96289, writes that he was born Dec. 18, 1940, and received a ScD degree from Newark College of Engineering in June 1966 at which time he was assigned to the Chemical and Coating Laboratory, Aberdeen Proving Ground.

Capt Ram is younger than Dr. Graffeo by 30 days and younger than Capt Lucheta by 23 days.

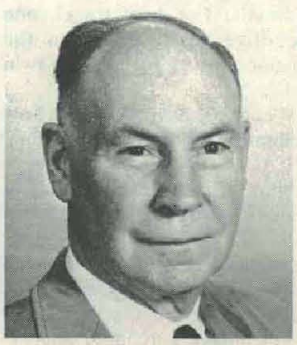
Any other contenders?

Picatinny Arsenal Honors First 50-Year Employe

Fifty years service at Picatinny Arsenal, ranging from laborer at $1.60 a day to supervision of 2,500 employes in munitions R&D activities,was recognized Apr. 8 at a gala testimonial dinner for Wilfred Hosking.

With the exception of military service in World War I, Hosking has been employed continuously since July 13, 1916, and is now director of the Industrial Services Directorate. Staffed with a large proportion of scientists, engineers and technicians, the directorate is the largest segment at Picatinny Arsenal.

Responsibilities of the directorate include experimental pilot plant production of explosives, components, propellants and a variety of nuclear munitions as well as conventional weapons projects. Hosking also is charged with completely integrated methods of engineering and machine tool design programs to assure optimum preproduction evaluation.



Wilfred Hosking

Highlights of his service to Picatinny Arsenal and the Army include development of a skeletal organization in 1939 to provide early munitions manufacture; production of a low-altitude bomb fuze used in General Doolittle's surprise bombing raid on Tokyo in 1942; and the manufacture of the 2.75- and 3.5-inch rockets used in the Korean War. He was also the guiding force of many cost-reduction projects.

Hosking has received the Exceptional Service Award, the Army's highest honor for a civilian employee, and two Meritorious Civilian Service Awards. Notables who have commended him for outstanding performance of duty include the Honorable Kim Sung Eun, Minister of National Defense, Republic of Korea; Maj Gen E. L. Ford Jr., former Army chief of Ordnance; and Maj Gen F. A. Hansen, CG, U.S. Army Munitions Command.

Agencies, Industry Help DoD Compile Scientific Thesaurus

Combined efforts of Department of Defense agencies augmented by other governmental organizations and private industry from coast to coast have produced a Thesaurus of Engineering and Scientific Terms.

Undergoing final review before delivery to the printer by May 31, TEST is an interagency interdisciplinary vocabulary of some 23,000 main terms and is an outgrowth of Project LEX. Panels of specialists prepared it as an authoritative standard for use throughout DoD in describing, communicating and documenting scientific and technical subjects.

Updating, revision and consideration of further "candidate terms" is assigned to the Office of Technical Terminology of the Defense Documentation Center (DDC), Cameron Station, Alexandria, Va. TEST is recorded on magnetic computer tape to facilitate editing and future development of the vocabulary.

Project LEX—for lexicon-began late in 1965 after the Director of Defense Research and Engineering assigned the mission of developing a "DoD-wide technical thesaurus" to the Office of Naval Research (ONR).

Shortly after the project was initiated, arrangements were made with the Engineers Joint Council (EJC), international "focal point" of the engineering profession representing 29 societies, to conduct a cooperative effort which would result in a thesaurus for the engineering community and a thesaurus for DoD that would be compatible with each other.

Interest in Project LEX, essentially a Department of Defense task force at the beginning, increased because of the widespread need for a standard vocabulary suitable for the engineering and scientific communities.

Government agencies outside the Department of Defense, such as the Committee on Scientific and Technical Information (COSATI) of the Federal Council on Science and Technology, supported the effort. The task force also included representatives of such organizations at Battelle Memorial Institute, Massachusetts Institute of Technology and the Engineers Joint Council.

The nonprofit EJC provided a large input of engineering terminology developed for its member organizations. A Project LEX "Manual for Building a Thesaurus," published in April 1966, was the first major step of the task force.

Basic rules and conventions established by the manual will be used in revisions of the EJC *Thesaurus of Engineering Terms.*

Project LEX included a systematic review of existing thesauri, subject-heading lists, glossaries, dictionaries and other authorities used by DoD, the military services and private sources.

Of the 119 indexes and thesauri systems amalgamated in TEST, the Army contributed 17 main systems. Among these are the Army Vocabulary of Technical Descriptors, prepared under contract for the U.S. Army Research Office, Office of the Chief of Research and Development, and the QDRI (qualitative developments requirements information) activities of Frankford Arsenal, Philadelphia, Pa.

Other system contributions came from the Army Logistics Management Center at Fort Lee, Va., Plastics Technical Evaluation Center (PLASTEC) at Picatinny Arsenal, Dover, N.J., and the Redstone (Ala.) Scientific Information Center.

TEST will be published from computer tapes by a photocomposition process. The DDC is responsible for maintaining continued computer controls of the terminology to provide codes, programs, tapes and special printouts. DDC lexicographers are establishing procedures for formal review and input of candidate terms to the thesaurus.

TEST is considered "a flexible authority list" for vocabulary control that provides for the use of terms in combination for coordinate indexing systems and for traditional subject-heading systems.

TEST is divided into six sections:

• *Introduction.* This explains how the thesaurus can be used for indexing and searching. It also presents the thesaurus philosophy.

• *Thesaurus Rules and Conventions* explains the use of two types of terms—descriptive and bibliographic—for information storage and retrieval.

• *Alphabetical Section* is a comprehensive, cross-referencing alphabetical listing of all terms in the thesaurus.

• *Subject Categories* is a display of all descriptors categorized according to the fields and groups of the COSATI Subject Category List with some slight modifications found necessary to accommodate the terminology.

• *Heirarchical Display* is a listing of descriptors in heirarchical arrays arranged alphabetically by the most generic descriptor in each, showing by indentations the relationships of the narrower members of each class.

• *Permuted Term Display* groups all terms containing the same word according to the meaningful word in single or multiword terms. The single-word term appears first; others follow in alphabetical order.

Col Stockton Directs Armor Materiel Testing

Col John B. Stockton is the new director of armor materiel testing for the U.S. Army Test and Evaluation Command, Aberdeen Proving Ground, Md.

A 1943 graduate of the U.S. Military Academy, he was assigned to the Armor Materiel Testing Directorate at Aberdeen (Md.) Proving Ground in 1966. He received an MA degree in international affairs from George Washington University in 1961.

In 1963 he joined the experimental 11th Air Assault Division at Fort Benning, Ga. He commanded the 227th Helicopter Battalion, was later the deputy commander of the 11th Aviation Group, and served as a squadron commander in the 9th Cavalry when the division was reorganized in 1965 and assigned to Vietnam as the 1st Cavalry Division. He was deputy commander of the 1st Aviation Brigade in July 1966 when ordered to Great Britain for a 6-month tour.

Since 1955 he has completed a 3-year tour in the Aviation Directorate of the Office of the Army Deputy Chief of Staff for Operations, and served in Korea and Vietnam. Assignments followed with the Howze Board and Army Combat Developments Command.

Col Stockton served in the Rhineland and Central Europe campaigns while with the 13th Armored Division from 1943 to 1945.

Col Stockton's decorations include the Legion of Merit, Bronze Star Medal with "V" Device and Oak Leaf Cluster, Air Medal (7 OLC), Army Commendation Medal (OLC), Purple Heart, and the Vietnamese Medal of Honor and Gallantry Cross with Gold Star.

Col John B. Stockton

SCIENTIFIC CALENDAR

Symposium on Reversible Photochemical Processes, sponsored by ARO-D, National Cash Register Co., University of Dayton and the Charles F. Kettering Foundation, Dayton, Ohio, May 1-3.

Meeting of the American Society for Quality Control, Chicago, Ill., May 1-3.

International Conference on Research Reactor Utilization and Reactor Mathematics, sponsored by the American Nuclear Society, Mexico, D.F., May 2-4.

4th Annual National Colloquium on Information Retrieval, sponsored by Frankford Arsenal, Philadelphia, Pa., May 3-4.

6th Rare-Earth Conference, sponsored by OAR, AFOSR and the Oak Ridge National Laboratory, Gatlinburg, Tenn., May 3-5.

Electronic Components Conference, Washington, D.C., May 3-5.

47th Annual Convention of the Western Psychological Association, San Francisco, Calif., May 4-6.

Meeting of the Electrochemical Society, Dallas, Tex., May 7-12.

Symposium on the Photochemistry of Polyatomic Molecules, sponsored by ARO-D and the University of Minnesota, Minneapolis, Minn., May 8-10.

Meeting of the American Society of Civil Engineers, Seattle, Wash., May 8-12.

Meeting of the American Society of Mechanical Engineers, N.Y.C., May 15-18.

Conference on Expandable and Modular Structures for Aerospace Applications, sponsored by AF Aero Propulsion Laboratory, Space General Corp., and GCA Viron Division, Miami Beach, Fla., May 15-19.

HumRRO Publishes Teaching Guide

An 85-page technical report titled *The Design of Instructional Systems* prepared by a U.S. Army contract agency, while slanted particularly to skill training, is a concise text almost any teacher could adapt for course planning.

The Human Resources Research Office (HumRRO), George Washington University, based the report on a survey of literature, drawing from HumRRO experience and methodology in training research. It was prepared for the Office of the Chief of Research and Development.

Robert G. Smith Jr., the author, also wrote *The Development of Training Objectives* (HumRRO Research Bulletin 11) and *Controlling the Quality of Training* (HumRRO Technical Report 65-6).

The Design of Instructional Systems summarizes the principles and techniques of learning which the author believes must be applied. Major sections deal with the instructional system as a concept, research evidence bearing on the major system functions, and methods for designing and evaluating the system in terms of cost and effectiveness.

The system is discussed in terms of development of training objectives, practice of task performance until an objective is obtained, practice of the knowledges and skills comprising the task, presentation of knowledge to the student, directing student activity to learning, and control of training.

Critical aspects of practice of performance covered include simulating the job task, using a detailed task description as a guide; providing for knowledge of results; arranging a suitable practice schedule; and maximizing transfer of training.

The practice-of-knowledge section covers analysis of the relationship between the cues and responses required by the knowledge, developing through practice a high level of achievement, and devising ways of making material meaningful.

The report notes that knowledge can be successfully presented in several ways, provided the presentation communicates to the student, the material is meaningful, and the special characteristics of the various media are taken into account.

The section on management of students deals with arrangements for dealing effectively with individual differences, reinforcement of learning, overall sequencing of tasks to be learned, and controlling avoidable class absences.

The report notes that automated instruction makes possible the consistent teaching of large numbers of students but has the drawback of not being easily modifiable for changing training requirements.

Selection of instructional devices and media and evaluation of the entire system, it is stressed, should be made in terms of cost and effectiveness.

Documented detail on various teaching techniques is provided, including specific guidance for setting up an instructional system and a formula for determining the sequence of teaching individual tasks.

"An Annotated Bibliography on the Design of Instructional Systems" to supplement the report is in preparation.

Further information on Technical Report 66-18 can be obtained from the HumRRO Research Information Coordinator, 300 North Washington Street, Alexandria, Va.

Army Plans Summer Jobs for ISF Winners

Army award winners of the 18th International Science Fair in San Francisco, Calif., May 10-13, will be offered summer jobs at Army research and development laboratories or week-long expense-paid lab visits to observe research in progress.

For the fourth year, Dr. J. Fred Oesterling, deputy scientific director for Research, Natick (Mass.) Laboratories, will serve as chairman of the Army panel of judges.

Army participation in the Science Fair is sponsored by the Office of the Chief of Research and Development and administered by the Programs and Concepts Branch, Scientific and Technical Information Division of the Army Research Office, OCRD. Project officer is Jack B. Fenn.

The Army panel of judges will select leading young scientists to receive certificates of achievement signed by the Secretary of the Army and the national director of Science Service, Inc., sponsor of some 230 annual science fairs which lead to the international event.

The Army, Navy and Air Force have been invited by the leading Japanese newspaper, *Yomiuri Shimbun*, to select one representative each to be sent to the Japan Student Science Awards Exhibit planned for January 1968 in Tokyo. The Army's choice last year was Kenneth L. Hurst of Ephrata (Pa.) High School.

Although the Department of Army panel of judges had not been selected at press time, officers of Army Reserve R&D units in Sacramento, Sunnyvale and Oakland, Calif., will judge the competition in various categories, as follows:

Environmental sciences—Lt Col Chester B. Shapero of the 6153d R&D Unit, research scientist at the NASA-Ames Research Center, and Lt Col Arthur R. Spurr of the 6157th, professor in the Department of Vegetable Crops, University of California, Davis, Calif.

Zoology—Capt John N. Grim of the 6157th, assistant professor of zoology, University of California.

Mathematics—Maj Harold T. Hahn of the 6153d, research specialist at the Lockheed Missiles and Space Co., and Maj J. Bradford John of the 6152d, associate research engineer, California Research Corp.

Physics—Maj Thomas A. Hughes of the 6151st, group superintendent at the Liquid Rocket Plant, Aerojet-General Corp., and Maj Frank K. Inami of the 6152d, project group leader, Lawrence Radiation Laboratory.

Chemistry—Col Ernest M. Card Jr. of the 6153d, chemical engineer, Food Machinery Corp., and Capt Paul H. Gilbert of the 6151st, assistant structural mechanics engineer, State of California.

Medical—Capt LeRoy L. Bertsch of the 6153d, research assistant, Stanford University Medical School.

AWC Briefs Swedish Army Maintenance Director

SWEDISH ARMY Director of Maintenance, Brig Gen Carl-Gustaf Bore Regardh, shows the Swedish Bremse Model 25-36, 7.92 machinegun during visit with Brig Gen William J. Durrenberger (right), CG of the U.S. Army Weapons Command (AWC), Rock Island (Ill.) Arsenal. General Regardh and his staff members (l. to r.) Karl Nial Andersson, Col Ake Sunesson Palmborg and Maj Sven Johan Sorman, were briefed on the AWC mission, involving more than a $1 billion-a-year program. The AWC manages research, design, development, procurement and logistics support for all U.S. Army weapons except missiles. Subordinate installations are Watervliet (N.Y.) Arsenal and Springfield (Mass.) Armory. Supporting work is performed at Frankford Arsenal and the Army Tank-Automotive Command.

3 Firms Awarded TACFIRE Contracts

Computerized control of artillery weapons moved ahead recently with award of contract definitions to three industrial teams for the Army's TACFIRE (Tactical Fire Direction System) program.

TACFIRE is the lead system of ADSAF (Automatic Data Systems for the Army in the Field), an overall tactical program to exploit the new technologies of data processing and subminiature electronics.

Three ADSAF systems will be developed. TACFIRE is a digital computer-based system designed to improve response time and accuracy of the field artillery by automation of certain data-handling functions. TACFIRE's general purpose hardware will provide the basis for equipping the other two tactical data systems.

Contract definition involves 5-month studies in which industrial teams headed by Burroughs Corp., Litton Industries and IBM Corp. will compete in technical designs. One will be selected for full-scale development.

Included in the definition phase is the requirement to plan and price a "total package procurement." This relatively new concept in Defense Department procurement includes in a subsequent contract terms for development, production and field support of a delivered system.

The Electronics Command, Fort Monmouth, N.J., is furnishing procurement and technical support to TACFIRE project manager, Brig Gen Roger M. Lilly, commander of the Automatic Data Field Systems Command (ADFSC), Fort Belvoir, Va. Col Frederick C. Spann, chief, TACFIRE Division ADFSC, is the contracting officer's representative.

Other Army agencies participating in the development program include the Ballistics Research Laboratory and HQ Test and Evaluation Command (TECOM), Aberdeen Proving Ground, Md., and TECOM test facilities at Fort Sill, Okla., White Sands, N.Mex., and Fort Huachuca, Ariz.; the U.S. Continental Army Command, Fort Monroe, Va.; the Combat Developments Command HQ, Fort Belvoir, Va., and its Artillery Agency, Fort Sill; Combined Arms Group, Fort Leavenworth, Kans.: Institute of Nuclear Studies, Fort Bliss, Tex.; Chemical-Biological-Radiological Element, Fort McClellan, Ala.; and the Army Behavioral Science Research Laboratory, Office of the Chief of Research and Development, Department of the Army.

IDEP Workshop Set In Texas, May 16-18

Representatives of the Military Departments, the National Aeronautics and Space Administration (NASA) and 160 major defense contractors will meet in Houston, Tex., May 16-18, for the Fifth Annual Interagency Data Exchange Program (IDEP) workshop.

Programed for the keynote address is Dr. B. L. Dorman, NASA Assistant Administrator for Industry Affairs. Lt Gen Thomas P. Gerrity, Air Force Deputy Chief of Staff for Systems and Logistics, will speak at the May 17 banquet.

Col Charles T. Campbell, chief, Technical Data Office, Army Materiel Command, is scheduled to give the luncheon address May 16. Capt H.B. West, USN, director of the Propulsion Division, Navy Air Systems Command, will speak at the luncheon May 18.

Organized eight years ago as the Interservice Data Exchange Program, IDEP provides for a timely exchange of component reliability, test and usage information among the member agencies. Contractors submit reliability reports on component items procured from vendors; reports are then circulated to other participants.

Primary purpose of the workshop is the training, education and indoctrination of the Contractor Data Coordinators responsible for coordinating the flow of data handled by the program. Topics to be discussed include cost effectiveness, new data media and failure analysis.

Nearly 180 defense contractors and government research facilities participate in IDEP. NASA became an official member last August after participating until that time through the Army representative.

Dr. John Hayes, Scientific and Technical Information (S&TI) Division, Army Research Office, Office of the Chief of Research and Development, was designated recently as the Army member of the IDEP Policy Board. He will be assisted by Jack B. Fenn, S&TI Division, who will serve as board secretary.

Conference administrative arrangements are being made by IDEP's Contractor Advisory Board, with Irving Jurist, North American Aviation, Inc., as chairman.

Army Research Scientists Author Article on Toxins

Two scientists of the Life Sciences Division of the U.S. Army Research Office, Arlington, Va., are coauthors of an article in the March issue of *Clinical Pharmacology and Therapeutics*, official publication of the American Therapeutic Society.

Dr. Carl Lamanna, bacteriologist and deputy division chief, and Dr. C. Jelleff Carr, pharmacologist and chief of the Scientific Analysis Branch, collaborated on "The Botulinal, Tetanal, and Enterostaphylococcal Toxins: A Review."

In an introduction, the authors state it is their wish "to stimulate awareness of the problems and opportunities existing for future studies of the nature and actions of the . . . toxins."

Successful methods of purification, they state, make it possible "to employ these toxins as specific reproducible and selective reagents or aids in the study of physiological and pharmacological questions."

Both scientists are authors of numerous articles published in bacteriological and pharmacological periodicals and each is a coauthor of advanced textbooks.

Basic Bacteriology—Its Biological and Chemical Background, by Dr. Lamanna and Johns Hopkins professor Dr. M. Frank Mallette, is in its third edition. Dr. Carr and University of Maryland professor Dr. John C. Krantz Jr. currently are working on the seventh edition of *The Pharmacologic Principles of Medical Practice*, first published in 1949.

MICOM Names Col Redmon Project Manager of Hawk

The U.S. Army Missile Command (MICOM) has assigned Col John G. Redmon as project manager for the Hawk Missile System at MICOM HQ, Redstone (Ala.) Arsenal.

Lonnie N. Hightower, who succeeded Col George H. McBride as acting project manager several months ago, will revert to deputy project manager.

A 1941 graduate of the U.S. Military Academy, Col Redmon was last assigned as senior ordnance adviser to the Republic of Korea Army. Before that he was chief, Army Field Office, Pacific Missile Range and Western Test Range.

Col Redmon received an MS degree in mechanical engineering from Massachusetts Institute of Technology in 1950. He is a graduate of the Command and General Staff College and the Industrial College of the Armed Forces.

CSC Announces Institute For Scientific Executives

The U.S. Civil Service Commission (CSC) has announced an "Institute for Executives in Scientific Programs," May 22-26, in Washington, D.C. Designed for officials with responsibility for formulating policy or program goals, it is limited to 25 civilian and military scientists, engineers, and R&D administrators at the GS-15 to GS-18 levels (or equivalents).

The institute affords those occupying executive and laboratory positions an opportunity to explore basic concepts and current issues relating to the evolving relationship between science and government. Members of Congress and leading authorities in universities, industry and policy levels of the federal government will be among the speakers.

Further information may be obtained by calling CSC on area code 202, 343-9441. Employes interested in taking the course must submit Optional Form 37 and OCSA Form 30 to the Training and Development Branch, Staff Civilian Personnel Division, Office, Chief of Staff, Army. Nominations from field facilities are particularly welcome.

Kudos

LEGION OF MERIT. The Oak Leaf Cluster (OLC) to the Legion of Merit (LOM) was presented recently to Col Thomas W. Davis III upon his retirement from more than 27 years of military service. A survivor of the battle of Corregidor, he served last as the Army Materiel Command project manager for Combat Vehicles, U.S. Army Weapons Command, Rock Island, Ill.

Col Joseph D. Goldstein received the LOM for his work as consultant to The Surgeon General in Nuclear Medicine and as chief of the Nuclear Energy Division, Medical Research and Development Command, Washington, D.C. He is chief, U.S. Army Medical Research Unit, Presidio of San Francisco, Calif.

Lt Col Cecilia P. Jamula, Army Nurse Corps, was honored with the LOM upon her retirement as supervisor of the Anesthesia Nursing Section, Walter Reed General Hospital (WRGH). At Fort Belvoir, Va., the LOM was presented to Capt Gerald M. Tippins and Capt Arthur E. Williams for 1966 meritorious service in Vietnam.

SILVER STAR. A first OLC to the Silver Star (SS) was presented to Capt John P. Sanders of Edgewood (Md.) Arsenal for service in Vietnam.

The SS and Bronze Star Medal with "V" device rewarded SFC Joseph E. Genereux for gallantry and heroism in Vietnam with the 101st Airborne Division. He is now stationed at Fort Huachuca, Ariz.

Believed the first Army Signal technician to receive the SS for valor in Vietnam, SFC Gerald H. Bamberg was until recently a troposcatter team chief with the U.S. Army Strategic Communications Command (STRATCOM). He is now assigned to a STRATCOM unit in Europe.

BRONZE STAR. The Bronze Star Medal (BSM) with OLC was presented to Maj Bruce D. Hartnitt, Capt Robert F. Greene and SFC Frank J. Maxon, all stationed at Fort Belvoir.

Other recent BSM recipients at Fort Belvoir are Maj Thomas C. Winter; Capts Ronald A. Adsitt, Roger A. Berg, James A. Brueggeman, Joe M. Cannon, Albert R. Colan, James D. Frost, Michael A. Jezior, Richard G. Riorden and Louis J. Shuba; 1st Lt James A. Fowler; and

SFC Herald E. Brown, SFC Harney D. Denham Jr., S/Sgt Charles D. Keen, Sp/5 Jerome E. Alexander, Sp/4 Garey D. Benton and Sp/4 Gerald J. Moses.

Maj Norman M. Rich, WRGH, received the Bronze Star and Army Commendation Medal for his work as chief, Surgery Department, 2d Surgical Hospital, An Khe, Vietnam, October 1965 to October 1966.

Capt Albert C. Keating, STRATCOM HQ at Fort Huachuca, Ariz., was awarded the BSM for performance with the 5th Special Forces Group in Vietnam. Capt William S. Cleverly, Communications Engineering Department at STRATCOM, received the BSM for duty in Southeast Asia. Sgt Roger L. Karnes and Sp/6 Kenneth A. Gould also received the BSM at Fort Huachuca.

SOLDIER'S MEDAL FOR HEROISM was awarded to Lt Col James E. Anderson, Armed Forces Institute of Pathology, for aiding a technician burned by sulphuric acid from a broken bottle.

JOINT SERVICE COMMENDATION MEDAL was presented to Lt Col Earle E. Dills and CWO Fernand H. Girouard, Fort Huachuca.

ARMY COMMENDATION MEDAL. Col Charles C. Alling, oral surgeon at WRGH, received the first OLC to the ACM for his work while serving as chief, Dental Research Branch, U.S. Army Research and Development Command. Lt Col Wilmot L. Gibson, MSC, administrator of the Department of Hospital Clinics at WRGH, and M/Sgt John J. Troxler, NCOIC, Department of Dentistry, U.S. Army Institute of Dental Research, also received the ACM.

Maj Marjorie A. Smith and Maj Betty F. Morgan at the Walter Reed Army Institute of Nursing also received ACMs.

The first OLC to the ACM was awarded to Maj Robert V. Wills, Doctrine Directorate, Combat Developments Command (CDC), Fort Belvoir, Va. Col John W. Moses, Materiel Directorate, CDC, received an ACM for his service with the U.S. Standardization Group, United Kingdom.

Lt Col Arthur T. Cummings, chief of staff, U.S. Army Satellite Communications (SATCOM)Agency, Fort Monmouth, N.J., received the ACM upon his retirement. At Fort Huachuca, the first OLC to the ACM was presented to Maj Oliver O. Leininger (retired). SFC Barney Blanco also received the ACM at Fort Huachuca.

PATRIOTIC CIVILIAN SERVICE. An Army Certificate of Appreciation for

General Taylor Cites Dr. Pollack of IDA

General Maxwell D. Taylor (USA, Ret.), Institute of Defense Analysis (IDA) president, recently presented the Outstanding Civilian Service Medal to Dr. Howard Pollack, IDA senior research staff member, for service to the Army.

IDA is a nonprofit research organization sponsored by 12 of the nation's leading universities. It conducts scientific studies under contract to the U.S. Government, primarily for the Office of the Secretary of Defense.

Dr. Pollack was cited for "providing profound advice, penetrating analyses, and sage counsel in the medical sciences" and "his rare preception and dedication to medical research to support Army requirements which provided the guidelines for an ever-expanding military medical research program."

With the cooperation of IDA in making his services available, Dr. Pollack has worked with the United Nations World Health Organization in defining medical requirements in developing countries, particularly in Africa and Asia. Working with Pan-American health organizations, he has chaired several committees to develop public health programs in the Latin American countries.

Dr. Pollack also is known for his studies on the medical aspects of life support systems for the National Aeronautics and Space Administration's Project Mercury man-in-space program. He has written more than 160 articles in scientific and professional journals, and is associate editor of the *Journal of Metabolism.*

Graduated from Cornell University Medical College with an MD degree, he earned a PhD in medicine from the University of Minnesota.

Dr. Pollack is a member of the board of directors of the American Heart Association, chairman of the advisory panel to the administrator of the Federal Aviation Agency, a member of the Interdepartmental Committee on Nutrition for National Defense, and a past director and member of the executive committee of the famed health organization, MEDICO, founded by the late Dr. Dooley.

International renown has greatly increased the demands on Dr. Pollack to serve as a consultant on medical and nutrition problems. He is currently a consultant to the U.S. Food and Drug Administration, The Army Surgeon General and other U.S. Government agencies. He is a Fellow of the American Medical Association, the American College of Physicians, and the New York Academy of Medicine, and a past member of the board of directors of the Health Council of Greater New York.

General Maxwell B. Taylor (USA, Ret.), and Dr. Herbert Pollack, IDA staff.

patriotic civilian service was presented to G. T. Willey, who retired Apr. 1 as vice president and general manager of the Orlando (Fla.) Division of the Martin Co. Maj. Gen John G. Zierdt, CG. U.S. Army Missile Command (MICOM), presented the award for "many years of personal effort by Willey in activities related to Army efforts in management and missile research and development, including the Pershing missile system."

CERTIFICATES OF ACHIEVEMENT (CA) were presented to MICOM employes Harold Martin, Curtis Stapler and Benjamin Wensinger. They spent 90 days in Vietnam as volunteer members of civilian specialists Quick Reaction Assistance Teams.

Lt Col Ian G. Gilmore, Australian Army Royal Engineers, was awarded a CA for "exceptionally meritorious service" as liaison officer to the U.S. Army Mobility Equipment Command's Engineer Research and Development Laboratories, Fort Belvoir, Va. Sp/4 Darrell R. Olsen, Fort Belvoir, received the same award.

Lt Col Quinn H. Becker, MC, assistant chief, Orthopedic Service, WRGH, was presented a CA for service as assistant chief of the Orthopedic Service at the U.S. Army Hospital in Wurtzburg, Germany.

INCENTIVE AWARD PROGRAM suggestions paid off recently for U.S. Army Aviation Test Activity personnel. Steve Mann, armament technician, received $1,000 for a suggestion to re-use aircraft armament pods in flight testing by parachute recovery methods.

Other prize-winning suggesters at Fort Huachuca were Sp/5 Brenda Dobbs, Frank O. D. Hayes, George M. Jossart, Joe Ferry, Lillian Alford, Monty E. Ward, Lois B. Spring, John H. Chevalier, Grant S. Owens, Harry W. Herman, Jimmie D. Boyles, Robert L. Connell, Helen R. Martinez, Jose Caballero, Raul Villasenor, Ralph Gorrell and M/Sgt Edward Philbin.

SPECIAL ACT AWARDS have been given to two employes of the Atmospheric Sciences Laboratory of the Army Electronics Command, Fort Monmouth, N.J. William C. Barr, a physicist and project director of studies of atmospheric electricity and cloud physics, received an award for "having significantly advanced the Army's knowledge of the electrical field near thunderstorms and laid the groundwork for future operations in weather modification."

Robert Olsen, an electronic technician, was commended for coordinating program needs and supervising installation of complex scientific equipment.

Special Act or Service Awards were presented to Fort Huachuca employes Jeanne T. Copland and Bernice Campbell.

OUTSTANDING PERFORMANCE RATINGS (OPR) at Fort Belvoir were given to Paul L. Whims, James H. Yeardley, Joseph F. Mancuso, Luther Little, LeRoy L. Stark and Carlos O. Segarra.

Fort Huachuca employes who received OPRs are Frederick B. Hoyle, Rio J. Charland, Wayne D. Haddock, Louise Moson, Joan Leininger, Rosalie A. Borboa, Juanita D. Gregory, Emma H. Walker and Juan V. Rojas.

John Carter, Weapons Development and Engineering Laboratories, Edgewood (Md.) Arsenal, also received an OPR.

STRATCOM Views Third Year Gains

Additional areas of responsibility assigned to the U.S. Army Strategic Communications Command during its third year of operation accounted for an increase in personnel strength from 16,000 to nearly 40,000—due almost entirely to transfer of functions and consolidation of commands.

STRATCOM CG Maj Gen Richard J Meyer, on the command's anniversary Mar. 1, noted its expanding role in worldwide communications and cited significant highlights of the past year, as follows:

• Activation of the 1st Signal Brigade as a major subordinate command to consolidate control of Army communications support elements in Southeast Asia, with responsibility for all communications requirements of the U.S. Military Assistance Commands in Vietnam and Thailand. Acquired approximately 6,000 new personnel in this new realignment.

• Activation of a major segment of the ET-A (European Tropo-Army) network, a major Department of Defense communications network spanning several nations in western Europe.

• Establishment of a Field Office in Korea to coordinate technical requirements for a Republic of Korea (ROKA) and Ministry of Communications (MDC) microwave system involving 55 sites.

• Incorporation of the 11th Signal Group, STRATCOM's air-mobile emergency communications unit—formerly a special subcommand—into STRATCOM-CONUS to provide support in depth.

• Assignment of operational control of all ground terminals, a 5-station transportable network, in the SYNCOM satellite program, plus fixed terminals at Fort Dix, N.J., and Camp Roberts, Calif., which are employed in development and testing of the Defense Satellite Communications System.

• Dedication of the first satellite terminal of the Initial Defense Satellite Communications System Program (IDSCP)—at Helemano, Hawaii. Eight such terminals were established around the world.

• Inauguration of a 2-hat concept of communications operations in U.S. Army Pacific (USARPAC) and U.S. Army South (USARSO), by consolidating most of the Army Signal units and resources down to the largest tactical maneuver unit under STRATCOM-Pacific and STRATCOM-South, respectively. STRATCOM acquired about 3,500 additional personnel. To accomplish its broadened mission, STRATCOM-Pacific assigned area responsibilities to five newly established Signal Groups, one each in Hawaii, Korea, Japan, Okinawa and Taiwan.

• Activation of STRATCOM Facility-Korea to operate and maintain Army portion of Defense Communications System.

• Relocation of HQ STRATCOM to Fort Huachuca, Ariz., was announced Dec. 14. With the prospect of continued growth and expansion of STRATCOM's mission, command officials are looking forward to greater operational effectiveness. General Meyer pointed out that facilities at Fort Huachuca permit assembling all headquarters elements under one roof, instead of having them scattered in four or five different locations in Washington, D.C.

ATAC Executive Selected for SARS Fellowship

Selected for a Secretary of the Army Research Study (SARS) Fellowship, Ronald A. Liston of the Army Tank-Automotive Command (ATAC), Warren, Mich., will enter Michigan Technological University in June for advanced study of soil mechanics.

Reportedly the first ATAC employe to receive a SARS Fellowship, Liston is chief of the Land Locomotion Laboratory and project engineer of the Quadruped Walking Machine Program (QWMP) involving a vehicle that uses legs instead of wheels.

In 1962 a QWMP feasibility study contract was awarded, followed by a design, development and construction contract to the General Electric Co. Liston has had a leading role in the developmental effort.

Related to land-locomotion mechanics, soil mechanics concerns engineering properties of soil such as compressibility, moisture content, and other aspects. Liston has been Land Locomotion Laboratory chief since 1960 after serving two years as assistant chief.

He received a BS degree in mechanical engineering and commission as second lieutenant through the Army ROTC program at the University of Vermont in 1950 and an MS degree from the University of Michigan in 1961. He served as an Ordnance test officer in Germany and later at Aberdeen (Md.) Proving Ground.

Approximately a dozen SARS Fellowships are awarded annually by a special Department of the Army panel to civilian employes directly involved in R&D.

Ronald A. Liston

Army Outlines R&D Objectives to Congress

(Continued from page 2)

capability objectives for which the solutions are considered to be technically feasible are:

(1) *Target location and identification* and *battle area surveillance* problems have become more demanding and complex with the advent of nuclear weapons, with resulting increases in dispersion as well as increased ranges of weapons and improved mobility.

(2) Significant improvement in the capability to conduct the full range of *combat activity under all conditions of reduced visibility* will provide a distinct advantage in the effective application of improved firepower and mobility.

(3) Improvements in *firepower* must be complemented by improvements in *tactical ground mobility* to exploit more effectively the art of maneuver as a function of land combat over increased distances and a variety of terrain conditions.

(4) The advantages of *air tactical mobility* have been demonstrated over and over again in Vietnam. The helicopter has made possible a divisional operational area much larger than if the same troops were required to move by surface means. Use of the new armed helicopters has provided us with unequalled flexibility in the application of firepower. However, at present they fall short of what technology can provide to furnish sufficient support to air-mobile operations, both in terms of speed and firepower.

(5) The field army of today is vulnerable to air attack. Discontinuation of the MAULER program has caused a delay in deployment of field army forward-area air-defense weapons. For the present, the Army must depend on HAWK, NIKE HERCULES and, soon, REDEYE to provide *forward area and theatre air defense.* Interim measures such as the VULCAN/CHAPARRAL are under development for the forward-area air-defense mission. The SAM-D will follow as a replacement for the HAWK and NIKE HERCULES.

(6) The large numbers of improved armored vehicles in the hands of potential enemy forces demand effective countermeasures. The development of highly effective ground launched *anti-tank weapon systems* such as SHILLELAGH, TOW and MAW has provided, or will provide, the defensive capability vitally needed.

(7) Increased mobility and dispersion have generated demands for *lighter, improved, ground weapons systems,* with greater range and accuracy, capable of delivering a variety of more lethal ordnances in a sophisticated countermeasures environment.

(8) ALL RDT&E activities which contribute to improved performance, increased reliability and reduced maintenance enhance the *overall logistics posture* of the Army. A constant effort aims to develop simpler, sturdier, more reliable and economical weapons and equipment. Improvements in these areas, even if minor, can result in substantial increases in effectiveness, because the resultant savings in money, time and manpower are repeated over and over again in the continuing operation of the logistics system.

(9) The Army would be less than prudent if it failed to pursue *development of defensive capabilities* in the chemical-biological field.

(10) The future battlefield will be characterized by an increased tempo of operations over widely dispersed areas and will have a complex electromagnetic environment. These conditions demand *improved, secure communications* and the application of new techniques and concepts.

(11) The Army must improve the capability of men and materiel to survive the *effects of nuclear weapons.* Our nuclear deterrent is no deterrent at all unless we are fully prepared to function in that difficult environment, should it become necessary.

(12) The conduct of modern warfare is an exceedingly complex and demanding task for the field commander. *Automatic Data Processing* will provide a capability to aid the field commander in the control and coordination of the forces for which he is responsible and in the most efficient application of his combat power.

An RDT&E effort confined to no specific Budget Program is PROVOST. Associated with the priority R&D program to respond quickly to Vietnam needs, by modification or improvement of current materiel items or accelerated development of special items, PROVOST approximates $120 million in FY 1967 and $83 million in FY 1968.

Over half of the appropriated sum in the FY 1967 supplemental is to be used, in con-

TECOM Names New Director of Test Facility at APG

Following a tour of duty in Vietnam, Col Stanton W. Josephson recently became director, Development and Proof Services (D&PS) of the Army Test and Evaluation Command (TECOM), Aberdeen (Md.) Proving Ground.

Col Josephson relieved Col George C. Clowes, APG Commander, who had doubled as acting director since the retirement last year of Col William L Clay. Col Josephson was graduated from the Ordnance School at APG in 1953.

One of the Army's oldest test facilities, D&PS started operations in 1917 when Aberdeen Proving Ground (APG) was established to succeed the Sandy Hook (N.J.) Proving Ground.

Before he became CO of the 52nd Ordnance Ammunition Group and director of ammunition, First Logistical Command in Vietnam, Col Josephson headed the Research and Development Directorate, U.S. Army Missile Command, Redstone Arsenal, Ala. (1964-1966).

Other recent assignments include CO, 82nd Ordnance Battalion and deputy commander, Advanced Weapons Support Command in Germany (1961-1963); and chief of the Overseas Test Branch, Military Applications Division of the Atomic Energy Commission, Washington, D.C. (1958-60).

Col Stanton W. Josephson

A 1942 graduate of the U.S. Military Academy, he received an MA degree from the University of California in 1948. He has attended the Command and General Staff College and the Industrial College of the Armed Forces. His decorations include the Legion of Merit, Bronze Star, Army Commendation Medal with Oak Leaf Cluster and campaign ribbons of World War II, Korea and Vietnam.

Col Josephson directs about 1,350 scientists, engineers and support personnel of the principal TECOM test facility, which comprises 90 percent of the APG land area —about 68,000 acres of land and water.

Technical director is Harry A. Noble, assisted by Deputy Directors J. A. Tolen (Engineering and Testing) and R. P. Witt (Supporting Services).

D&PS is not confined to Army ordnance items, but tests and proofs all Army materiel assigned by TECOM. The D&PS complex is equipped for instrumented firing of weapons with ranges up to 42,000 yards, testing of tanks and other tracked vehicles over specially engineered courses, and a wide variety of laboratory investigations.

The evolution of D&PS from the original "Proof Department" of APG began in 1923 when it was consolidated under Ordnance Testing and Automotive Testing. With World War II expansion, it became the "Proving Center" and in 1943 was the "Ordnance Research and Development Center."

In 1945, the Center was split into three units—D&PS, the Ballistic Research Laboratories, and Aberdeen Ordnance Depot, which was deactivated after a few years.

It is said that since the early 1920s "every gun, every lot of ammunition and every tank produced by the Army has borne in some fashion the 'imprint' of this organization's work."

junction with other available resources, to accelerate a development program aimed at providing a night-combat capability for our forces in Vietnam. SEANITEOPS denotes Southeast Asia Night Operations. Assembled in the program are the several night-vision, target-acquisition, and surveillance efforts which have been under way in the past few years.

SEANITEOPS includes an airborne target-detection system capable of acquiring moving targets under limited visibility conditions and a more powerful airborne gunsight than presently used.

Included are prototype night-vision devices in the weapons-mounted, hand-held, and head-mounted (goggles) modes; a stabilized night-vision device suitable for mounting on air and ground vehicles; a hand-held surveillance radar and a thermal imager; low-light level television and forward-looking infrared prototype systems for helicopters; and aircraft-mounted highpower searchlights.

Funds requested also support an electronic warfare quick-reaction requirement for Southeast Asia, and the Defense Communications Planning Group.

The FY 1968 program is some $22 million lower than the FY 1967 program. A special effort was made during the budget process to delete marginal efforts—to defer projects whose postponement would not have a serious adverse effect on future military capabilities—to meet the needs growing out of the Southeast Asia situation.

During the budget process, adjustments to the Army's program were made to keep the average civilian grade and salary to about the FY 1966 level and to provide for improvements in productivity of assigned personnel. The level of in-house work is expected to remain relatively stable, although costs are increasing.

The remainder of the discussion will be in program category terms by budget activity and will be related to Table 3.

Military Sciences. This program provides for new ideas and basic concepts. It finances research where the goal is primarily an increase in the reservoir of fundamental knowledge adaptable to the solution of widely variant future operational requirements. Exploratory development is also financed to apply new knowledge to solutions of known or anticipated military requirements.

Research is necessary to the continued progress of R&D because resultant fundamental discoveries are ingested into the concept phase of new materiel and provide the starting point for the entire R&D cycle. Research then continues to contribute valuable inputs throughout the cycle.

Initial results of Project HINDSIGHT, an effectiveness study of our research and exploratory development programs, have demonstrated that there is a large payoff of the research program in terms of improved weapons systems. For example, in rocket systems, the cost, weight, and reliability have been improved by factors of two to ten. In radar, present models are five or more times superior to those of the World War II era.

Management of research is usually in terms of level-of-effort and primarily in terms of discipline, i.e., materials, general physics, chemistry, etc. The category also includes the In-house Laboratory Independent Research (ILIR) effort, which will continue at the same level as FY 1967. The THEMIS program, previously known as the University program, is also included.

Much of the exploratory development work in this activity is of the sustained level-of-effort type. It covers information processing, materials, human factors, environment, biomedical investigations and others. The major increase is due to efforts to combat malaria and diarrheal disease in Vietnam.

Funded under this budget program are studies and analyses to support the planning function by assisting in the identification of critical decision areas, detection of potential problems, predicting the consequences of various alternatives, and the development of integrated decisions relating to complex problems.

In-house and contract effort are closely coordinated to achieve the required objective. The scope of the study effort relates to developing concepts of organization, doctrine, materiel, and employment of Army

(Continued on page 32)

TABLE 3
FY 1968 Program Category
($ In Millions)

Budget Activity	Research 6.11	Exploratory Development 6.21	Advanced Development 6.31	Engineering Development 6.41	Management & Support 6.51	Operational Systems 6.71	Total
Military Sciences	87.3	62.4	.7		15.0		165.4
Aircraft		19.5	25.6	22.5		48.1	115.7
Missiles		30.5	62.5	412.3	116.3	84.6	706.2
Military Astronautics			11.1				11.1
Ships and Small Craft				.9			.9
Ordnance and Combat Vehicles		46.5	29.4	66.3		41.4	183.6
Other Equipment		57.4	88.6	73.9	59.4	30.0	390.3
Programwide Management and Support					78.1	.7	78.8
TOTAL	87.3	216.3	217.9	575.9	268.8	204.8	1571.0

Titanium Hardcoating Tested for Helicopter Engines

An anodized "hardcoating" for titanium developed by a Watervliet (N.Y.) Arsenal Army scientist is being investigated as an erosion preventive for helicopter engines in Vietnam.

Theodore M. Pochily, a chemist in the arsenal's Research and Engineering Division, compounded the coating. It is being tested at the Army Aero Depot Maintenance Center (ARADMAC), Corpus Christi, Tex., as a protective binder for the T-53 gas-turbine engine for the UH-1 helicopter.

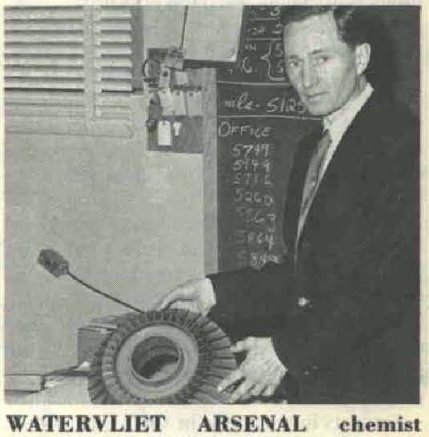
ARADMAC has responsibility for Army helicopter maintenance and operation. Erosion on the engine's titanium compressor and turbine components is caused by the intake of "debris" during operations over Vietnamese rice paddies and beaches.

Salt-laden beach sand drawn into the engine's intake accelerates to a velocity of 2,000 feet per second, resulting in considerable metal removal from titanium components.

Developed two years ago, the coating was improved recently by Pochily's origination of a technique which deposits energy-absorbing material to retard abrasion and wear. It prevents titanium from "galling" or seizing upon itself when used as a bearing surface.

The high-temperature elastomer coating is expected to reduce the impingement erosion in addition to providing a certain measure of corrosion protection. By treating the anodic coating with a mild acid etch, a more receptive surface with a greater degree of adhesion for supplemental coatings is assured.

More than 60 private firms and government agencies have expressed interest in the anodizing process, first employed at the arsenal to coat experimental mortars. Among them are aircraft firms, which have tested the coating for several applications on components of the supersonic transport (SST), the Lockheed C5A transport and the F-111 experimental aircraft.



WATERVLIET ARSENAL chemist Theodore M. Pochily displays "Huey" helicopter housing treated with a protective anodized "hardcoating" and an energy-absorbing "elastomer" which retard erosion in titanium compounds.

Army Outlines R&D Objectives to Congress

(Continued from page 31)

combat forces in future warfare. Types of studies include costs analysis, comparisons of organizations and systems, war gaming of Army plans, and analysis of strategic aspects of selected world areas and their possible future interactions with U.S. policy.

Aircraft and Related Equipment. Work financed in this activity advances the state-of-the-art in air mobility and aerial firepower. Air mobility has added a new dimension to the battlefield and airmobile units are now a firmly established part of the Army's force structure. R&D efforts include piloted aircraft, components and accessories, aircraft suppressive fire systems and avionics.

Exploratory development is directed toward exploring concepts of new and follow-on aircraft suppressive fire weapons, avionics, improvement in aerodynamic qualities of aircraft suppressive fire weapons, avionics, improvement in aerodynamic qualities of aircraft as well as reliability, capability and availability, and to provide technology with emphasis on low-speed and V/STOL aircraft research.

The Army Research Helicopter Program has resulted in marked advances in technology and performance with speeds and stability unattainable a decade ago. Major effort currently is on the Advanced High-Speed Rotary-Wing Project, more commonly referred to as a Composite Research Aircraft Program. FY 1968 work will be directed to wind tunnel and dynamic scale models of stowed and tilt-rotor models.

Aircraft Suppressive Fire System work is on improved helicopter-borne weapons. Operational System development work is directed to the engineering of specific hardware items, involving continued work in weapons systems and aircrew armor. To increase the effectiveness of the aircraft armament, several aircraft weaponization projects are being given top priority.

The proximity airburst fuze for the 2.75" rocket is an outstanding example of quick reaction in response to an urgent requirement in Vietnam. It is much more effective than the impact fuze, depending upon the type of target. Results of this program, started in February 1966, have been extremely successful.

Over the past several years, the Army has been developing and perfecting armor for use by pilots and aircrewmen. The armor, formed from rigid ballistic materials, such as aluminum oxide, silicon carbide, and boron carbide, is worn selectively to protect the torso, buttocks, groin, thighs and legs.

Since its introduction in Vietnam in 1966, crew armor, including the armored seats for pilots, the chest protector and the torso armor, has either saved the life of or prevented a major wound to at least 100 aircrewmen.

Project SEAMORE will contribute to meeting the requirement for an improved intelligence-gathering capability. It will improve sensors used in the MOHAWK aircraft and will result in an increase in the effectiveness of the infrared and side-looking airborne radar sensors.

General Westmoreland stated in July 1965 that an urgent requirement existed for an improved armed helicopter to escort the present troop-carrying helicopter without having to degrade the speed capability.

To fill this critical need in the shortest possible time, the Army initiated a program on the UH-1 series aircraft to provide an improved armed helicopter as an interim measure, pending development of the integrated 3-dimensional Advanced Aerial Fire Support System (AH-56A). This interim armed helicopter, designated the HUEYCOBRA, is being flight tested.

The AH-56A appears to be the best aerial weapons system compatible with troop-lift helicopters that can satisfy the Army's divergent needs. The AH-56A development program is on schedule and a full-scale mockup has been constructed. With its day-and-night target-detection and weapons-employment capability, it will be the most versatile and potent aerial weapons system the Army has ever developed.

Missiles. This budget category finances work on surface-to-air and surface-to-surface missile systems and supporting equipment. Included are support costs of two national ranges operated by the Army—White Sands Missile Range, N. Mex., and Kwajalein Test Site in the Pacific Ocean.

The single largest effort in the Army RDT&E budget—NIKE-X, one of the nation's highest priority programs—is in this activity, funded at a proposed level of $443 million in FY 1968. The SPRINT missile, one of the system's interceptors, is propelled by a gas-driven piston from its underground silo, and can travel one mile in the time it takes your heart to beat twice.

NIKE-X radars engineering development has advanced to the point where the emphasis has shifted from the drawing board to the fabrication and testing of hardware. Radar beam forming and beam steering equipment for the Tactical Multifunction Army Radar, or TACMAR, is being fabricated and assembled for testing prior to shipment to Kwajalein Test Site. The tactical prototype of the TACMAR will be constructed and tested at Kwajalein.

In September 1966, a second-stage static test firing of the SPARTAN missile was conducted satisfactorily at Restone Arsenal, Ala. Formerly identified as the ZEUS DM15 X-2, the redesigned missile provides the NIKE-X system with a capability to intercept targets at greater ranges, higher altitudes and to carry a more lethal warhead than the DM15 X-2, which repeatedly demonstrated a capability to intercept live ICBM-type targets over the Pacific Missile Range.

Exploratory development of missile components, systems studies, aerodynamics, new propellants and motors and propulsion techniques will continue at a lower level than in FY 1967. This is due primarily to the movement of some component tasks to the advanced development stage.

Advanced development will continue on Forward Area Defense Systems, evaluation of combinations of missile components and subsystems based on exploratory effort, and the Surface-to-Air Missile (SAM-D), an advanced air defense system to replace the Hercules and Hawk batteries.

The threat has increased over the years so that now U.S. air defenses are faced with targets that are much faster, harder to locate and more difficult to destroy. However, advances in fields of phased-array radar technology, digital computers and electronic componentry, such as microelectronics and integrated circuits, now promise the possibility of an air-defense system capable of coping with this threat.

SAM-D will provide a more effective air and missile defense for the field army with fewer batteries, and it has a potential application for continental air defense. The program is closely related to the Navy's Advanced Surface-to-Air Missile System program.

The SAM-D is in a contract definition phase, which should determine whether to proceed directly with development of an integrated system suitable for direct operational use, to limit development to a prototype for feasibility demonstration, or to return to concept formulation.

Engineering and Operational Systems developments in the budget proposal provide primarily for work on equipment for evaluating and testing missile systems, for Lance, Pershing, Vulcan/Chaparral, Hawk and Hercules.

The Lance guided missile, with improved accuracy, provides a significant improvement over the aging Honest John and Little John rockets it will replace. The Lance system is more mobile, lighter in weight, more rugged, and has the ability to swim inland waterways.

Including the most desirable characteristics of both free rockets and guided missiles, the Lance is currently in the advanced stages of development. The major portion of the FY 1968 RDTE funds will finance the engineering service tests.

The longest-range missile in the Army inventory is the Pershing, an inertially guided ballistic missile capable of carrying a nuclear warhead 100 to 400 miles. Currently deployed in Europe in the tracked-vehicle configuration, Pershing has in the past year undertaken a new mission there—that of quick reaction alert (QRA).

This new QRA role demands improved capabilities. A ground support equipment improvement program will include work on a better erector-launcher and programer test station, as well as a change to wheeled

vehicles. Items under development will result in improved road mobility, faster reaction time, and a better command and control capability.

To provide air defense against enemy tactical aircraft on low-altitude missions, the U.S. Army is continuing development of the VULCAN/CHAPARRAL system for deployment in the forward areas of the field army as well as installations in rear areas.

Composite battalions of VULCAN/CHAPARRAL containing a mix of missiles and guns will provide an effective, comparatively low-cost, high-density type system. The CHAPARRAL employs the passive homing, modified Sidewinder 1C infrared missile on a newly designed turret and pallet capable of independent operation.

Mobility is normally derived by mounting the CHAPARRAL on a modified M548 Full Track Cargo Carrier. A complementary point defense gun system called the M61 Vulcan is a 6-barreled, 20mm Gatling gun similar to that used on our U.S. Air Force tactical fighters.

Adapted for ground use and mounted on a modified M113 Personnel Carrier, with selective firing options, VULCAN is a versatile weapons system fully capable of engaging ground as well as airborne targets.

Deployed with each VULCAN/CHAPARRAL platoon will be a simple Forward Area Alert Radar (FAAR), capable of providing additional early warning and Identification Friend or Foe (IFF) of aircraft within its detection area.

Efforts are underway to ensure that Hercules and Hawk will continue to operate effectively in the 1970s. This work will provide a hedge against possible slippage in SAM-D development.

The budgetary Management and Support category provides for operation of two National Ranges—Kwajalein Test Site (KTS) and White Sands Missile Range. Activities at Kwajalein, some 4,300 miles southwest of Los Angeles, are increasing.

A significant portion of the current mission of KTS involves range support to Advanced Research Projects Agency for its ballistic missile reentry measurements programs. Kwajalein also serves as a downrange impact area for scoring of ICBMs launched from Vandenberg Air Force Base, Calif.

Improved instrumentation and ability of the White Sands Missile Range to support off-range launches has increased greatly the capability to support an increased variety of missile and space programs.

For example, the Air Force ATHENA program, which involves firings from Green River, Utah, 471 miles north of White Sands, is one of the range's largest users. These tests are part of the Advanced Ballistic Reentry System. Its mission: To test the behavior of missiles and ground radars during the reentry phase of flight.

Military Astronautics. To meet the long-haul communications needs of the military, particularly in Southeast Asia, the Army is developing transportable satellite communications ground terminals.

Oriented at the tactical level is a second satellite communications R&D effort, under the same budget program, which addresses the current urgent communications needs of field commanders for a reliable Command Control System, employing highly mobile ground terminals.

The air delivery to Saigon in November 1966 of an AN/MSC-46 satellite communications terminal climaxed a successful year of R&D in satellite communications.

Fourteen 60-ton transportable terminals, each of which can provide 2 voice and 2 teletype channels simultaneously, with a growth potential to 11 channels, are being built by Hughes Aircraft Co. for the Army.

Three were in place and ready for communications R&D testing at locations in Hawaii, Western Germany and the Philippines June 16, 1966, when the first seven Initial Defense Communications Satellites were launched. Since then, three additional terminals have been deployed.

The first production model of the lightweight AN/TSC-54, a new family of satellite communications terminals being built for the U.S. Army by Radiation Inc., has been delivered.

With an 80 percent weight reduction, compared to the AN/MSC-46, the AN/TSC-54, with antenna folded, can be transported in a single C-130-E aircraft together with a crew of six.

This capability satisfies the tri-Service requirement for a highly transportable, quick-reaction terminal which is better suited for contingency operations than the AN/MSC-46. Environmental testing started in January 1967.

For the Tactical Satellite Communications Program, in which the satellite carries more of the electronic and power burden than in the strategic system, a family of quarter-ton, jeep-mounted and three-quarter ton shelter-housed terminals has been designed.

The field commander will be provided with a terminal which is easily transportable, although some of the capabilities of the major terminals must be sacrificed to achieve this transportability.

The terminals will be tested in a tri-Service program employing the Air Force-developed Lincoln experimental satellites. Development efforts among the three Services are continuing.

Ships, Small Craft and Related Equipment. This program provides for the development of Beach Discharge Lighter MB II, initiates development of a Harbor Tug, evaluates new advances in marine propulsion techniques and marine equipment, and studies new amphibian concepts and designs.

Ordnance and Combat Vehicles. This program provides for ground firepower delivery systems (other than missiles), munitions, weapons and vehicles critical to maintaining a superior edge in combat. Areas of coverage include Field Artillery, Infantry and Armor weapon systems, chemical and biological munitions, nuclear and nonnuclear munitions, antitank weapon systems, and combat and combat-support vehicles.

Exploratory development will continue on surface mobility techniques and components, chemical-biological techniques, and various firepower (other than missiles) at a somewhat reduced level from FY 1967.

Advanced Development efforts involve power systems and convertors, nuclear munitions, chemical-biological techniques program, a field artillery direct support weapon, mine warfare, an antitank weapon system and a lightweight howitzer.

Antitank work is directed to evaluation of new missile concepts and toward identifying those system characteristics which together seem to offer the best chance of achieving

(Continued on page 34)

OKLAHOMA STATE UNIVERSITY leaders invited a distinguished graduate of the Class of 1939, Dr. K. C. Emerson, Assistant for Research, Office of the Assistant Secretary of the Army (Research and Development), to inspect the institution's research facilities. Pictured are (left to right) Dr. V. S. Haneman, director of engineering research; Dr. Emerson; Dr. Robert Kamm, OSU president; and Dr. Marvin T. Edmison, director, OSU Research Foundation. Dr. Emerson also visited Oklahoma University for similar observation of research facilities.

Army Outlines R&D Objectives to Congress

(Continued from page 33)

an effective low-cost antitank weapon.

The lightweight howitzer effort will support the development of a 155mm self-propelled weapon.

Engineering and Operational Systems (EOS) development can generally be structured in terms of firepower and mobility.

Firepower includes Infantry and individual support weapons, field artillery weapons, munitions and equipment, nuclear munitions, CB weapons, fortifications, mines and obstacles, TOW, the Medium Antitank/Assault Weapon and Shillelagh.

The MAAW is one of the largest projects in this type of activity. The Army has a requirement for a medium antitank/assault weapon that is lightweight, man-portable, accurate and that will provide an antitank/assault capability for all infantry platoons far superior in range, weight and lethality to the current crew-served 90mm recoilless rifle it will replace.

The primary purpose of this weapon is to defeat enemy armored vehicles. The 28.7-pound MAAW presently being developed will weigh the odds in favor of our frontline soldier.

The gunner needs only to place and keep the cross hairs of the conventional telescopic sight on the target. Once fired, the missile is automatically tracked and commanded to follow the line-of-sight.

Shillelagh has reached the point of quantity procurement and TOW is planned for initial procurement.

Mobility work includes wheeled vehicles, tracked special vehicles and the Main Battle Tank-70. Engineering development will be initiated on the new 1¼-ton XM-705 truck for use in rear areas. Work will continue on a new armored reconnaissance vehicle capable of operation in adverse terrain and the "mechanized infantry combat vehicle-70," a replacement for the current personnel carrier.

The MBT-70 has taken shape after extensive parametric design and cost-effectiveness analyses and will provide us with the firepower, mobility, and protection envisioned at the outset of the program. Its missle armament, supplemented by a conventional tank gun system utilizing both kinetic energy and high-explosive antitank ammunition, provides a flexible tank kill capability across a wide spectrum of ranges.

Equipped with a new power package and suspension which enables it to operate cross-country much faster than tanks we know today, the MBT-70 will be capable of operating 48 hours without maintenance.

The MBT-70 weapon system is composed of the Shillelagh missile system for the defeat of armored vehicles and other hard targets by direct fire. In addition, the kinetic energy gun capability will defeat stationary or moving armored vehicles.

Other Equipment. This activity provides for a broad range of materiel and equipment which cannot be directly associated with the previously discussed activities. It includes communications-electronics, communications security, electronic warfare, surveillance and target acquisition, night-vision, mapping and geodesy, chemical-biological (CB) warfare, defensive measures, general combat support and combat feeding, clothing and equipment.

Operational cost of the Limited War Laboratory, the Army Electronics Proving Ground and Army-wide engineering and service testing is included in this item.

The provision of an improved defensive capability against CB weapons is concentrated on physical protective devices, as complete medical protection is not foreseeable at this time. Research and exploratory development is being conducted toward providing an individual with his own micro-environment. Improved warning devices, vaccines, treatment for potential biological agents and, to a lesser extent, investigations of immunological techniques for chemical agents are under development.

Advanced Development includes work of the Limited War Laboratory—the Army's quick-reaction R&D facility for counter-insurgency operations, fuel cell research, CB defense, communications development, surveillance and target acquisition, intelligence and electronic warfare, night-vision and therapeutic development.

This last budget item continues the development and testing of new antimalarial drugs. Fuel cell work is new to this category in FY 1968.

The powered equipment employed by a modern Army, such as vehicles, cargo-handling equipment, and aircraft, draws the required energy for operation almost exclusively from internal combustion engines. A vast array of ancillary equipment, such as communications equipment and generators, is also powered by these primary power sources or, to a much lesser extent, from batteries.

Internal combustion engines have the disadvantages of noise, mechanical complexity, weight, bulk and the requirement for a continuous supply of fuel. Batteries have the serious drawback of a short life.

A current project which has great potential for overcoming the disadvantages of internal combustion engines and batteries is the fuel cell development program. Successful employment of fuel cells as a power source could be a major step in fulfilling the requirement for improved logistics in the Army. Some of these fuel cells are being tested in Vietnam.

Fuel cells are also being developed to provide power for future electric propulsion systems. The 94-horsepower internal combustion engine normally used in an 8,000-pound truck has been replaced by a 40-kilowatt hydrazine fuel cell.

The vehicle is strictly experimental and will probably not have extensive military application for at least a decade, but it is giving us vital information of the interrelationship between a fuel cell and an electric propulsion system.

The Army's goal is to develop a fuel cell system which will burn gasoline or other conventional hydrocarbons. Some engineers believe they can reach this goal within the next decade.

Since the ultimate fuel cell system could conceivably drive a truck 150 miles on a gallon, it could very well be one of the most significant logistics developments in history.

Automatic Data Systems for the Army in the field are being developed. Electronic data processing equipment can help the field commander maintain and analyze data on his own and enemy units tactical status and determine various alternatives to tactical plans. A series of exercises will be conducted on an experimental system.

Protective Equipment. Investigations are under way to produce individual and collective protective equipment and clothing which is lighter, more effective, and less impeding in the conduct of operations. A newly developed collective protection device is the CB Pod.

Management and Support provides for testing activities at the U.S. Army Electronic Proving Ground, Dugway Proving Ground, Project Deseret and the Army test boards.

Program-wide Management and Support. The last program provides for expenses incident to the operation of RDT&E facilities which cannot be attributed to specific projects. This covers support of facilities and installations, management costs and special-purpose equipment.

Within the overall R&D program, over 500 separate projects are being funded. In a paper such as this, it is, of course, out of the question even to mention a majority of them. Projects mentioned have been chosen either for their military importance, their bright promise, their boldness of concept, their fiscal prominence in the program, or a combination of these. They provide a representative sampling of the type of work being done.

The overall program is based on the requirement that R&D be responsive to the operational requirements of the Army, by generating equipment with the required characteristics necessary to meet the threat the Army faces and will face.

The weapons and equipment under development may be the result of the regular R&D cycle or they may be the result of a quick-reaction program such as PROVOST for requirements in Southeast Asia.

Whatever their initial stimulus, the R&D programs presented to Congress are all designed to contribute to the combat capability of the Army in the coming year and initiate the actions to assure the continuation of that capability in years to come.

Behavioral Sciences Research. In seeking advanced scientific techniques for application to the goal of the most effective possi-

ble utilization of military manpower through selection, classification and training, the Army has achieved savings far in excess of the cost of the research involved.

Admittedly, it is more difficult to show concretely what gains result from this research effort than it is to offer the clear proof that is evident in military hardware and equipment that is new or improved by R&D.

Some of the results of behavioral sciences research, however, are far-reaching in impact and are furnishing convincing evidence that activity in this field of investigation might profitably be expanded.

For example, this effort has provided an inexpensive self-study course in the Vietnamese language being used by the U.S. Marine Corps as well as by the Army. In Korea, a study has resulted in development of a handbook and checklists that are proving valuable in the KATUSA Program.

Stress studies have produced knowledge to reduce the negative effects of stress on combat personnel. Programmed texts for Nike Hercules system fire control platoon leaders have been furnished to every NH battery for self-study by battery officers. Critical human factors problems in the use of the new passive night-vision devices are being investigated, and more effective training for their use is being developed.

White Sands Range Tests Redesigned Hawk Missile

Testing of an improved Hawk missile, redesigned as a more reliable and capable defense against enemy aircraft, is being conducted at White Sands Missile Range.

Outward configuration of the 16-foot supersonic missile is unchanged. Tests involve a new guidance package, larger warhead, and improved motor propellant under the improvement program started in late 1964. A "wooden round" concept, obtained by use of solid-state components, eliminates maintenance and adjustments in the field.

Ground electronics equipment also is being modified. An improved continuous-wave acquisition radar will sweep the area of defense. When an enemy aircraft is detected, a high-power illuminator radar will "light" the target with a beam of radio waves. These waves bounce back to a receiver in the missile, which tracks the target by homing along the reflected beam.

Helicopters and medium-sized aircraft can lift Hawk and its ground support equipment. Some Hawk units are being converted to a self-propelled configuration mounted on full-tracked vehicles for added mobility.

Hawk is in operation with U.S. Army and Marine Corps troops overseas as well as in the United States. The system is also built and operated by a North Atlantic Treaty Organization consortium.

The U.S. Army Missile Command at Redstone (Ala.) Arsenal is responsible for technical supervision of Hawk, with Col John G. Redmon as project manager.

ECOM Gives 2 Advisers Command Authority

In keeping with Army Materiel Command (AMC) policy of assigning command responsibility to scientific advisers, the U.S. Army Electronics Command (ECOM), Fort Monmouth, N.J., has increased authority of two veteran officials.

Dr. Hans K. Ziegler is now deputy for science and also retains his advisory role of chief scientist. Chief engineer A. W. Rogers also carries a new title of deputy for engineering. Both assume command authority under Maj Gen W. B. Latta, CG.

Dr. Ziegler now has "primary responsibility for the scientific activities of the command throughout the range of the materiel life cycle, for preparation and issuance of scientific policy and guidance in the formulation and execution of the materiel plans and programs of the command, and for supervision of compliance therewith." He will provide "command direction, guidance and supervision for all scientific work of the command."

Similar responsibilities in the engineering field are given Mr. Rogers.

Other duties assigned to them in their respective fields include program guidance on research, development, testing and evaluation; analysis of technical intelligence; review of plans and programs and budget submissions; and liaison with other AMC commodity commands in science and engineering.

Dr. Ziegler has been at Fort Monmouth since 1947, when he came to the United States from Germany. Rogers has been with the government since 1942 as an officer during World War II and a civilian thereafter. With the exception of two years in the Office of the Chief Signal Officer in Washington, all of his civilian service has been at Fort Monmouth.

WSMR Installs Electronic Communications Network

Communications lines that can carry 2,880 voice channels over the 4,000 square miles of White Sands (N. Mex.) Missile Range are being installed to keep pace with increasingly sophisticated missile systems.

Eight control centers and two line-of-sight relay stations are nearing completion in a system designed to transmit missile-firing data at the rate of 24,000 bits per second, with an error rate of less than one per million. The communications channels will be used for transmission of radio, television, high-speed data, or in combination.

Installation of the microwave-multiplex and high-speed data system is part of a $2 million range modernization program started early in 1965. Called the Instrumentation Data Transmission System (IDTS), the electronic network will tie in with range instrumentation to give full data and evaluation of each missile fired.

Technological Forecasting Committee Meets in Europe

Western Europe was the research arena last month for a 3-man tri-Service segment of the steering committee studying technological forecasting methodology.

Dr. Samuel Rothman, acting director of the Exploratory Development Division, U.S. Naval Material Command (NMC), headed the group. It consisted of Howard A. Wells, U.S. Air Force Systems Command; Halvor T. Darracott, U.S. Army Materiel Command; and Marvin J. Cetron, NMC.

Meetings were held with the International Organization for Economic Cooperation and Development in Paris, the Federation of West Germany System Study Group in Heidelberg, and British tech forecasters of the Ministry of Defence in London.

The 3-month study is scheduled to be completed by Apr. 30. The tech forecasting committee, representing various R&D elements of the Army, Navy and Air Force, is hopeful that a composite manual of collective findings and analyses of forecasting methodology will be available this spring.

In addition to collecting vital meteorological data, the Army teams receive valuable training during work with NSSL scientists.

Army Math Seminar Slated

An advanced seminar on "Stochastic Optimization and Control Procedures" will be held at the Mathematics Research Center, U.S. Army, on the University of Wisconsin campus, Oct. 2-4.

Further information may be obtained by writing to Prof. Herman F. Karreman, Mathematics Research Center, U.S. Army, University of Wisconsin, Madison, Wis. 53706.

4 Army Met Teams Support Project Tornado Alley

Project Tornado Alley, a concerted 60-day upper-air research project supported by four U.S. Army meteorological teams, will begin Apr. 15 in the severe-storm area of north Texas and western Oklahoma.

The Army is participating for the sixth year at the invitation of Dr. Edwin Kossler, director of the National Severe-Storm Laboratory (NSSL) of the Environmental Science Services Administration (ESSA), U.S. Department of Commerce, Norman, Okla.

About 25 specialists provided by the U.S. Continental Army Command and the Army Electronics Command from Fort Sill, Okla., and Fort Huachuca, Ariz., are operating a network of rawinsonde stations at Wichita Falls, Tex., and Fort Sill, Altus and Chickasha, Okla.

Charles Schaefer

William Wyatt

Dr. Maxine Savitz

Charles Sarle

Rudolph Messerschmidt

Joseph Boneta

Richard Schmitt

John Kerr

USAERDL Nominates 12 Employes For Special Achievement Awards

Winners of Scientific Achievement, Technological Achievement, and Leadership Awards presented annually by the commander of the U.S. Army Engineer R&D Laboratories (USAERDL) at Fort Belvoir, Va., will be announced at ceremonies May 19.

Twelve scientists, engineers and supervisors have been nominated—two for scientific achievement, four for technical achievement, and six for the leadership award.

Selections this year were made by USAERDL commander Col Frank Milner and the R&D Directorate, based on nominations made by department chiefs and staff officers. Each nominee will receive a certificate of achievement and a cash award. Winners will receive engraved medals mounted on plaques.

Scientific and technological award winners are selected on the basis of individual accomplishments in science and engineering. The Leadership Award recognizes individual accomplishment in organizing or directing an activity or a group with efficiency, while maintaining high group morale.

SCIENTIFIC NOMINEES for awards this year are Dr. Maxine L. Savitz and William T. Wyatt Jr.

Dr. Savitz, a senior research electrochemist, was selected by the Electrotechnology Department for her contributions to the fuel cell program, particularly the reaction involved in direct oxidation hydro-carbon fuel cells. Dr. Savitz also represented the department for the award last year.

Wyatt, a 25-year-old physicist, was named by the Military Technology Department for his work on nuclear electromagnetic pulse effects. He has contributed significantly to knowledge of the physics of electron mobility in moist air.

TECHNOLOGY NOMINEES are Charles M. Schaefer, Richard W. Helmke, Charles R. Sarle and Rudolph Messerschmidt.

Schaefer represents the Engineering Department in recognition of his work in providing all technical support for quantity procurement of various generator sets.

Helmke, Military Technology Department, was nominated for his contributions in developing an experimental lightweight bridge structure as an in-house laboratory project.

Sarle, Electrotechnology Department, was named on the basis of his outstanding work in development of turbocharging engines.

Messerschmidt was selected by the Mechanical Technology Department for his work in developing a CONEX transporter.

LEADERSHIP NOMINEES and the departments they represent are:

John V. Kerr, Engineering Department; *William C. Hall*, R&D Procurement Office; *Richard P. Schmitt*, Military Technology Department; *Joseph P. Boneta*, Electrotechnology Department; *Frank Robertson*, Technical Research and Support Department; *Arthur Rutherford*, Mechanical Technology Dept.

Richard Helmke

Arthur Rutherford

William Hall

Frank Robertson