ARMY RESEARCH AND DEVELOPMENT

Progress in Materials Research... Page 16

MAY-JUNE 1976

U.S. Army Materials and Mechanics Research Center's Lead Role

SPEAKING ON . . .

DARPA Mission: Investment Strategy

Advanced R&D Programs for Late '70s

Director of the Defense Advanced Research Projects Agency Dr. George A. Heilmeier recently presented to the Subcommittee on Research and Development, Senate Armed Services Committee, a statement justifying ARPA's proposed budget for Fiscal Year 1977. The statement is organized under subheadings of: Space Defense; Undersea Vehicles; Undersea Surveillance; Land Combat; Command, Control and Communications; Lower Defense Cost; Technological Revolutions; FY 1976 DARPA Achievements. The introductory statement follows.

Mr. Chairman. It seems customary, based on an examination of past statements, to review what was done in the previous year and what will be done in the coming year. To be sure, this information can be found in my detailed statement, but such information alone does not represent an investment strategy, nor does it give you a framework within which an over-all assessment can be made of where we are or where we are going.

An investment strategy is formulated by carefully balancing technology assessments, projections, initiatives and opportunities against potential mission initiatives and needs. In the process, the uniqueness of the opportunity must be weighed against the potential payoff and required investment.

An investment strategy is needed for several reasons. First, the keystone of our efforts must be selectivity. We simply cannot afford to follow all possible paths or single-handedly support all of the worthwhile science and technology in this country.

Secondly, the lead-time for research and development is typically more than four years while the budgetary process, which is structured around operational considerations, tends to focus on a year at a time.

Finally, our competitor, the Soviet Union, has a solid appreciation and long-range commitment to military-related advanced technology. This commitment, coupled with their extreme secrecy and the fact that we no longer hold a monopoly on advanced technology, presents a free society with the challenge to view defense-related technology from a comprehensive, longer-term standpoint.

Within this framework, it is legitimate to ask why the Department of Defense needs a Defense Advanced Research Projects Agency (DARPA). To answer this question, one must recognize that DARPA is entrusted with the corporate, or central research, function of the Department of Defense.

The reasons why such a function is needed in the Department of Defense, in addition to the Service R&D activities, are the same reasons as those that justify the central research activities of such major corporations as IBM, DuPont, AT&T, RCA, GE, Westinghouse and many others, in the presence of other R&D activities conducted in the various separate divisions of these large corporations.

In brief, the Secretary of Defense, like his corporate counterparts, needs an organization such as DARPA, reporting at the highest levels and working at the cutting edge of technology, that has the following missions and characteristics:

• An effective central research organization is blessed with operational flexibility that enables it to move rapidly into new areas and respond to new challenges and opportunieies. DARPA's technical staff is small. It consists of 65 highly professional scientists and engineers. The professionals are imaginative, aggressive and highly motivated.

After making a full, creative contribution and seeing the projects through to completion, they usually leave DARPA for positions of leadership in universities, industry, and the military services. It is our size, our emphasis on quality and our orderly personnel turnover that has helped maintain the vigor and creativity that is necessary in today's increasingly intense technological competition.

• One of the functions of a central research organization such as DARPA is to generate options and prevent technological surprise by constantly advancing the state-of-the-art and exploring the limits of the possible. The best way, indeed maybe the the only way, to prevent surprise or evaluate what someone else might be doing based on fragmentary evidence is to have been there yourself - ahead of him.

For example, we were able to discern that the Soviets were working on high energy lasers because we understood the "footprints" of such activity from our own work in this important area.

• If it is to be faithful to its mission, a central research organization must have no vested interest in the status quo nor can it be encumbered by current roles and mission limitations. Large organizations sometimes have a tendency to reject or overlook that which represents change from traditional patterns. Perceptive organizations recognize the need for a catalyst (i.e., organizational mechanisms) to get new things started in the face of bureaucratic inertia. They do this by pulling diverse technologies and groups together in synergistic ways to focus on important questions.

The central research laboratory serves this function in industry. DARPA serves this function for the Department of Defense. It is vital because new technologies often lead to totally new missions that could not otherwise be defined. For this reason, it is simply not possible to cope adequately with a high degree of technological uncertainty by relying solely on present perceptions of future threats and the requirements that they imply. The validity of this principle has been proven many times in the past.

• If one would advance the frontiers and take major risks where the payoff is greatest, one must also have the freedom to fail. Prudence should be the watchword, but no large organization can be entirely dominated by excessive caution. The inevitable result is stagnation and mediocrity. The primary responsibility of the Services is to deter conflict by maintaining a defense that is adequate to cope with threats as they exist today and as they are evolving in the years immediately ahead. Hence, they tend (properly) to minimize risks.

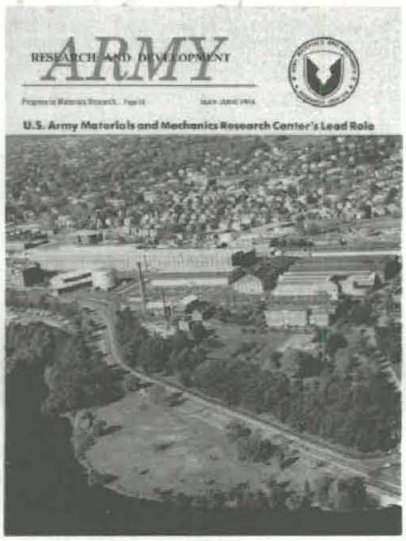
The private sector has recognized the problem and the solution. They have their central research laboratories somewhat divorced from the near-term and permit them to take risks where long-term benefits seem possible. The Secretary of Defense faces an infinitely more serious penalty for technical stagnation. Hence, DARPA was created and assigned a unique role in establishing and maintaining the technological initiative by conducting higher risk/higher payoff programs than those of the Services.

• To advance the frontiers, it is necessary to have a focused "critical mass" effort that cannot be easily diverted or diluted when a development program runs into problems. DARPA reports to the top - not the middle - of the Department of Defense; therefore, our activities are viewed in a broader context which is less subject to specific, immediate pressures.

• There needs to be a mechanism by which new ideas and concepts can be explored without preordaining a commitment to go into full-scale development even if the concept proves workable. The decision to explore must be clearly separated from the decision to develop and the decision to produce or deploy. The inertia of large organizations is such that these distinctions are sometimes blurred.

DARPA provides the Secretary of Defense with the ability to explore new concepts in a manner that clearly separates them from bureaucratic inertia, roles and mission dogma and the syndrome of

(Continued on page 19)



ABOUT THE COVER . . .

The U.S. Army Materials and Mechanics Research Center (AMMRC), shown in this aerial view, and its predecessor agencies at Watertown, MA, can attribute much of their success to the advantages of location. The wealth of nearby scientific talent in numerous universities and major defense industries has facilitated AMMRC's advancement of Army materials and mechanics research, dating back about 135 years. See feature article, page 16.

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FEATURES

DEPARTMENTS

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Selective Scanner . . .

6 Prototype Trailers for XM128 Near Completion

Building of six additional prototypes of a trailer for the Army's new ground vehicle mine dispensing system, the XM-128, towable by a truck or tracked vehicle, is scheduled for completion by the end of June, the Army Tank-Automotive Command, Warren, MI, reports.

Further refinements in design will be incorporated in the prototypes, resulting from troop evaluation of earlier models last fall. Additional extensive field testing of the new design is scheduled for completion in 1978.

Harry Hoffmeyer, who heads the M-794 trailer modification project, said the new version is a major breakthrough in design of military trailers, and that the effort has been under way since April 1974.

The system is designed to permit laying of a wide or thin trail of antitank or antipersonnel mines over a wide variety of terrains. Payload is increased from 4 to 5 tons.

Inertia Welding Used to Close Munition Canisters

Inertia welding is being used the first time for closing liquid-filled canisters of munitions, through a contract effort with Edgewood Arsenal, a part of Aberdeen Proving Ground, MD, and an element of the U.S. Army Materiel Development and Readiness Command.

Generated during Manufacturing Methods and Technology Project 5761319, Process Design for Impregnating Wicks with WP, as part of an improved smoke munition program, the inertia welding technology will be used in establishing a production baseline data in two other MM&T Projects.

Production Technology, Inc., Peoria, IL, has the contract. The canister is clamped to the welder base and a cover is attached to a flywheel spun to speed until the two parts are forced together under pressure. Friction converts the energy of the flywheel into heat at the two surfaces until they are bonded to complete the weld.

Used by Edgewood Arsenal to close canisters for the 8-inch Binary Projectile, a chemical weapon, and the 155mm Improved Smoke Projectile, inertia welding, resulted in decreased production cost and zero leakage rate - one of the faults of a small percentage of mechanical closures.

Contract Calls for Research Animal Facility at APG

Award of a $5,289,369 firm fixed price contract for construction of a research animal isolation facility in the Edgewood Arsenal segment of Aberdeen Proving Ground was announced Apr. 30 by the Department of Defense.

The 67,000 square foot structure will be used primarily for housing and care of animals needed for the arsenal research program. Forty-four bids were solicited, eight received, and William F. Wilke, Inc., Baltimore, is the contractor.

DoD Specifications Development Guide Published

Department of Defense Specifications Development Guide is the title of a new publication prepared by the U.S. Army Logistics Management Center, Fort Lee, VA.

Identified as DMSSO-GB-1, the 186-page document is designed as an information source for all DoD personnel tasked with managing the research, development, production, use and support of specified products.

Limited numbers of the guide are available and may be obtained by writing to: Commander, Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA.

New System Aids Rough Area Tanker Unloading

Unloading fuel tankers over undeveloped beaches or where port facilities are unavailable due to battle damage or natural disaster is facilitated by an air-transportable mooring and off-loading pipeline system, as announced May 7 by the U.S. Army Mobility Equipment Research and Development Command.

Tankers up to 25,000 deadweight tons can be moored, recent tests have shown, while bulk fuel is discharged through pipelines up to 5,000 feet long (just short of one mile) to onshore storage facilities.

Deliverable by C-130 transport planes to rough landing zones, the system can be installed in 72 hours by an Engineer Port Construction Company. Each of four mooring legs is comprised of a catamaran connected to a 50,000-pound holding capacity explosive embedment anchor. Lowered by catamarans, anchors embed automatically.

Catamarans serve as mooring buoys for hawsers after bow anchors are dropped. Support equipment includes two motor surf boats, pulling block assemblies, winches and mooring site survey instruments. The submersible 6-inch pipeline is installed by use of the winches, and a special floating block is anchored by explosive embedment. Fifty-gallon drums also serve as buoys.

ARO Contract Extends S&T Personnel Inventory

Maintenance of an inventory of reliably qualified scientists and technical analysts available to assist Army R&D agencies on problems of national importance is extended for five years under a contract renewed recently by the U.S. Army Research Office.

Located in Research Triangle Park, Durham, NC, the Army Research Office receives requests from more than 50 R&D agencies and laboratories for scientific and technical analysts, involving a wide range of disciplines. Some 2,000 leading scientists and technologists have been involved in the ARO program during the past four years.

The contract to maintain the inventory is with Battelle's Columbus, OH, Laboratories and Dr. Robert S. Carbonara is program manager at Battelle's office in Durham, NC.

Army Post-Rosette Seeker Scores 2 Direct Hits

Direct hits in the first two of five scheduled test firings of the Army's new Post-Rosette seeker in tracking down unmanned drones, MQM 61-A and MQM 34-D (Firebee), are reported by HQ U.S. Army Missile Command.

Firings were conducted from the Stinger launch facility at White Sands (NM) Missile Range and the seeker was incorporated into an unarmed Stinger missile.

MICOM test engineers said the Rosette scan seeker, which is capable of operating in both the ultraviolet and infrared spectrums, offers the potential for countermeasure immunity and can acquire and track targets at longer ranges than current operational seekers.

Under MICOM contract, General Dynamics Pomona Division is developing the seeker for the Army and Marine Corps for possible use on Stinger and Chaparral, but MICOM reports the system could be adapted to almost any missile airframe. MICOM laboratories have worked on the system since the late 1960s.

President's Consultant Named Defense Adviser

Special Consultant to the President Dr. Robert A. Goldwin was selected recently to serve also as adviser to Secretary of Defense Donald Rumsfeld. Dr. Goldwin served in a similar capacity when Secretary Rumsfeld was U.S. Ambassador to NATO in 1973-74.

A member of the Smithsonian Institute's Board of Trustees of the Woodrow Wilson International Center for Scholars, Dr. Goldwin received his bachelor's degree from St. John's College and his PhD degree in political science from the University of Chicago.

Listed among his previous career assignments are dean of St. John's College (1969-73); associate professor of Political Science and director, Public Affairs Conference Center, Kenyon College; and lecturer and director, Public Affairs Conference Center, University of Chicago.

Dr. Goldwin has edited publications such as *Readings in World Politics, Readings in American Foreign Policy, Readings in Russian Foreign Policy, America Armed, Why Foreign Aid?, and Beyond the Cold War.*

Corps of Engineers Chief LTG Gribble Retiring

LTG William C. Gribble Jr., chief of the U.S. Army Corps of Engineers since August 1973, has announced his retirement, effective June 30, following more than 35 years of active Army service.

Graduated from the U.S. Military Academy in 1941, he was commissioned in the Corps of Engineers and later earned an MS degree in physical science from the University of Chicago. He has an honorary doctorate from Michigan Technological Institute.

LTG Gribble was promoted to that rank when he became chief of Army Research and Development Jan. 1, 1971 after successive assignments as commander, U.S. Army Engineer Center and Fort Belvoir, and commandant, U.S. Army Engineer School.

Other career assignments included deputy chief of R&D and deputy assistant chief of staff for Force Development, Department of the Army; director, Army Nuclear Power Program; and deputy director for Military Construction, Office, Chief of Engineers.

Army Unveils Helicopter Closed Refueling Nozzle

Faster, safer refueling of a helicopter while its engine is running and the rotor is tuning is assured by use by a new closed refueling nozzle developed by U.S. Army Mobility Equipment Research and Development Command.

Scheduled to go into production as part of a forward area refueling system for helicopters on combat missions, the nozzle locks into a receiver attached on the aircraft.

The direct connection eliminates the spume build-up that might cause an explosion, and prevents contamination that could occur during open port fueling from rain, or dust raised by the rotor.

Spillage is prevented by a dry-break design for separation of the nozzle from the receiver. Interface pressure between the nozzle and receiver is regulated at 15 pounds per square inch regardless of the nozzle inlet pressure. The refueling rate for a given aircraft is controlled with an orifice that overrides the regulator in event of failure.

The CCR nozzle can be used with 1¼, 1½ and 2-inch hose and its rated capacity of 150 gallons per minute at 125 psi is faster than that of a gravity refueling nozzle.

Laser Marksmanship Device Identifies Hits

How realistic in terms of true hit capabilities are simulated laser training exercises? The U.S. Army Training and Doctrine Command recently unveiled a new device designed to answer this question.

Identified as the Rifle Laser Marksmanship System, it consists of a rifle-mounted transmitter and a receiver device adaptable to a variety of targets. Development is credited to the U.S. Army Training Support Activity and Training Aids Service Office.

The battery-powered, low-cost, eye-safe transmitter is mounted on a plastic M16 rifle just forward of the front sight. The receiver is plugged into existing TRAINFIRE pop-up target mechanisms.

Sensors are placed on standard E and F-type silhouettes or 3-dimensional dummies and connected to a laser receive box plugged into the target mechanism. The rifle's laser beam trips the target hit-kill indication.

WRAMC Gets Army's First Mobile Blood Bank

Walter Reed Army Medical Center recorded another Department of the Army "first" recently with acquisition of a mobile blood donor center as a pilot project of WRAMC's Blood Bank. The 37-foot-long van has all the equipment needed to draw up to 40 units of blood a day and separate it into its component parts.

Completely self-contained, the vehicle is equipped with three beds, a centrifuge, refrigerators, complete heating and air-conditioning, bathroom facilities and its own electrical system powered from a 30-kilowatt generator.

WRAMC Blood Bank Director MAJ John Radcliffe explained that the mobile lab is designed to collect and process blood where no adequate facilities exist. The unit can be quickly modified as an emergency aid station.

Radcliffe believes the van will make it more convenient for the Blood Bank to send teams out for "small draws" of 10 or 15 donors, such as women's or church groups who sponsor a blood donation project. The van's staff of three can do what formerly required six to eight people for a temporary blood bank center.

WRAMC is assigned responsibility for providing blood supplies to Army hospitals in the northeastern United States; it also participates in blood exchange programs with some Navy, Air Force and civilian hospitals.

Redstone Dedicates Audio Visual Support Center

One of the first Army buildings designed specifically for use as an audio visual facility was dedicated Apr. 30 at Redstone Arsenal, AL, headquarters of the U.S. Army Missile Command.

The Audio Visual Support Center, a 6,000-square-foot structure, will be used to train projectionists, preview films, and store and maintain films and audio visual equipment. It replaces an AV facility destroyed by a 1974 tornado.

All rooms are designed for a specific function, such as the preview room equipped with sound-absorbing tiles. A separate cooling-humidfying system in the film library will prevent damage to about 3,400 stored prints.

A training room will accommodate 40 students and three learning carrels will be used to teach requesting customers how to operate various film projectors through self-paced instruction.

R&D News...

White Sands Missile Range Group Views Solar Energy as Future Power Source

Use of the sun's energy to provide power for remote instrument stations moved a step closer to reality during recent planning conferences at White Sands (NM) Missile Range.

Dr. John W. (Jack) Bond, a research physicist with the Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, made his second visit to WSMR to meet with officials of the Atmospheric Sciences Laboratory, U.S. Army Electronics Command.

Dr. Bond is conducting feasibility and planning studies for use of solar cells to provide power for field instruments. Cooperating in the Department of Defense project are the Jet Propulsion Laboratory, Pasadena, CA, and the National Aeronautics and Space Administration's Lewis Research Center, Cleveland, OH.

The U.S. Energy Research and Development Administration also is seeking to stimulate production of solar cells to reduce cost.

During his first visit, Dr. Bond said that WSMR - with 1,100 instrument sites scattered over its main range and many more along its off-range corridor - is an ideal place to pioneer a project of harnessing sun power for electrical power. But he has visited most of the other military installations in the West and Southwest, where the idea also will be applied.

The energy is created when sunlight enters silicon crystals in the solar cell panels. Electrons are released and flow to batteries for use at night and on cloudy as well as sunny days.

Electrical power lines are not available at many remote stations. Diesel-powered generators are used instead, resulting in considerably greater operating costs. Generators are expensive, requiring regular maintenance including repairs and refueling.

With solar power, neither power lines nor generators would be required. While there would be savings of electrical power and fuel, the greatest savings would be through elimination of labor required for refueling maintenance, repairs and operation of generators.

ANTENNA ADJUSTMENT is made on Data Collection Platform (DCP) at the Atmospheric Sciences Laboratory's Synchronous Meteorological Satellite (SMS) Facility, WSMR, NM.

One of the early applications of the solar concept will be with ASL's Synchronous Meteorological Satellite (SMS) Facility. Operated by the ASL Meteorological Satellite Technical Area, the facility is headed by Dr. Willis L. Webb.

Instrumented ground-based systems, known as DCP's (Data Collection Platforms), obtain data through orbiting satellites from remote sites. One DCP is in operation at White Sands. Others are in operation, mostly in remote areas, all over North America.

Currently the WSMR SMS facility is obtaining data from the solar-powered Synchronous Meteorological Satellite No. 3 (SMS-3), which is "parked" in space 22,000 miles above the equator over the Atlantic Ocean.

Launched earlier by the U.S., SMS-2 is parked 22,000 miles above the equator over the Pacific. The fourth, fifth and sixth satellites are to be launched in the Eastern Hemisphere by other nations cooperating in the SMS program.

The WSMR SMS facility has a circular antenna, 25 feet in diameter, which is a centralized reception point for data from DCPs located anywhere in the Western Hemisphere.

Dr. Webb said operators are experimenting with new methods of bringing data from the satellites to the local facility for analysis at its direct readout ground station.

In discussions with Dr. Bond, Dr. Webb described plans to build a solar-powered DCP at White Sands. Eventually, it is anticipated, solar-powered units would replace many power plants now in use in the Western Hemisphere.

"The plan is feasible because the DCP needs only 40 milliwatts of power in the standby mode," Dr. Webb said. "When it is interrogated by the ground station, it uses 20 watts to respond. This takes only a few seconds and then the DCP goes back on standby."

Dr. Bond said costs are expected to be reduced substantially, possibly as much as 75 to 80 percent, when the solar cells become available in the large quantities that will be required. "Our goal is to obtain lightweight, mobile solar panels weighing one-tenth of a pound per watt of collection capacity. Obviously, more panels or larger ones will be required for some stations."

Solar power advantages of lower costs through modulization, useful life of 30 years, silent operation and no fuel costs are offset by some disadvantages, he said. Among these are the high cost of the panels, the larger areas they will require, their susceptibility to environmental damage and the problem of storing solar energy for future use. Participating agencies are working to overcome these disadvantages.

CRREL Constructing $5 Million Ice Engineering Lab

Capabilities of the Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH, will be augmented by a new $5 million Ice Engineering Laboratory, dedicated to research on structural and navigation problems.

Three refrigerated zones for research on lock gates, approach structures and intakes, roller and tainter gates for dam spillways, water intake and discharge penstocks for dams and powerhouses will be provided in 70,000 square feet of floor space.

The 2-story masonry and steel structure also will include a 30 x 120 x 8-foot deep test basin, a refrigerated flume 4 x 2 x 120 feet, and other facilities for developing improved designs for ice control structures and/or fences such as ice booms and artificial or man-made islands and peninsulas, and mooring in lock chambers.

Typical studies planned for the test basin include evaluation of ice forces on structures, the formation of ice pressure ridges, ice problems in and around navigation locks, and the effects of ice on marine plants and equipment.

The flume is designed to study formation of sheet and frazil ice, as well as the hydraulics of ice-covered rivers and jams, and other construction engineering aspects.

When completed, the new facility will be operated by CRREL, which is commanded and directed by COL Robert L. Crosby. Announcement of the contract award to Wexler Construction Co., Inc., of Newton Highlands, MA, was made by the Army Corps of Engineers, New England Div., headed by COL John Mason.

CRREL Ice Engineering Laboratory

BRL Pulse Radiation Facility Transferred to TECOM

Transfer of the U.S. Army Pulse Radiation Facility at Aberdeen Proving Ground, MD, from the Ballistic Research Laboratories to the Army Test and Evaluation Command was announced in April as a part of the Army-wide realignment of R&D elements and functions.

Termed the most powerful nuclear reactor of its type in the United States when it was dedicated in mid-1968, and constructed at a cost of about $5 million, the APRF was still acclaimed by Dr. Robert Eichelberger, BRL director, as one of the most modern of its kind in the Free World at the turnover ceremonies.

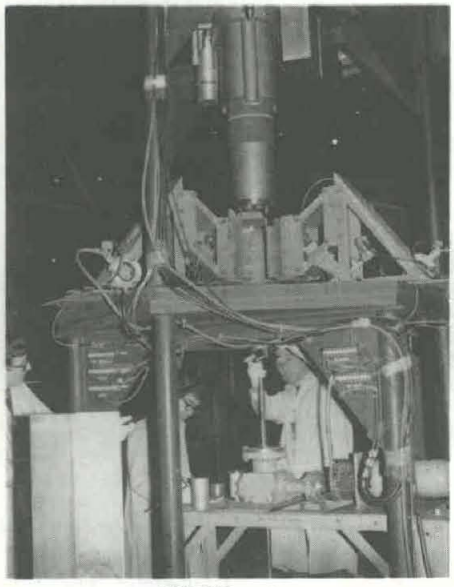
TECOM Commander MG Patrick W. Powers accepted the transfer of administrative responsibility and functions of the APRF, noting that Army Regulation 71-1 stipulates that all requirement documents for developmental materiel contain nuclear vulnerability criteria or a justification for their omission. The facility will continue to have an important role in nuclear weapons effects testing for the Army and for Department of Defense and NASA customers.

Dr. Hubert P. Yockey, APRF superviser, described the unique and advanced character of the facility, which simulates in intensity and in "real time" the environment of weapon systems in nuclear warfare. The reactor reaches a power level of 250,000 megawatts for a few millionths of a second at the peak of a radiation pulse fifty-millionths of a second in duration.

The APRF staff has exploited the "stretch capability" incorporated in the advanced design and has greatly expanded the original capability to include precise "tailoring" of the delayed gamma and neutron radiation in any ratio in a pulse width from 50 us to 5 ms. A neutron pulse nearly free of gamma rays, or, in a continuous fashion at the other extreme, a delayed gamma pulse nearly free of neutrons, can be provided as required by the customer's test specifications.

A 106mm "glory hole" provides access to the high flux available in the interior of the reactor core. This has been achieved by removing a central cylindrical fuel element and replacing its function by reflectors which scatter otherwise escaping neutrons into the reactor core.

This feature provides the APRF customer with a cylindrical volume 106mm in diameter and 198mm in height in which a uniform and high-intensity nuclear weapons environment can be simulated. This makes it possible to test complete integrated circuit electronic systems.



APRF Reactor

The APRF is active in support of Army and NASA nuclear-pumped laser research. A "thermal flux trap: has been developed for the glory hole to provide a peak pulsed thermal neutron flux of 10^{18} n/cm^2-sec. This is reported to be the highest thermal flux in any test facility.

Excellent flash neutron radiographs have been made by using the 50 u second reactor radiation pulse as a photographer uses a flashbulb. This capability enables the customer to see low atomic number material such as powder grains and plastics difficult to radiograph with X-rays.

These advances in the state-of-the-art were achieved by the APRF staff, which provides customers with consultation and engineering and scientific services as required.

The APRF is a key component of a complex of nuclear weapons effects facilities located in the Baltimore-Washington area. APRF customers often utilize the Defense Nuclear Agency AURORA flash X-ray facility at White Oak, MD, operated by the Army's Harry Diamond Laboratories (HDL), to obtain a high-level prompt gamma environment.

Nuclear weapons effects test facilities include the Nike-X shock tubes at BRL to simulate blast effects, the new Defense Nuclear Agency CASINO facility at White Oak, MD, the Electromagnetic Pulse (EMP) facility operated by HDL at Woodbridge, VA, and LINAC operated by the Armed Forces Radiobiological Research Institute, Bethesda, MD.

APRF Supervisor Dr. Hubert P. Yockey, BRL Director Dr. Robert Eichelberger and TECOM Commander MG P. W. Powers.

The transfer of the APRF significantly increases TECOM's capability to meet its responsibilities for nuclear weapons effects testing.

Solar Photovoltaic Military Applications Studied

Military applications of solar photovoltaic systems are being investigated by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), in conjunction with differing aspects of interest to the U.S. Energy R&D Administration and the Federal Energy Administration.

Based on recommendation by the Assistant Secretary of Defense (Installations and Logistics), MERADCOM has entered into separate agreements with ERDA and the FEA. MERADCOM was selected because of its long record of R&D achievements in power generation, including fuel cells and energy conversion.

Five demonstration projects, covering a broad spectrum of power size, electrical characteristics, and the type of use required, are programed. Efforts include a small battery charger, radio relay system, truck-mounted telephone operator's switchboard, water purification plant and remote radar. All except the battery charger are part of MERADCOM's inventory but use conventional power sources.

Applications of solar energy fall into three basic categories. Conversion of solar energy into heat for limited use in heating homes, schools and public buildings is receiving the most public attention. Conversion of solar energy into heat used to generate electricity is a second major area of interest.

The third system, photovoltaic or "solar cell," converts solar energy into electricity without the intermediate heat process. This application was initiated in the U.S. space program with the launch of the Vanguard satellite. Terrestrial application is "still in its infancy."

Scheduled for preliminary test and demonstration at HQ MERADCOM, Fort Belvoir, VA, are the battery charger, radio relay system, truck-mounted telephone operator's switchboard, and water purification plant. The first three projects will later be transported to military sites for longer-term demonstrations in a more representative military environment.

The water purification plant will remain at Fort Belvoir until conclusion of its test and demonstration phase. Remote radar will be demonstrated solely at the Naval Weapons Center, China Lake, CA.

MERADCOM will plan the field demonstrations, with consultation and test support furnished by the respective test site agency. Solar panels for the projects are being provided by the National Aeronautics and Space Administration's (NASA) Lewis Research Center. Solar cells were procured for ERDA by the California Institute of Technology Jet Propulsion Lab.

MERADCOM will perform the required engineering and technical support functions to design, fabricate, test and demonstrate the five systems; also, will identify longer-range R&D requirements.

Department of Defense benefits of the project are expected to include:

- Energy and cost savings in reduced use and storage of petroleum products.
- Decrease in logistics burden of replenishment of fuel and batteries.
- Furtherance of energy self-sufficiency for remote or isolated military applications.
- Improved reliability, availability and maintainability of energy consuming systems.
- A silent, alternative source of electric power based on the inexhaustible and widely distributed energy supply of the sun.

Under its agreement with FEA, MERADCOM has responsibility to identify early markets within the Department of Defense for photovoltaic systems. Annual market volume as a function of price is to be determined for a variety of applications, including remote sites. Combined systems will also will be analyzed.

FEA hopes that if the DoD market is substantial, the related R&D will expedite conversion to solar cell systems for civilian commercial and residential use.

The project will include, by DoD requirement, creation of a tri-service coordinating body for photovoltaic applications surveys and R&D.

DARPA Report to Senate Unit Lists FY76 Achievements

Highlight achievements of the Defense Advanced Research Projects Agency (DARPA) during FY 1976 are listed in a recent report to the Sub-committee on Research and Development of the Senate Armed Services Committee.

Some of the accomplishments are termed in the "technical milestone category," offering options to the Military Departments in terms of both gains in operational performance and decreased cost of weapon systems, and some "have been transitioned to the appropriate Service for specific application."

The report lists these accomplishments:

Laminar Flow Vehicle Program. Results from efforts to develop low-drag design concepts have shown dramatic progress. Tow tank tests in December 1975 demonstrated a drag coefficient for a torpedo-size body, less than the typical torpedo shape being used today.

In application, this could mean that low-drag torpedoes might be designed to go at least 30 percent faster with the same power. The Navy is considering the technology in its lightweight torpedo program. Further testing is planned to establish design parameters.

AEQUARE - Long Range Mini-RPV Systems. Air launch technology for mini-RPVs was demonstrated for the first time in two consecutive successful flight tests in September 1975. An RPV pod was jettisoned from an aircraft and was controlled through a relay. Solid video was received through both flights. This technique permits operations in the high-threat region approximately 30 kilometers from the forward edge of the battle area.

Laser Beam Rider (LBR). Survival of antitank weapons crews are linked directly to exposure time before and during missile flight to the target. First- and second-generation command-to-line-of-sight links depend on a wire-wound bobbin carried in the missile. This necessitates relatively slow missiles and hence long flight times to preclude wire separation. During 1975 DARPA completed flight demonstration of a laser beam rider command guidance link.

Space Surveillance. An array of visible imaging CCDs has now operated in real-time against a simulated star field with moving targets. The successfully operated CCD² combined high-sensitivity detectors, low noise readout, accurate memory storage, and miltiframe difference to allow several orders of magnitude increase in sensitivity of surveillance sensors.

Current sensors have limited search capability, are clutter sensitive, and require complex data processing. The CCD² feature allows automatic clutter rejection and moving target acquisition and results in a greatly reduced cost of search systems.

Infrared CCD Technology Program. A monolithic extrinsic silicon structure containing over several hundreds of detectors using charge-coupled devices for readout and processing has been successfully demonstrated.

The potential application is for infrared sensors which would contain millions of detectors at a cost per detector of only a few cents. Previous infrared sensor technology was limited because it employed discrete detectors with individual chains of amplifying and processing electronics where the cost per detector was in the several thousand dollar range.

Bistatic Radar. Large bistatic coverage was shown to be achievable for aircraft detection. Simulation models to allow processing technolgy trade-offs were developed. A resulting preliminary concept evaluation has defined the necessary technology development required to establish feasibility.

Special Communications Technology (TEAL WING). Important technology has been developed in the DARPA program, which has resulted in identifying: (1) advanced techniques for communications through nondedicated next-generation satellites such as DSCS-III, (2) issues of significance pursuant to satellite onboard processing functions applicable to future generations satellites, (3) limitations of current technology, and (4) candidate techniques that

Air Navigation Systems Undergo Competitive Tests

Developmental and operational testing of two competing lightweight (under 30 pounds) doppler navigational systems designed to tell Army aviators where they are, where they are going and even where they have been was announced recently by HQ U.S. Army Electronics Command, Fort Monmouth, NJ.

System AN/ASN-128 is being developed under the direction of COL C.B. Maddox, project manager, Navigation/Control Systems (NAVCON) at Fort Monmouth, with engineering and design assistance from the Army Electronics Command (ECOM) laboratories.

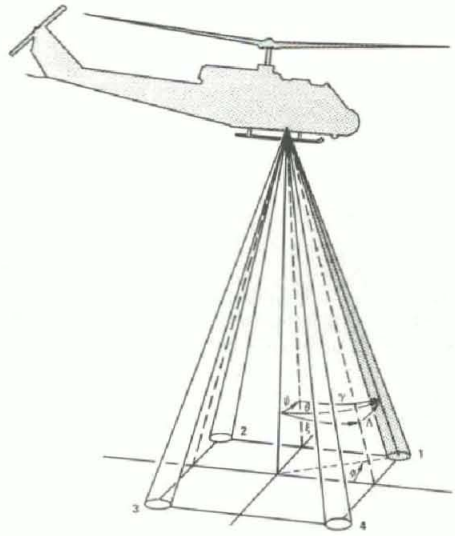
Working under strict "design to cost" conditions, the competing contractors for a production order to be issued in October are Teledyne Ryan, San Diego, CA, and the Singer Kearfoot Division, Little Falls, NJ. Both have produced systems which successfully completed engineering tests well within the prescribed time limits.

The advantage of the doppler system over other navigation systems is that it needs no signal from a ground reference point. Therefore, it is not as vulnerable to electronic countermeasures that could distort or eliminate ground signals.

The doppler nagivator works by sending four radar signals to the ground and measuring the doppler shift - the change in frequency caused by the change in distance - between the transmitted and received signals.

Measurements are fed into a minicomputer and compared with each other as well as a single ground reference point previously inserted. The computer then feeds material to a control display unit on the aircraft's console - including present position, predetermined waypoints, course or distance off course, targets, range and compass bearing, ground speed, wind speed and direction.

Great accuracy is achieved by the system, with less than a two percent variation in distance traveled and comparative accuracy on other readouts. The AN/ASN-128 is designed to fit into rotary- and fixed-wing aircraft. In addition to its own readout, it will provide essential supplemental information to the steering and hover information indicator.



DOPPLER navigator works by sending four radar signals to the ground and measuirng the doppler shift - the change in frequency caused by the change in distance - between the transmitted and received signals.

ELECTRONICS ENGINEERS Donald Kiernan (left) and Carl Galanti discuss AN/ASN-128 doppler nagivational system with LTC LeRoy White, assistant project manager, Positioning and Navigation Systems, Navigation/Control Systems, HQ U.S. Army Electronics Command.

will permit intra-task force communications in the presence of high ambient interference.

Internetwork Computer-to-Computer Communication. An internetwork protocol was designed and implemented. This protocol was especially designed to enable computers to communicate reliably across multiple and possibly different packet switched networks. It provides end-to-end control and allows high throughput to be achieved between computers.

If, for example, Network A transmits data in 2,000-bit packets and Network B, by its design, further fragments these packets into 1,000-bit packets, the destination computer can still fit the pieces of arriving information reliably back together again, even if the fragmented packets arrive out of order, or in duplicate.

The protocol also works over a point-to-point circuit. Previously, packet network computer protocols required the received data packets to arrive exactly as they were sent, that is, without being fragmented, in the correct sequence, without duplication and free of any errors. A single lost or missing packet could cause the communication to halt.

Furthermore, it would simply be assumed that no errors would occur - an optimistic but impractical assumption for operational use. Previous protocols could not provide reliable communication across multiple networks. The new protocol will provide both new capabilities and the reliability controls previously missing.

Automatic Morse Interpretation. A new approach to the problem of automatically interpreting manual Morse Code in a multisignal, low signal-to-noise environment has been formulated and feasibility demonstrated. Previous automatic Morse interpretation efforts have been unable to perform adaptively on a network.

The new approach takes into account network protocols, and embodies novel word signature techniques which allow accurate interpretation in the presence of most common sender errors.

Interpretation of manual Morse is labor intensive. It is anticipated that the automated Morse Code stations which this research makes possible will be widely used, satisfying important operational needs at reasonable cost.

Initiation of Packet Satellite Communication. A successful demonstration of the operation of a single wideband satellite channel in a packet broadcast mode was conducted in FY 76.

The test was carried out on INTELSAT IV between the United States and the United Kingdom, but the technology allows additional sites to share easily the same channel, subject to administrative controls.

If three or more sites are sharing the channel, each site can communicate to any set of the others by transmitting a single packet of information addressed to the desired set of receivers. The address is included in the packet and examined by each receiving ground station to determine if it should accept the packet or discard it.

This is the first operational demonstration of this capability. Previously, a satellite channel only allowed a single site to be the transmitter, so that two sites required two channels to communicate with each other; additional channels were required for three or more sites.

This technology will provide increased flexibility in long-haul communications (a must for C^3 - command and control applications) and at far lower cost and complexity.

New Borehole Seismometers and Advanced Recording Stations. A major achievement by DARPA was the design, development and installation for research use of a new long-period seismometer capable of operating in a 7-inch diameter, 100-meter deep borehole.

Operation at this depth provides, for the first time, protection from surface noise in the solid rock caused by minute atmospheric pressure fluctuations. Initial operation showed that the instrument is capable of measuring three component earth background noise levels as low as 6.2 nanometers peak-to-peak in the 20- to 40-second period band.

This represents an order of magnitude improvement in the sensitivity of horizontal measuring instruments and provides the capability to measure signals only slightly larger than the lowest backgrounds known to exist anywhere in the world. These sensors have been adopted for operational use in the U.S. Atomic Energy Detection System.

Computer Simulation of Earthquake and Explosion Signal Generation. Over the past several years, considerable effort has gone into the development of a comprehensive computer model of seismic wave generation and propagation to distant seismometer locations.

The research was aimed at overcoming the difficult problems associated with the positive identification and accurate yield determination of underground nuclear explosions, based on empirical measurements.

The computer model is now essentially complete permitting investigators to study seismic wave generation and propagation over the full range of yield, source, and geological conditions pertinent to discrimination and yield determination.

(Continued on page 21)

More than $2 Million Saved In USARCCO's First Year

Savings of more than $2 million for a new U.S. Government agency during its first year of operation are generally considered sufficient for that organization to pride itself on significant achievement - as does the U.S. Army Commercial Communications Office.

USARCCO is a field operating activity of the U.S. Army Communications Command, headquartered at Fort Huachuca, AZ. Established Feb. 3, 1975, the office was fully operational in less than six months and had taken over the responsibilities of four ACC subcommands.

This consolidation involved the 5th Signal Command in Germany, the 6th Signal Command in Hawaii, the 7th Signal Command at Fort Ritchie, MD, and the Ballistic Missile Defense Communications Activity, Fort Huachuca.

USARCCO is now the single manager for all leased Army long-haul telecommunications worldwide, and DECCO is its Department of Defense counterpart. When a request from USARCCO goes to DECCO, the action certifies that the requirement is valid, and the Army is prepared to pay mutually acceptable costs involved in its fulfillment.

DECCO responds by contracting with a commercial communications agency, such as American Telephone and Telegraph Co. or Western Union, to fulfill the requirement. In terms of money, it means that USARCCO represents some 12,000 individual facilities and manages upwards of $65 million annually.

Another $44 million each year is devoted to local installations communications managed by the 5th, 6th and 7th Signal Commands but supported by USARCCO. The office also provides leased communications support to other U.S. agencies such as the White House staff, the National Guard, Army Recruiting Command, and special Department of the Army activities.

USARCCO Director William B. Bogardus commented: "While we have been able to achieve significant results in the management of the Army leased communications resources this first year, there are additional programs under way which will permit the USARCCO to realize additional savings and even greater efficiencies."

APG Conducting Improved UET Government Acceptance Tests

Government acceptance testing of an improved Universal Engineer Tractor (UET) designed for military requirements of versatility, mobility, air transportability, durability and reliability is being conducted at Aberdeen Proving Ground, MD.

The UET was developed by the product manager, FAMECE (Family of Engineer Construction Equipment)/UET at the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA. The multipurpose tracked vehicle can doze, scrape, rough-grade, tow, dump and haul in performing earthmoving tasks required for combat engineer operations.

Features include a ballast concept to keep the 32,000-pound weight within the limits for air transport, airdrop, and high cross-country mobility while providing the work capability of a heavier unit. The front, loaded with eight cubic yards of soil, provides enough additional weight to almost double the UET's earthmoving capacity. The 285-HP diesel engine provides more than enough power for all operations.

With a speed of 30 mph on level ground, the UET will provide the combat engineer with the mission capability to keep pace with armored units. It also is fitted with light armor protection and has a swim capacity of 3 mph.

Four improved pilot models completed Project MASSTER tests at Fort Hood, TX, in December 1975 and are scheduled for completion of APG tests in July. Test personnel report that to date results indicate that reliability problems encountered with prototypes fabricated earlier in the development program have been overcome.

Universal Engineer Tractor

Medical Material Agency: Army's 'Consumer Advocate'

Project managers at the Medical Equipment Test and Evaluation Division (MET&E) of the U.S. Army Medical Material Agency are concerned with "the best return-on-investment."

Located at Fort Sam Houston, TX, the MET&E has been termed the U.S. Army Medical Department's "consumer advocate," without any attempt to rival the realm of Ralph Nader. Its consumers range from the largest Army Health Services Command medical center to the smallest Army Forces Command combat-ready medical team.

Designated as the Surgeon General's executive agent, MET&E has authority to review medical equipment of the Army, Navy and Air Force as well as appropriate additional federal and civilian activities.

Since 1964, when it began operations, MET&E has evaluated a wide variety of new and replacement equipment, ranging from test tubes to field ambulances. MET&E Chief is COL Edward Carmick. LTC Marvin Walker is deputy.

Test requirements for MET&E normally are generated by the originator through the Logistics and Facilities Division, Office of the Surgeon General, Washington, DC. Requests for assistance are generally submitted from one of the following:

- *Defense Medical Material Board* requests for assistance are usually submitted relative to product improvements for items being considered for purchase.
- *Army Medical R&D Command* queries often involve evaluating in-house developed designs and systems.
- *U.S. Army Materiel Development and Readiness Command* requests may have medical implications but generally do not.
- Army medical centers and hospitals requests usually involve commercial market items.

MET&E project managers generally conduct a background study on all items selected for testing. Criteria used in choosing test sites include test objectives, data required, estimated costs and resources.

Test sites have included areas as distant as Europe and the Arctic region and as nearby as Brooke Army Medical Center and the 1st Medical Group, both at Fort Sam Houston.

After completing all tests on a particular item, MET&E's project managers analyze their findings, reach a conclusion and send recommendations to Office of the Surgeon General. Final reports are signed by the PMs and their consultants.

MET&E often coordinates projects in San Antonio with the U.S. Air Force Aerospace Medical Center, Brooks AFB and Wilford Hall Medical Center, Lackland AFB. San Antonio is considered one of the best Emergency Medical Service (EMS) areas in the nation.

Other sources for coordination have included San Antonio's University of Texas Medical Center, the Veterans Administration Hospital and 14 civilian medical centers and hospitals.

MET&E may be contacted by telephoning Area Code (512) 221-5503 or 221-2624 or Autovon 471-5503 or 471-2624.

New WSMR Photo Plant Termed 'Most Modern in DoD'

Housed in a new $3 million facility at White Sands (NM) Missile Range is a consolidated photographic processing plant heralded as "the most modern in the U.S. Department of Defense."

Performing services previously provided at four different sites, including one at Holloman Air Force Base, the laboratory is extensively automated. It offers users of WSMR one-day service for test data support, documentary motion picture film and still photo processing.

"Fast service and quality work" are assured by Donald Risinger of the National Range Operations Directorate Data Collection Division, plant manager. Overnight film processing service, he said, enables range testing, planning and scheduling to move along at a faster pace. Photographic processing formerly required as long as four days.

Thirteen Civil Service employes are charged with motion picture printing, management, inspection and monitoring and are aided by 35 contract employes. Services include duplication of original data or documentary film in 16mm, 35mm and 70mm sizes, color or black and white; reduction printing of 35mm and 70mm original film down to 16mm; optical printing; and special effects.

About 10 years were devoted to planning, constructing and equipping the 3-story facility, which is capable of processing up to 40,000 feet of 16mm color film, 100,000 feet of 35mm color film and 30,000 feet of 70,000 color film during a regular production run. Black and white film output generally matches color film totals for an 8-hour production run.

Support also is provided to documentary and training film services for the Department of the Army motion picture program.

ARRADCOM Unit Drafts Structure/Functions

Structure, functions and procedures of the U.S. Army Armament Research and Development Command (ARRADCOM), as they will become effective Oct. 1, are being determined by an "Implementation Task Force" of about 120 members.

Serving on the group are representatives of Watervliet (NY) Arsenal, Ballistics Research Laboratories, MD, Edgewood (MD) Arsenal, Frankford (PA) Arsenal, Picatinny Arsenal at Dover, NJ, Rock Island Arsenal and HQ U.S. Army Armament Command, both in Illinois.

MG Bennett L. Lewis, who headed the Army Materiel Command Committee-Armament that acted on pertinent recommendations of the Army Materiel Acquisition Review Committee (AMARC), is scheduled to head the ARRADCOM. COL Lee T. Doyle, who served with him on the study group, heads the ARRADCOM Implementation Task Force.

MG Bennett L. Lewis

Organization of the task force reflects in miniature the general shape of things to come in ARRADCOM. The technical teams include Large Caliber Weapon Systems Laboratory, Small Caliber Weapon Systems Ballistics Research Chemical Systems Lab.

Interim ARRADCOM HQ will be at Picatinny Arsenal. Scheduled to go under the command control of ARRADCOM are the Benet Weapons Laboratory at Watervliet Arsenal, the Chemical Systems Laboratory at Edgewood Arsenal, and the Ballistics Research Laboratory at Aberdeen (MD) PG.

Data 'Landmark' Progress Reported in Collecting Suppressive Force

Success in combat relates to how well a commander comes up with correct answers to such questions as: How much of my firepower must I commit to suppress an enemy force? What actions can I take to protect my unit from suppressive effects of enemy fire?

Quantifiable answers through scientific techniques and collection of data are reportedly being provided by the U.S. Army Combat Developments Experimentation Command, Fort Ord, CA, in simulated battles.

Early in May, following trials with different calibers of artillery - 15 weapons ranging in size from the infantry rifle through the tank cannon, including the 8-inch howitzer - CDEC reported "landmark" results in collecting data "useful to both the field commander and the research and development managers."

CDEC's tests were designed to provide information that will aid in developing techniques to insure gaining the advantages of suppression. Until relatively recent methodology was introduced, measurement of the capability of various weapons or mixes to achieve suppression was viewed as unreliable.

EXPLODING on impact, 40mm rounds were included in experiments to evaluate suppressiveness of 15 weapons, ranging from the infantry rifle to the 8-inch howitzer.

Most of the experimentation, involving placement of soldiers in protected foxholes under variable degrees of suppressive fire and measurement of response, was done in California at Fort Hunter Liggett, except for a CDEC element that traveled to Fort Sill, OK, home of the U.S. Army Artillery School, to conduct important scientific tests.

CDEC soldier-players peer through periscopes to observe incoming ammunition during suppressive fire field experiments.

CDEC reported that the suppression experiments have generated information currently affecting doctrine, materiel, and training development. Methodology and experience for future studies reportedly are established. Total information collected, however, will require "months of analysis and evaluation of all data."

Propellant Analysis Process May Aid Heart Patients

Nitroglycerin content of rocket fuels and other propellants can be measured with unmatched accuracy by a technique developed by two Army Missile Command chemists - so precisely the method is being considered for quality control of nitroglycerine tablets used for treatment of heart patients.

Inventors of the process are H. W. H. Dykes and Bernard J. Alley of the MICOM Propulsion Laboratory. They believe it can be adapted to qualitative and quantitative analysis of numerous organic compounds, including some that are very difficult or impossible to analyze by other methods.

Another potential application is in pollution control inasmuch as some of the compounds it measures and identifies are toxic. A description of the technique appears in the *Journal of Chromatography*, Volume 72.

Scheduled for publication also in a forthcoming book, the technique is regarded as having "definite potential" for use by the drug industry. Dr. H. C. Stober, Ciba-Geigy Corp., is co-editor of the chapter on pulmonary and vasoactive drugs, including analysis of therapeutic agents.

The technique uses a gas-liquid chromatograph, an inexpensive instrument that separates a solution into its component comopunds. In analyzing nitroglycerin, the device can be used to achieve accuracy within ± one percent, according to the coinventors' report.

Dykes and Alley also have devised a technique for ultrasonic extraction of samples that cuts sample preparation time from 24 hours to about 15 minutes. Qualitative and quantitative analysis time thus is reduced from about one week to a few hours, they state.

INVENTORS of process for analyzing nitroglycerin content of rocket fuels and other propellants, Bernard J. Alley (left) and H. W. H. Dykes, examine tiny nitroglycerin tablets used to treat heart patients.

Bracy Heads New DARCOM Foreign Intelligence Office

Establishment of a Headquarters, DARCOM, Foreign Intelligence Office (FIO) within the Development and Engineering Directorate was announced in May.

COL Alfred M. Bracy, head of the new office, will report directly to the Director of Development and Engineering, MG Harry A. Griffith, and will work to improve the utilization of threat and intelligence information.

"General Griffith sees my responsibility as substantially that of an intelligence broker," COL Bracy explained. "That means I will work with the U.S. Army Foreign Science and Technology Center at Charlottesville, VA, the Missile Intelligence Agency at Huntsville, AL, the Assistant Chief of Staff for Intelligence, DA, the Defense Intelligence Agency, and with my FIO counterparts throughout DARCOM toward stimulating the flow of intelligence to RDT&E elements as an aid to intelligence impact evaluation related to planning and programing."

COL Bracy also will support the DARCOM Battlefield Systems Integration Directorate. COL Bracy said his contact with the production agencies and foreign intelligence officers serving project managers throughout DARCOM will expedite flow of intelligence to the BSID.

COL Alfred M. Bracy lists his home town as Little Rock, AR. He graduated in 1952 from the United States Military Academy, West Point, NY, the Army War College in 1970, and attended the University of Richmond, receiving a master's degree in commerce in 1974.

Assigned until recently as commander, 3d Basic Combat Training Brigade, Fort Leonard Wood, MO, he also served as congressional liaison officer to the U.S. House of Representatives (1970-72) and in Vietnam (1967-68) as battalion commander and 25th Division G-3.

COL Alfred M. Bracy

Cargo Pallet Capability Added To Ribbon Bridge Transporter

Cargo pallet capability ranging from 5 to 10 tons has been added to the U.S. Army's ribbon bridge transporter by an improvement program of the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA.

The 5-ton transporter, equipped with a hydraulic boom, is used primarily to carry, launch and retrieve complete bays of the Army's most advanced version of the floating bridge, also a MERADCOM development.

When austerity cutbacks in development funding for military vehicles made maximum utilization of existing vehicles necessary, pallets were procured, tested and type classified in eight months - a fraction of the time required to complete a new item development cycle.

An initial production quantity of 120 of the 19x10-foot pallets will be delivered to the field this summer. Each pallet can be loaded with up to 5 tons of equipment or supplies by the self-loader capability of the transporter, which can support loads up to 10 tons on highways.

PRODUCT IMPROVEMENT PAYOFF. The M110A1 8-inch Self-propelled Howitzer has been classified as standard, following several years of system development and testing, and will replace the current M110 and M107 175mm guns. Cost of the new howitzer is estimated at less than $80 thousand per vehicle. LTC Benjamin A. Huggin, product manager for the M110E2 weapon system at the U.S. Army Armament Command (ARMCOM), Rock Island (IL) Arsenal, reports the Army saved several million dollars by improving the M110 rather than designing and developing a completely new system. "After development of a new system," he said, "production costs alone could have been as high as $700 thousand per vehicle. That is a spell-binding figure when one contemplates a fleet of 1,000 vehicles."

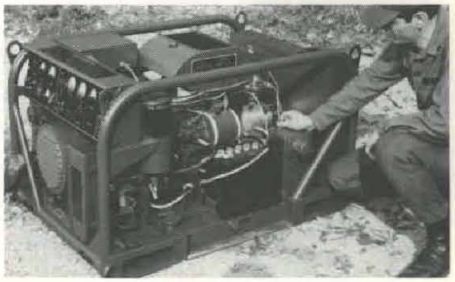
Componentry Tests Completed On Synchronous Generators

Synchronous generators designed to provide mobile field units with reliable power sources that can use a variety of fuels recently completed componentry testing by the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA.

A 10-KW gas-turbine engine-driven generator (GTED), weighing about half as much as its gas and diesel counterparts, established that it can operate up to 10,000 hours between overhauls in a $3.7 million design, development and test contract with Solar Division of International Harvester Co.

Compared to the current standard 850-pound 10-KW engine driven set, the new GTED weighs 450 pounds, is 20 versus 28 cubic feet in size, is operable 500 to 1,200 hours mean time between failures compared with 160 hours, and 6,000 to 10,000 hours between overhaul versus 1,500 hours.

The 10-KW GTED can operate on a variety of fuels, including no-lead gasoline, jet and diesel fuel, and at temperature extremes of 120° F. to −65°F. Operation is vibration-free, low-pollutant and requires no external cooling.



10 KW Turbine Engine Driven Generator

Guide for Military Standardization: ABCA Armies' Operational Concept, 1986-95

By MAJ John D. Elliott
Long Range Studies Group, U.S. Army Concepts Analysis Agency

American, British, Canadian and Australian (ABCA) members of the Quadripartite Working Group on Combat Development (QWG/CD) have published and distributed the *ABCA Armies' Operational Concept 1986-95* as a follow-up to the *ABCA 81-90 Concept*, effective until 1981.

The "new" concept is designed as a guide for research and development of tactics, equipment and logistics for the ABCA Armies during the long-range (10-20 years) timeframe.

This article is directed toward overcoming a primary obstacle to the ABCA military standardization effort - widespread lack of knowledge about the organization, management structure, working groups and aims of the program. The *ABCA Armies' Operational Concept, 1986-95* is our most important working document. (See Fig. 1).

Standardization Agreement. Coordination, publication and distribution of the long-range concepts here mentioned translates to continuing military standardization effort started during World War II. Aims of the ABCA Program are specified by the Basic Standardization Agreement signed in 1964. New Zealand joined as an associate in 1965. Primary objectives are prescribed as:

- Ensure the fullest cooperation among the ABCA Armies to achieve the highest possible degree of operational capability among the ABCA Armies through materiel and nonmateriel standardization.
- Obtain economy by use of combined resources and effort.

ABCA Organization. These aims are translated into working objectives mainly by the Quadripartite Working Groups (QWGs) under the guidance of the Washington Standardization Officers (WSO), Quadripartite Materiel and Agreements Committee (QMAC) and Quadripartite Research Committee (QRC).

QWGs (currently 23) provide the focal point for exchanging information and dealing with specific tasks. They meet every 12 to 18 months, and between meetings, conduct coordination and review by correspondence.

Primary functions of the QWGs are to: Develop quadripartite thought and ideas; exchange information; discuss impact of future development; originate Quadripartite Standardization Agreements (QSTAGS); recommend items and procedures for standardization; review Standardization Lists; and identify potential areas of cooperation.

Over-all guidance is provided to the ABCA Program by TEAL (Tactics, Equipment, Logistics) discussions at the vice chief of staff level. TEAL directives are implemented by the Washington Standardization Office representatives of each Army who serve as senior managers of the ABCA Program. These general officers meet regularly to review progress, expedite projects, and resolve significant differences among member armies.

Assistance is provided by the Primary Standardization Office (PSO), charged with continuously reviewing the program to ensure that WSO objectives are met. The QMAC manages activities of all QWGs except QWG/CD and QWG/Army Operations Research (AOR), which report directly to the WSO. The QRC coordinates research in the program. Figure 2 depicts this management structure.

The *QWG on Combat Development* constitutes the primary operational forum for the ABCA Program, providing guidance to member armies and the other QWGs, and developing operational concepts which specify agreed objectives for standardization of materiel and nonmateriel needs.

The *ABCA 86-95 Concept* is a "combat developments guide" and not a directive to member armies; it is developed parallel with national concepts and studies. This process provides a solid foundation for success.

In the past year the QWG/CD has been developing specialized concept papers such as the "ABCA Armies' Concept for Arctic Operations" and "The Implications of Sustained Day and Night Operations."

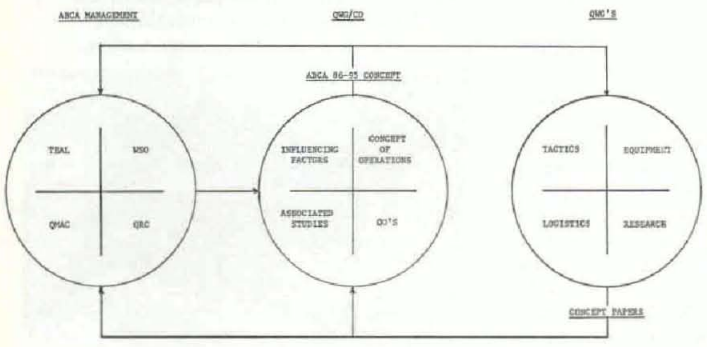


Fig. 1. ABCA Standardization Process

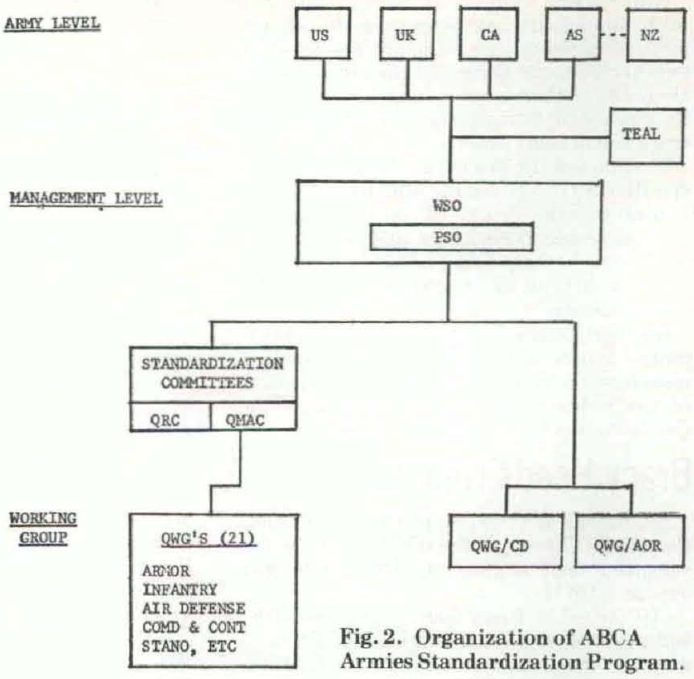


Fig. 2. Organization of ABCA Armies Standardization Program.

Other work involves review of designated concept papers of other QWGs attending QWG meetings to give briefings on the current Concept, and providing assistance in development of Concept Papers.

This assistance is all important, considering the relationship between the *ABCA 86-95 Concept* and desired level of military standardization.

The *ABCA 86-95 Concept* is presented in two volumes, the first containing an introduction and three sections that comprise the concept. *Section I* addresses influencing factors such as the Strategic Appraisal, the Impact of Science and Technology, and Factors Shaping ABCA Armies.

- *Section II* contains the Concept of Operations and devotes chapters to High, Mid, and Low-Intensity Conflict (Type "A," Insurgency and Type "B," Peacekeeping).
- *Section III* contains the all-important Quadripartite Objectives (QOs) - statements of "desired military capabilities" to provide guidance to those concerned with standardization, concept study, and R&D.

Important to note is that the QOs were developed from the influencing factors in Section I and the four operational concepts described in Section II. The resulting QOs forge the link between the *ABCA 86-95 Concept* and the other work of the standardization program.

Volume II, *Associated Studies,* contains three studies directly related to the content of Volume I. • *Study 1,* "The Strategic Appraisal for 1986-95," analyzes the strategic factors and trends of the period and seeks to identify the threats and characteristics of the levels of conflict that may confront the ABCA nations. • *Study 2,* "The Impact of Science and Technology, 1986-95," analyzes the five functional areas of combat - mobility; firepower; command, control and communications; intelligence; administration and logistics. Results delineate expected limits of the technological environment in the timeframe. • *Study 3,* "The Threat Assessment, 1986-95," provides an intelligence baseline threat to the ABCA Armies by outling situations that conceivably could emerge.

Quadripartite Objectives. There are 22 QOs in the 1986-95 Concept, covering core military subjects like Armor, Infantry, and Air Defense as well as more conceptual subjects like Surveillance, Target Acquisition and Night Observation.

The QOs enhance the following ABCA Program activities: Exchange of information on national concepts, doctrine, requirements, and trends in particular studies required to support further developments; consideration of future concepts which will impact on the development of equipment, tactics, training, logistics, and organizations; and identification of areas which could lead to cooperation, particularly R&D.

Concept Papers reflecting "quadripartite thought," based on the factors and operational concepts expressed in the *ABCA 86-95 Concept,* are prepared to activate developments in tactics, equipment, logistics and research. This is a dynamic relationship that changes by producing a new concept every five years and by scheduled reviews of the QOs.

Over-all, this initiates a feedback process between the QWGs and management via Concept Papers and memoranda; and between QWG/CD and

management via the ABCA Concept. This further demonstrates the linkage between elements of the ABCA Program and the ABCA Concept prepared by the QWG/CD.

In continuing the military standardization process begun in World War II, the basic aim of the *ABCA 86-95 Concept* is to guide research and development of tactics, equipment and logistics for the ABCA Armies during the long-range timeframe.

As the concept designed for the 1996-2005 timeframe is developed over the coming five years, the current concept will provide the guidance required for further progress in military standardization among the member armies. With growing economic constraints and escalating R&D costs, the *ABCA 86-95 Concept* shows considerable promise for providing continuing guidance on R&D of doctrine, organizations and materiel without constraining national initiatives or interests.

Department of Defense activities interested in learning about the *ABCA 86-95 Concept* in greater detail are encouraged to contact the International R&D Office, U.S. Army Materiel Development and Readiness Command, 5001 Eisenhower Avenue, Alexandria, VA 22333.

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MAJ Elliott's assignments have included duty with the Army Ordnance School, HQ U.S. Army Europe, Office of the Deputy Chief of Staff for Logistics, and Special Forces in Europe and Asia.

In addition to his work on international military standardization for the American, British, Canadian, Australian (ABCA) and NATO armies, he is actively involved in research in international terrorism. His most recently published work is "Action and Reaction: West Germany and the Baader-Meinhof Guerillas" in Strategic Review, Winter 76.

'Integrated Helicopter Control System' Benefits Cited

Cautious optimism is the attitude of a developmental team regarding the future of an "Integrated Helicopter Control System." U.S. Army Human Engineering Laboratory scientists at Aberdeen Proving Grounds, MD, envision it as increasing the survivability factor and revolutionizing aircraft cockpit design.

Initial flight testing results indicate other benefits may include simplification of helicopter flying and reduced pilot training needs.

IHCS prototype initial flight testing was done at Phillips Army Airfield, Aberdeen.

The system is intended to permit one-handed flying in an emergency when a pilot is wounded.

HEL engineer and co-inventor of the system John A. Stephens, along with Ralph Kibler, also a design engineer at HEL, believes results of the preliminary tests constitute a significant breakthrough in control technology and cockpit design. Pilot response is "generally favorable."

The test aircraft had a "100 percent override safety system built into it, so the copilot could take over with conventional controls in the event of pilot error or a system malfunction."

All the first flights were at altitudes of 2,000 to 3,000 feet—providing time for recovery action in case something went wrong. All tests were done in accordance with the test pilot's flight manual, gradually progressing into hovers, landings, takeoffs and auto rotations.

Stephens commented: "We are very encouraged by the fact that we feel the concept of a 3-axis controller has been demonstrated. But we are not sure yet that there is not a high workload associated with flying an integrated control system. . . . We have another year's work, maybe more, before we will get enough people to believe us to the point where things will break loose."

The first prototype control system was installed in a Bell OH-58 helicopter, under intensive coordination with the U.S. Army Aviation Systems Command, St. Louis, MO, and the Army Engineering Flight Activity, Edwards Air Force Base, CA. Flight testing was done at Phillips Army Airfield, Aberdeen PG, MD.

AVSCOM Initiates UTTAS Competitive Prototype Tests

Competitive prototype testing of the Utility Tactical Transport Aircraft System (UTTAS), designed to serve as the main combat assault helicopter of the 1980s, has been initiated by the Army Aviation Systems Command (AVSCOM), St. Louis, MO.

Three-phase testing will be conducted at Fort Rucker, AL, Fort Campbell, KY, and Edwards Air Force Base, CA. Award of a production contract is scheduled by January 1977 to Boeing-Vertol Co. or Sikorsky Aircraft Co.

Three weeks of pilot training followed by nine weeks of flight tests are scheduled at Fort Rucker. Personnel from the 101st Airmobile Division (Air Assault), Fort Campbell will supplement these tests.

One prototype from each contract is undergoing flight engineering tests at the Army's Aviation Engineering Flight Activity (AEFA) at Edwards AFB. AEFA is an AVSCOM activity which provides UTTAS logistical support.

Designed to carry a fully equipped combat squad and a crew of three at speeds up to 175 knots, UTTAS also will perform medical evacuation and supply missions. Specifications make it one of the safest as well as maintenance-simplified of U.S. Army aircraft.

Delivery of the first production units, with an eventual fleet of more than 1,100 aircraft by the 1980s, is planned for August 1978. UTTAS will replace the UH-1 Iroquois (Huey).

Integrated Helicopter Control System developmental team includes (l. to r.) MAJ Fred Stephenson, flight operations pilot; John D. Waugh, instrumentation and data processing; John A. Stephens and Ralph J. Kibler, coinventors and design engineers; John H. Rollins, instrumentation technician; and Vincent B. Strickler, machinist.

Military Standard 781C Describes 'All-Equipments Production Test'

Included in the Draft Triservice Military Standard 781C "Reliability Tests: Exponential Distribution" is a new test developed by an employe of the U.S. Army Communications Systems Agency, Fort Monmouth, NJ.

Lyman Sessen, a reliability engineer, invented the "Two-Line All-Equipments Production Test," included in the Military Standard of the Naval Electronic Systems Command.

Sessen also invented the Air Force "Inclined Line Fixed Length Qualification Test" used for procurement of weapon systems and equipment by the U.S. Air Force since 1970. The new Navy test is designed to preclude the acceptance of weak components or faulty workmanship.

Decade of Progress Under Army-NASA Pact . . .

Air Mobility R&D Laboratory Viewed as Cost Cutting Example

By COL Norman L. Robinson
Deputy Director, U.S. Army Air Mobility R&D Laboratory
NASA-Ames Research Center, Moffett Field, CA

Ten years ago the Chief of Staff of the U.S. Army and the Chief of Staff of the U.S. Air Force entered into a joint agreement by which the Air Force gained primary cognizance of fixed-wing aircraft and the Army of its rotary-wing aircraft or helicopters.

One of the direct results of this agreement was that the Army assumed responsibility for development of its rotary-wing aircraft. A later and indirect result was the establishment of the U.S. Army Air Mobility Research and Development Laboratory.

The establishment of a new laboratory within the Department of Defense is accomplished only after careful comparison of the relative effectiveness both from a cost and research accomplishment standpoint of a government versus a commercial or univeristy-associated facility. As stated in a recent Department of Defense Study:

"Justification of the existence of the in-house laboratories in a nation dedicated to free enterprise requires demonstration that they do or can provide something that is (a) vital to the system, and (b) not satisfactorily available from sources such as industry, universities, etc."

The study goes on to say: "The in-house laboratories differ from industrial organizations in that (1) they have no profit motive, (2) as part of the government, they are allowed virtually unlimited information access and, (3) they enjoy a close relationship with their parent military service, and consequently have extensive exposure to and familiarity with Service problems...

"As a result, the labs should have a better perception of how to bring technology to bear on the problems of their Service than would industry or the universities and a less biased position than industry."

The in-house laboratory performs several specific functions. Deputy Director of Defense (Research and Advanced Technology) Dr. John L. Allen has listed these functions as:

- Provide the technical know-how to assist in the planning, analysis, development and acquisition of new weapons systems and to originate new systems and to originate new system concepts.
- Provide the technical expertise to make the Services "smart buyers."
- Participate in test and evaluation of new systems and procedures.
- Provide engineering support of fielded systems.
- Provide a corporate memory in weapons development.
- Assess that the state-of-the-art in areas of importance to weapons systems development is advancing.
- Transfer military personnel in technical skills and provide knowledgeable personnel to assess intelligence information on a potential enemy's systems.

After assuming responsibility for the development of helicopters, the Army moved to establish an organization capable of providing the necessary technical management. The blueprint was in the form of the Carlson Report - findings and recommendations of an ad hoc advisory committee of experts in aeronautical R&D drawn from industry and academia.

Headed by Dr. Phillip R. Carlson, this group recommended that the Army establish an Air Mobility R&D Center which would combine and significantly expand separated Army elements then engaged in R&D activities for the Army's aircraft fleet.

While the Army agreed with the concept advanced by the Carlson Report, it found that there were insufficient funds to establish the needed development center and provide it with the required research facilities, such as wind tunnels, simulators, propulsion tests stands, and whirl towers.

Accepting the fact that it would have to settle for something less than the ideal, the Army inventoried its existing organizations and facilities in preparation for determining an alternate solution.

The Army did have the nucleus for an Air Mobility R&D Center, but these existing elements were widely dispersed. Headquarters of the Aviation Systems Command, St. Louis, MO, had responsibility for the entire spectrum of research, development, acquisition and support of Army aircraft.

AVSCOM's capability, other than general management, was principally in engineering development of air mobility systems, acquisition, and logistic and maintenance support. Helicopter overhaul was being performed at the U.S. Army Aero Depot Maintenance Center, Corpus Christi, TX.

The Department of Defense and the Army recognized that to have a viable rotary-wing development capability, a significantly greater research expertise was required in the aeronautical disciplines.

During the late 1960s, the Army had two organizations whose mission was focused toward rotary-wing R&D. The Aviation Materiel Laboratory, Fort Eustis, VA, was engaged primarily in planning, executing and monitoring exploratory and advanced aircraft development contracts.

The other activity was the Army Aeronautical Research Laboratory (AARL) at Ames Research Center, Moffett Field, CA, engaged primarily in aeronautical research. After carefully analyzing the situation, the Army decided to use this organization as the base on which to build a greater laboratory capability.

AARL and the joint elements of its successor, the U.S. Army Air Mobility R&D Laboratory, are the result of a joint agreement between the Army and NASA for participation in aeronautical research.

The agreement was first signed in 1965 and resulted in establishment of the AARL at NASA Ames Reserach Center, Moffett Field, CA. In 1970, the agreement was expanded and Army research organizations were established at two more NASA centers - Lewis Research Center, Cleveland, OH, and Langley Research Center, Hampton, VA.

The original written agreement between the Army and NASA governing the unique arrangement is characterized by its brevity and simplicity, 18 paragraphs, slightly more than three pages. The signers agreed that they have a common interest in aviation technology and can, by joining resources, "achieve tangible economies and promote efficiency with respect to continuing R&D of aeronautical vehicles."

Both parties agreed to provide certain resources, specifically personnel, facilities and administrative support, but no mention is made of the specific costs involved or exact numbers of personnel. The Army agreed to staff and operate facilities (unlisted) assigned under specific Use Permits.

NASA agreed to make available, without reimbursement, certain support to include technical and personnel services, but again the exact scope of the support and its cost are purposely excluded.

Provisions were included for an annual review and modifications have been made over the 10-year span of the agreement. Surprisingly, the modifications have been very minor and generally are the result of pressures from outside the laboratory by authorities who are not completely familiar with the organization's formation and operation, and who are uncomfortable with the lack of rigid requirements and constraints.

The Agreement has worked well because it gives both sides a free hand to adjust readily to each other's needs without undue restrictions. More realistically, it has worked because it has been in the interest of both parties.

Three joint Army-NASA elements of the Air Mobility Laboratory are an outgrowth of the original AARL at Ames Research Center. All have the same organizational structure and all are characterized by Army employes *performing under the operational control* of NASA supervisors. The Directorates have three organizational elements, an Army Aeronautical Research Group (AARG), a Joint Aeronautical Research Group (JARG), and a Technical Support Group (TSG).

Each directorate is under an Army supervisor who reports directly to the laboratory director. All Army employes are hired and paid by the Army. All members of the AARG are engaged in Army-oriented projects, performed in NASA-owned and operated facilities or in NASA facilities which have been made available for exclusive Army use.

Only when one examines the Joint Aeronautical Research and Technical Support Groups does one encounter the distinctive features of each organization. One is that each has no over-all Army supervisor or internal organization. The second is that each individual, in addition to being listed as a member of one of these two Army groups, also is carried on the organizational rolls of a NASA functional element and works in that element under the direction of a NASA supervisor.

The number and job skills of personnel in the Army Aeronautical Research Group are based exclusively upon Army research needs. The JARG is staffed primarily with scientists, engineers and technicians, based upon mutual agreement as to the number needed for the joint Army/NASA technical effort. The number and skills of the TSG are also negotiated and generally equate to NASA administrative support.

Joint aspects of the Army-NASA agreement extend to the administration of the Army directorates. The Army has found that considerable economies can be effected by relying to the maximum on NASA for administrative support, stemming primarily from the fact that at each NASA Center where an Army directorate was established there was in being a complete service capability of providing a full range of

supply, personnel, purchasing and contracting.

Further, a major NASA contribution has been provision of supplies, housing, technical and other support without reimbursement, including office supplies and equipment, utilities, graphics, computer service, medical support and training. Complete technical services in support of research, such as model making and instrumentation, are also furnished.

All of these services are provided automatically or performed upon request. Purchasing and contract support is performed entirely by NASA. The Army makes a transfer of these monies to NASA at the beginning of the fiscal year. The Army director exercises administrative control and ascertains that goods or services requested are charged to the appropriate Army project.

One very important area of support is not performed by NASA - personnel administration including pay. NASA and Army employes are regulated basically by the same Civil Service rules and procedures, but each of those agencies interprets regulations in a slightly different manner and issues its implementing regulations.

The Army Air Mobility R&D Laboratory receives support from the nearest Army Civilian Personnel Office. This method of support has not been without its problems. Position classification is susceptible to differing interpretations and in some cases Army and NASA employes performing the same job under the same NASA supervisor are classified at different grade levels.

In such a situation, if the employes are members of a union, a complaint by that union could well be the result. Consequently, Army management has examined feasibility of having the NASA personnel system administer Army employes at NASA Centers.

Facilities required for a viable program of aeronautical research are in many instances very costly and, consequently, one of a kind, such as the 40- by 80-foot low-speed wind tunnel at Ames Research Center. The Institute for Advanced Computation (Illiac IV), also at Ames Research Center, is another.

The Army needed facilities such as these but did not have the funds to construct them - indeed did not need to construct because they were available. Facilities such as these were not fully utilized because of the decrease in the size and scope of the NASA aeronautical research program during the peak years of the space exploration effort. Army use of NASA facilities is on a preferred customer basis, generally at no direct charge.

The magnitude of the NASA research facilities available to and used to support the Army is impressive. Forty-four of these are available in support of Army projects having a capitalized (not replacement) value of $223 million.

From almost every standpoint, the Joint Army/NASA Agreement and the Army organizations which it has spawned have been a success. An objective analysis shows the advantages outweigh the disadvantages. The agreement provided the Army with "instant laboratories" at savings of tax dollars.

The Army, by placing its laboratory elements at NASA Centers, has provided a very favorable recruiting environment which attracts top quality technical personnel.

Another benefit is that the Army has realized a high return for its research dollar. Collocation of Army and NASA technical personnel has resulted in a synergistic effect in rotary-wing aircraft research. Presence of an Army research element on site has tended to focus NASA efforts on rotary-wing research to a greater extent than heretofore. The Army has been able, by providing "seed money," to generate matching, or greater, funds from NASA.

NASA can show increased utilization of its expensive facilities and thus is able to justify the cost of maintenance, modification of existing structures and capital expenditure for new research facilities. The NASA aeronautical research mission is strengthened by inclusion of support to the Army.

Some disadvantages are involved. For example, the Army set out to establish an R&D center in a single location and ended up with a laboratory in four locations, thus generating obstacles to efficient operation and management.

Joint use of facilities must conform to NASA priorities. These priorities have meshed to date with those of the Army, but a situation might arise where this would not be the case. The Navy and Air Force also use NASA research facilities on a nonreimbursable basis.

While this somewhat diminishes the economic advantages of the Army-NASA arrangement, it appears that the Army receives a higher priority for its work and a greater availability of facilities than other Military Services.

Congressional comments have been generally favorable in respect to economies in operation and more efficient utilization of existing facilities. Most importantly, the agreement has conclusively demonstrated that two diverse federal agencies can create and sustain a continuing joint administrative operation if it is in the interest of both parties.

The U.S. Army Air Mobility Research and Development Laboratory is the laboratory capability of the U.S. Army Aviation Systems Command, St. Louis, MO, a major subordinate command of the U.S. Army Materiel Development and Readiness Command (DARCOM).

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COL NORMAN L. ROBINSON has served as deputy director of the U.S. Army Air Mobility Research and Development Laboratory, since Aug. 1, 1972, following a tour of duty as commander of Yuma Proving Ground, AZ. His record shows service in both Europe and in Asia and with Chief of Research and Development, Department of the Army, where he was involved in policy and review and analysis.

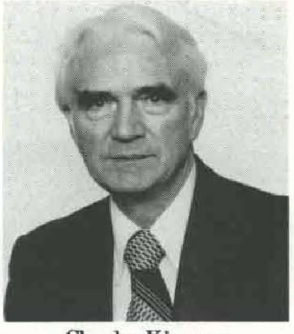
He received a BSL degree from the United States Military Academy and an MS degree in aerospace engineering, U. of Arizona.

LANDFAE Feasibility Shown

6 Nations Send Representatives

Large Area Nozzle Delivery of Fuel Air Explosive (LANDFAE) landmine neutralization capabilities were demonstrated recently to U.S. Army representatives and foreign officer observers from Australia, Canada, France, Germany and the United Kingdom, during a live firing at Eglin Air Force Base, FL.

The U.S. Army Ballistic Research Laboratories (BRL), Aberdeen Proving Ground (APG), MD, developed the LANDFAE concept. A high-pressure fuel spray is used to form a detonable fuel-air cloud.



Charles Kingery

Two other mine neutralizing systems utilizing fuel air explosives are being developed by the Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA. One is helicopter-delivered (FAESHED) and the other a surface-launched unit (SLUFAE).

An M67-A2 Flame Thrower Tank with a modified nozzle dispersed a detonable cloud of fuel over an area where 40 high-explosive M-15 mines were emplaced. A traversable path, 85 feet long, was neutralized with a one-spray detonation. Repeat sprayings could be made within seconds.

The live mine test was planned to demonstrate only the feasibility of the LANDFAE concept. Charles Kingery, credited with originating the concept, said the test "went well beyond this in showing that the Army has a potent system for landmine neutralization, requiring a minimum of engineering development."

Kingery has been engaged in terminal ballistics and blast effects research at BRL since 1949, and has guided BRL fuel-air explosive work.

During the Tripartite nations nuclear simulation tests in Canada, where one million pounds of TNT were detonated to simulate the blast effects predicted from a kiloton nuclear weapon, he was the U.S. technical chief.

Kingery is an Army member of the Working Party for FAE under the Joint Technical Coordinating Group for Munition Development. In discussing results of the Eglin AFB live mine test, he said:

"Product improvement of the system lies in developing a more efficient pressure system and dispersing nozzle to form a longer explosive cloud, resulting in a greater depth of clearance per shot."

The demonstration was the last test in a series sponsored and funded by BRL and conducted by the Air Force Armament Laboratory (AFATL), Armament Development Test Center (ADTC), Eglin AFB.

The mines were furnished and emplaced by personnel from the MERADCOM under supervision of James Dennis (see byline feature, p. 14). Project engineer for the firing was LT (Dr.) Ronald S. Fry, USAF.

An improved LANDFAE system is being developed by BRL for potential application in urban warfare and against other blast-sensitive targets requiring close-in attack by Army ground forces. A coordinated program with MERADCOM is directed to the design of adaptation kits attachable to the M-60 tank without degrading its offensive capabilities.

SLUFAE: Long-Range Minefield Breaching System Tested

By James A. Dennis
Mine Neutralization Division
U.S. Army Mobility Equipment R&D Command

Land mines and explosive booby traps accounted for up to 70 percent of our tank and vehicle losses and more than 33 percent of our personnel casualties during recent wars. Clearance of mines in the Suez area following the Middle East War was a major problem.

Current methods of breaching minefields and clearing explosive booby traps—including hand emplacement of demolition charges, use of tanks for pushing or propelling linear explosive charges, and mechanical clearing devices—are inadequate and outmoded for the modern battlefield (Fig. 1).

Requiring considerable preparation, manual effort or logistical support, these techniques are slow and inhibit mobility. The delivery vehicle must be adjacent to the mine or minefield during breaching or clearing operations. Exposure to enemy fire lessens chances of mission accomplishment. The U.S. Army needs a *stand-off or long-range* minefield breaching capability.

The Surface Launched Unit Fuel Air Explosive (SLUFAE) Mine Neutralization System is under development at the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA, to meet this requirement. Tests indicate it will provide Army ground combat forces with a vehicle-mounted system rapidly deployable to breach minefields and neutralize explosive booby traps, in daylight or darkness, or any environment.

Representing a recent development in advanced weapons technology, FAE weapons employ foliage discriminating fuzes that actuate on target contact and rupture thin-walled warheads to disperse highly volatile liquid chemical into aerosol clouds.

The clouds are detonated automatically by delay detonators projected into them by the central burster charges that formed them.

The state-of-the-art of FAE technology has been advanced but major technological restrictions remain for FAE weapons. They must be parachute-retarded and are 2-event systems. Repeatable impact velocities are required to allow time for FAE cloud formation and to insure proper detonator positioning. Blast effects, however, are sufficient to detonate or neutralize antitank and antipersonnel mines and explosive booby traps (Fig. 2).

Fig. 1. "Diamond Lil" Mine Clearing Snake

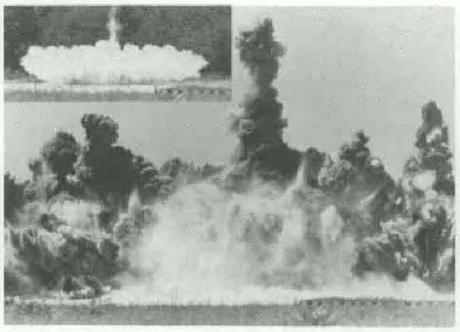


Fig. 2. FAE Cloud (insert) just prior to detonation by delay detonator, actuated and projected to proper position by center burster charge in propylene oxide liquid warhead filler. Black smoke plumes are generated from the exploding landmines.

Applications of FAE have proved effective in extensive tests and evaluations against live mines of U.S., NATO, and Soviet Bloc countries.

Conducted by MERADCOM's Mine Neutralization Division, these tests have shown FAE to be effective against not only single- and double-impulse pressure-fuzed antitank mines and pull-fuzed antipersonnel mines, but also against the complex fuzed magnetic-influence and long-impulse high-blast-resistant land mines.

FAE blast effects were found equally effective in detonating underwater land mines tactically emplaced in the waters in front of defended river lines or beaches and shorelines (Fig. 3). The SLUFAE Mine Neutralization System is variably important to U.S. Combat Forces in that it has the capability to breach land mines emplaced underground, on the ground surface, or underwater.

James A. Dennis

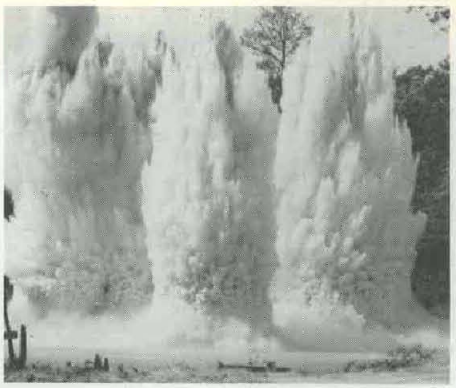


Fig. 3. MINES, under 1½ to 7½ feet of water, were exploded by FAE munitions that actuate when warhead probe fuze impacts water surface, exploding center warhead burster and dispersing FAE cloud above water; cloud detonation transmits explosive shock into water to detonate mines.

The SLUFAE system consists of a 30-tube armored launcher mounted on the M548 full-tracked cargo carrier (Fig. 4), a rocket-propelled FAE round, a firing control intervalometer, and launcher operating control.

An electric screw actuator elevating mechanism permits SLUFAE-round launching at 30-degree quadrant elevation on slopes of ±10 degrees. A manual elevating mechanism is provided as a backup in event the primary elevating mechanism should fail. The launcher can be elevated to the firing position in 30 seconds and depressed to travel position in 20 seconds.

The launcher module is mountable in the cargo compartment of the M548 cargo vehicle without modification. It has its own power source so that, under emergency conditions, it could fire a minefield breaching mission from the ground or from landing craft supporting

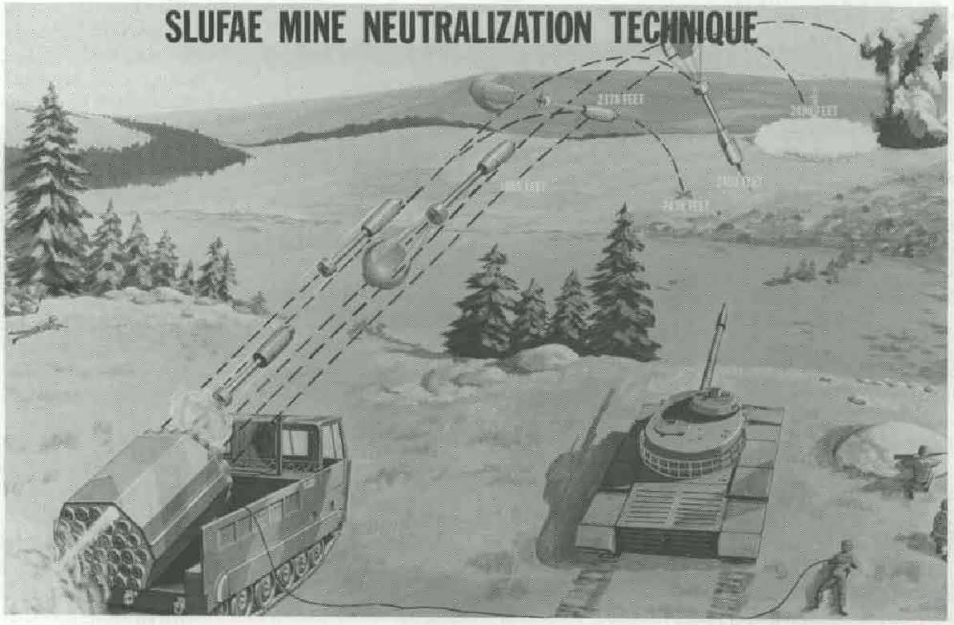


Figure 4

assault beach landings or large river crossings.

A firing control intervalometer permits firing of single rounds or ripple firing of any selected number of the 30 rounds, to impact at 300 meters minimum, 1,000 meters maximum, or in a linear pattern anywhere within this area. Rounds also can be impacted one on top of another at 1- to 5-second intervals.

The SLUFAE round (Fig. 5) is composed of a warhead containing 85 pounds of propylene oxide (PO) fuel, a central explosive burster, two cloud detonators, an electronic fuze, a foliage discriminating probe-fuze, a rocket propulsion motor, a ring fin-stabilizer, and a cross parachute.

Under development is an electronic fixed-time fuze that combines functions of the mechanical time fuze which deploys the parachute stabilizer, the probe-fuze that actuates the warhead on target contact, and the warhead initiation out-of-line pyrotechnic delay device.

This fuze is used to deploy the parachute. Variable fuze-set times are provided by the intervalometer, precisely controlling the time delay between fuze-timer start, rocket-motor ignition and round launch. The fuze always runs 12 seconds, but the rounds are delayed in the launch tubes to achieve the desired impact ranges and round-to-round spacings.

For example, a round to be impacted at 1,000 meters would be delayed in the launcher for 2.8 seconds to rocket-motor ignition and then fly 9.2 seconds to parachute deployment. For a 300-meter impact of a round, the delay in the launch tube would be 11.0 seconds and 1.0 flight of the round to parachute deployment.

Rundown of preselected fuze settings actuates explosive links that deploy the parachute and extend the 6-foot fuze probe after the parachute retards the SLUFAE-round descent to prevent fuze-probe damage. Target contact actuates the probe switch, detonating the burster charge to disperse the PO into a cloud 12 x 54 feet (Fig. 4).

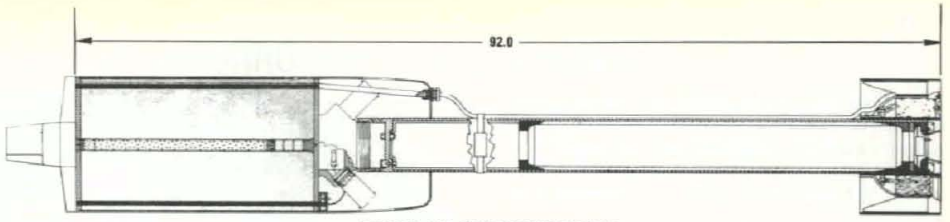
Accuracy firings have proved that the SLUFAE system of 30 rounds can clear a 12-meter-wide breach through a 300-meter minefield to a range of 1,000 meters. Compiled as standard deviations about the mean-impact point, results are 8.0 feet in deflection and 5.6 feet in range per 1,000 feet down-range. Range error can be corrected by changing parachute deployment times.

Two achievements recently advanced the state-of-the-art in FAE weapons technology and enhanced the versatility of SLUFAE. The first reduced the low-temperature operational limit from +20°F. (for the Navy BLU-73/B FAE bomblet) to −25°F. This was done by making the cloud detonator assembly independent of adverse influence of the ullage level of the PO fuel in the FAE warhead.

Contracting of the FAE fuel at temperatures below 20°F. in the Navy BLU-73/B FAE warhead exposed the burster charge, causing cloud burning rather than detonation, as the cloud detonators were mounted in the wall of the warhead. This effect significantly reduced warhead reliability.

Mounting the cloud detonators external to the warhead on the back plate solved this problem. Detonators (Second Event Package, SEP) cannot be affected by the contraction of the PO fuel in the warhead at low temperatures or on fuel expansion at high temperatures.

The SLUFAE round now has a high reliability at temperature ranges of −25°F. to +125°F. Detonators are projected from gun-type launch tubes into the area where the cloud will form 10 milliseconds before the central burster charge is initiated.



PHYSICAL AND PERFORMANCE FACTORS

WEIGHT	192 LBS
PROPELLANT WEIGHT	12 LBS
BURSTER WEIGHT	1 LB
FUEL WEIGHT (P.O.)	85 LBS
AVERAGE THRUST	8,750 LBS
MAXIMUM THRUST	11,000 LBS
TOTAL IMPULSE	2,625 LB-SEC
MAXIMUM RANGE	1,000 METERS
MINIMUM RANGE	300 METERS

Figure 5. SLUFAE Round

The second technology advancement was made after an accuracy analysis on the SLUFAE round showed that thrust malalignment was the major cause of deflection errors. The motor was designed with as short a burn-time as possible and still stay within the acceleration constraints of the thin-skinned SLUFAE warhead.

The present SLUFAE rocket-motor configuration, consisting of 12 pounds of fast-burning propellant, spun-cast into a 5-inch diameter rocket-motor case, provides 2,625-lb.-sec. impulse over a 0.3 second burn-time.

This combination of thrust and burn-time minimizes deflection errors caused by thrust malalignment, and provides an effective range of 1,000 meters (Fig. 5). This is the maximum range presently permitted by Free Flight Rocket Technology. (The clouds or kill zones of the FAE warheads must be connected to provide a continuous safe lane through a minefield.)

In FY 76, a fuze and intervalometer modification effort was initiated to meet the requirement for a rapid response (less than 10 minutes) field setting/resetting capability for all 30 SLUFAE rounds in the launcher tubes.

The experimental round contained an FMU-83/B mechanical-time-fuze for parachute deployment (range control) and an FMU-95/B extendible-probe-fuze to initiate warhead function. With this fuzing system, the mission had to be programed at the time the rounds were loaded into the launcher. Access to the fuze time-setting screw was not possible once the rounds were in the launch tubes.

The new fuzing system will combine functions of the FMU-83/B, FMU-95/B and warhead initiation out-of-line pyrotechnic delay device, into a single electronic fixed-time-fuze.

Variable parachute deployment times are provided by the intervalometer precisely controlling the time delay between fuze timer start and round launch. The proble on this fuze was increased from 4 feet (FMU-95/B) to 6 feet, to provide a more effective warhead height-of-burst in the dynamic mode.

A change was made from a ring-slot parachute deployed down the rocket motor to a cross-parachute deployed from the fin stabilizer. Allowing the parachute to trail behind the round, this change increased the round stability in the retarded mode and eliminated the problem of release of entrapped air from the parachute thinning the FAE cloud.

The static air column formed by air trapped in the ring-slot parachute was forced down into FAE cloud, hollowing out and thinning the center. This caused reduced impulse when the cloud was detonated. By deploying the parachute from the fin, the entrapped air column does not reach the cloud before it is detonated.

The present advanced development models have demonstrated that solutions to all problems are in hand and that all technical risks have been minimized. The SLUFAE system entered full-scale engineering development (6.4) in December 1975.

SLUFAE will be the U.S. Army's primary means of breaching enemy minefields in the 1980s. It has a unique countermine capability in that it permits the delivery system to standoff from the minefield during breaching. It is easily operated by a 4-man crew from the Engineer Combat Squad—three combat engineers (MOS 12B), one of whom is an E-6 combat engineer noncommissioned officer who will direct the crew, and one pioneer (MOS 12A).

SLUFAE has no sighting system; it is aligned on an azimuth with a standard Army compass. The launcher is raised to the firing position (30-degree quadrant elevation) determined by a gunner's quadrant. The range to the minefield is determined by the Army AN/GVS-5 portable range-finder.

The crew chief sets the range for the first-round impact into the intervalometer and enters the warhead-to-warhead spacing of subsequent rounds taken from a firing table. Current estimates indicate a minefield breach mission can be accomplished in three to five minutes.

SLUFAE development represents an excellent example of Joint Services RDT&E effort. The SLUFAE round is being developed by the Naval Weapons Center (NWC), China Lake, CA; the launcher, firing control intervalometer and SLUFAE-round shipping container are being developed by the U.S. Army Missile Command (MICOM), Redstone Arsenal, AL; and the new electronic fuze is being developed by the Naval Surface Weapons Center, White Oak, MD.

Over-all system development is managed by MERADCOM as part of the Army Countermine Program. MERADCOM has conducted all terminal effects testing, which provided the baseline concept and design of the SLUFAE.

Under the Army's new Single Integrated Development Test Cycle, the EDT-G testing portion of Development Test II is being conducted as a combined team effort of all four developing commands.

The U.S. Army Test and Evaluation Command (TECOM) is monitoring the tests after reviewing and approving test procedures, scope, and objectives. TECOM will conduct the DT II tests and HQ, MASSTER will perform Operational Testing (OT II/OT III).

AMMRC Functions in DARCOM Lead Laboratory Role

What do these four people have in common—an Army research administrator inspecting military facilities and equipment on Guam?

- A research mechanical engineer photographing buildings at 3 a.m. at Dugway Proving Ground in Utah?
- An Army supervisory materials research engineer working with the vice president of a chemical company in New York City for a year?
- An Army research scientist conducting an American Chemical Society conference she organized in Massachusetts?

F. J. Rizzitano, Paul E. J. Vogel, Dr. Robert W. Lewis and Dr. Janet S. Perkins have an affinity of interests in that they all work for the Army Materials and Mechanics Research Center (AMMRC) in Watertown, MA.

AMMRC is the U.S. Army Materiel Development and Readiness Command's lead laboratory in Materials Technology, Solid Mechanics Technology and Materials Testing Technology.

F. J. Rizzitano, chief of AMMRC's Materials Application Division, visited Guam, Hawaii and Germany this spring as part of an inspection of facilities and equipment for an artillery shell modification program.

Paul E. J. Vogel of AMMRC's Nondestructive Testing Industrial Applications Branch conducted full-scale thermographic heat loss surveys at 22 federal installations during the 1975-76 winter season at the request of DARCOM and other U.S. Government officials. *Purpose:* To gather information on possible preventive action to minimize heat loss as part of the national energy conservation program.

Dr. Robert W. Lewis, chief of the Composites Division, is spending a year in the New York City office of Union Carbide Co. Selected for the President's Executive Interchange Program, he is working on the planning phase of graphite fiber development.

Dr. Janet S. Perkins, a research chemist in the Composites Division, arranged and conducted a World of Polymers Conference at AMMRC in late 1975, in her capacity as chairman of the Northeastern Section of the American Chemical Society.

Assignments of these four employes, each recognized for special professional qualifications, illustrate the wide-ranging tasks handled by a modern military research center.

F. J. Rizzitano

Paul E. J. Vogel

Dr. Robert W. Lewis

Dr. Janet S. Perkins

A PROUD TRADITION. AMMRC professionals are proud of present progress but are mindful of "ancestors" traceable to the regime of Andrew Jackson as President. That raises a good question: What, you may ask, is the winning combination that has kept AMMRC and its predecessor agencies at Watertown important to the materials research needs of the Army for 135 years?

Part of the answer is *Experience.* Lessons learned continually are brought to bear on present-day problems by AMMRC's 216 professional scientists and engineers, 123 of whom hold advanced degrees. These researchers are supported by a staff of more than 120 technicians. Characteristic of the varied background of depth of experience is a scientist such as Dr. Homer F. Priest. Chief of the Materials Sciences Division, he was the first chemist hired, in March 1941, on the Manhattan Project at Columbia University and later at Oak Ridge, TN. When he left in September 1946 he had the longest service of any scientist on the project. His 30-year career at AMMRC has contributed invaluably to the Army's knowledge of the fundamental properties of materials.

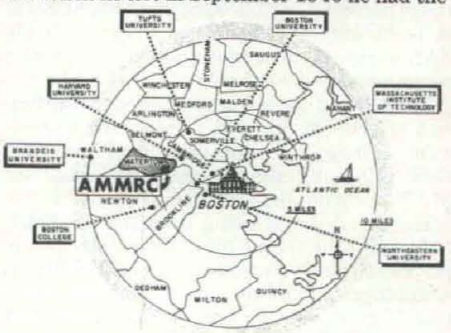


Fig. 1. AMMRC Location

Another part of the answer to the question about AMMRC's "winning combination" is *Location.* The view east from the center's highest buildings shows the historic Charles River flowing down to Boston Harbor. The red brick, Greek-columned buildings of Harvard University and the white granite of the Massachusetts Institute of Technology line its north bank. The white and gray walls of Boston University are on the south.

Educational and industrial research facilities of the area include Tufts University and Brandeis University, Boston College, Lincoln Laboratories and the Cambridge Research Laboratories—plus the many defense-oriented industrial plants along the famed Massachusetts Route 128. (See Fig. 1).

This wealth of nearby scientific talent and facilities has proven enormously valuable to AMMRC for the advancement of Army materials and mechanics research through the years by providing:

- Availablity to research libraries of the great universities.
- Opportunity to sit in on university lectures and nearby industrial meetings on problems under study.
- The chance to assemble blue-ribbon in-house seminars with speakers and panelists from eastern Massachusetts universities and industrial plants—recognized among the world leaders in their fields.

Succinctly stated, this is "where it's happen-

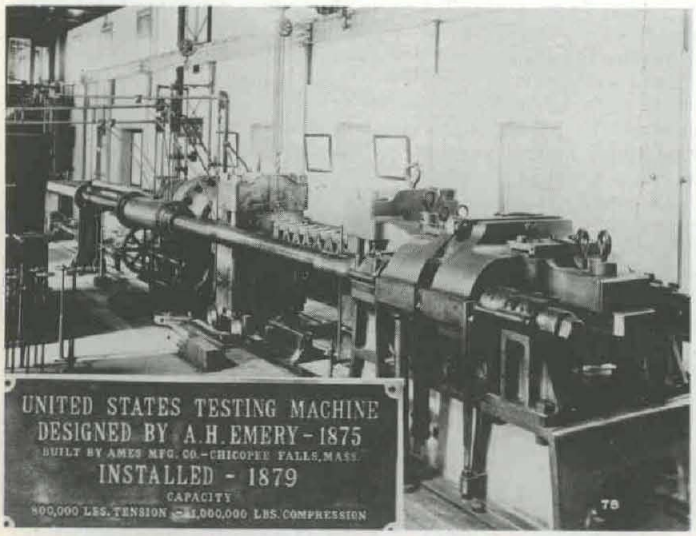


Fig. 2. Emery Testing Machine

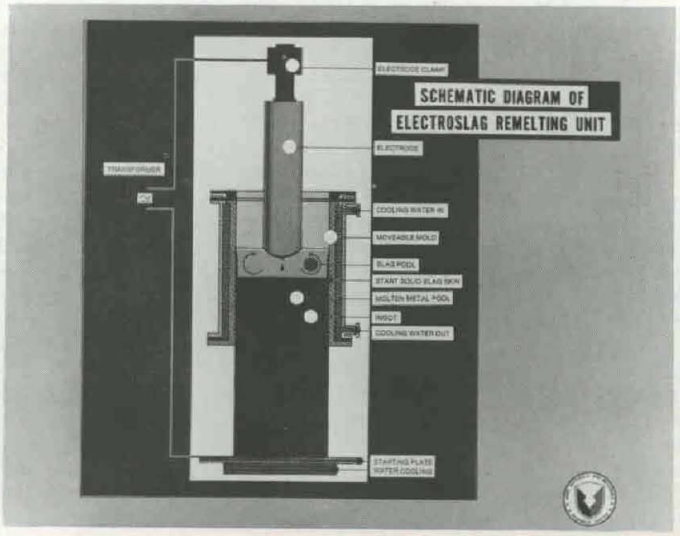


Fig. 3. Electroslag Remelting Unit

ing" in materials research and technological advances. AMMRC professionals benefit greatly from being situated in the center of the action.

Results. AMMRC's major functions within the U.S. Army Materiel Development and Readiness Command (DARCOM) are: To be the focal point of materials development within DARCOM; to perform materials research and development at the forefront of technology; and to insure responsiveness of its efforts to user requirements.

In fulfilling this mission, research efforts cover the gamut of modern materials. Areas of investigation include metals, organics, ceramics and composites; also, materials processing techniques such as melting, casting, forging, welding, coating and other materials processing.

The center adapts and improves materials for Army weapons and equipment in close cooperation with the systems developers, finds substitute materials for those that may be scarce in time of war, and sets up materials specifications and standards.

Testing techniques are also developed. AMMRC conducts and provides technical surveillance of DARCOM's industrial training program in nondestructive testing. Research in theoretical and applied structural mechanics provides for utilization of new materials in critical areas of design engineering.

During FY 1975 the AMMRC technical staff produced some 100 publications, including 52 open literature documents, made 84 presentations and were awarded 10 patents.

Staff members pride themselves on being expeditiously responsive to Army needs in the important areas of failure analysis and technical consultation—by providing technical know-how and assistance when and where it is needed. Most of this assistance is rendered to other Army agencies. Cooperation is often extended, however, to the other military services, federal agencies and defense-oriented industrial organizations.

Materials research results in steel offer an excellent example of the invaluable *results* of AMMRC advances for the modern Army. AMMRC and steel literally grew up together. In the 1840s, AMMRC's predecessor agency at Watertown was helping the U.S. Army develop the superior cast iron that made its cannon the best in the world.

After the Civil War, the famed Emery Testing Machine (ETM) was installed at Watertown, to settle the raging controversy over the suitability of steel for making cannon. It proved of great significance in the study of metals, and was the prototype of a long line of hydraulic testing machines, many of which are still in operation.

Fig. 4. AAH Fragment Barrier

Dr. Alvin E. Gorum

Dr. Edward S. Wright

LTC Edward E. Chick

Dr. John J. Burke

The ETM had a capacity for precision testing of 800,000 pounds in tension and one million pounds in compression. Results of its tests were published annually for 36 years, from 1882 to 1918.

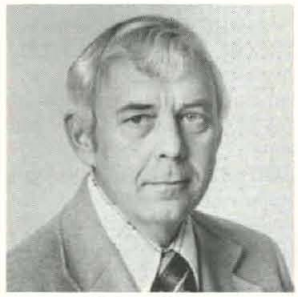
Authoritative information on the merits of steel which these results provided were the basis for the adoption of steel for armament. Today the machine may be seen at the Smithsonian Institution in Washington, DC.

Other milestone results of AMMRC research with steel include the use of radiography and spectroscopy for steel foundry control; centrifugal casting of gun tubes; all-welded gun carriages and molybdenum tool steel.

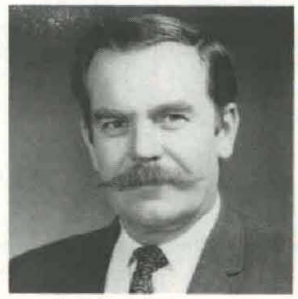
and explosion-proof fuel tank filler materials.

Composite materials, such as graphite fiber-reinforced aluminum and graphite or Kevlar-reinforced epoxies, are being studied for aircraft and missile applications. These materials offer high strength and stiffness in combination with lightweight applications where weight reduction is critical for desired performance.

Other areas of research emphasis at AMMRC include ballistic missile defense materials; damage-tolerant and laser-hardened materials; transparent/lightweight armor; life prediction reliability mechanics; conventional and nuclear shell components; electromagnetic window and optical materials; organic structural foam



Richard Shea
Mechanics Research Lab



Dr. Frank Larson
Materials Development Lab

Dr. George Thomas
Organic Materials Lab

Electroslag remelted steel (ESR) is currently of great interest to the Army, and AMMRC is still in the forefront of steel research. A program is being conducted to improve high-strength rolled ESR steel armor by using an electroslag remelting furnace added in 1975 to the center's Experimental Foundry. (See Fig. 3). TRIP and nickel-maraging steels are among AMMRC research and testing programs.

Emphasis has shifted, however, to include new, sometimes exotic materials that have some special qualities needed in modern technology—materials that are able to withstand very low or high temperatures, are lightweight with high strength, or have other desirable characteristics. (See Figs. 4, 5).

For example, AMMRC researchers played a very significant role in developing the technology of titanium including advances of great value in aircraft components during Southeast Asis combat in recent years.

Some of the more recent contributions include advancements in ceramic, organic and composite materials. Ceramics have been employed as a lightweight armor material for helicopters and in armored vests for protection of combat soldiers. Current research is aimed at utilization of ceramics for gas turbine engine components and radomes.

Polyphosphazene polymers are being studied for numerous potential Army applications. Areas of interest include low-temperature flexible hoses and gaskets, high-temperature seals

technology; high-density penetrator materials; improved fragmentation techniques; and preventive measures against gun tube erosion.

Under investigation also are ways of increasing immunity of metals to stress corrosion cracking; assessment of composite deterioration by dynamic mechanical analysis; crack closure analysis; superelastic alloys based on deformation martensite; techniques for precision joining of large structural components; advanced computer graphics techniques in engineering design; and ultrasonic techniques for evaluation of rotating band joints.

Management Team. AMMRC administration is entrusted primarily to a director, a command/deputy director, an associate director for Operations, and an associate director for Plans and Programs.

Dr. Alvin E. Gorum retired in March from the position of director after a 6-year tenure that earned him esteem as the "father" of the modern AMMRC. Associates have credited his leadership with results that greatly increased national and international recognition of AMMRC as the Army's key materials and mechanics research facility; also, with significant advances in the Army's materials progress posture.

Dr. Edward S. Wright was detailed by DARCOM in April as acting director of AMMRC. As associate director for Operations and technical director since 1970, he has participated in the planning and execution of the

(continued on page 18)

Progress in AMMRC Materials Research for Army Needs

(Continued from page 17)

Army's over-all materials and mechanics program, and serves as Technical Director of the Watertown Laboratories.

Dr. Wright came to the AMMRC in 1970 from the Stanford Research Institute, where he was manager of the Metallurgy Department. Engaged in materials research and development since 1949, he has held managerial positions at industrial, independent and government research laboratories since 1957.

Commander/Deputy Director *LTC Edward E. Chick* came to the AMMRC in September 1975 from London, England, where he was chief, Materials Branch, U.S. Army Research and Development Group, Europe. LTC Chick served in Washington, DC, as a staff officer in the Laboratory Review Office, Office of the Chief of R&D, now the Office of the Deputy Chief of Staff for Research, Development, and Acquisition. Earlier he was staff officer in the Physics and Engineering Sciences Division, Army Research Office in Arlington, VA.

Associate Director for Plans and Programs *Dr. John J. Burke* also serves as chief of the center's Planning Directorate and has served with distinction in various key positions at AMMRC for more than 20 years.

Dr. Burke is noted for his expertise in technical forecasting and long-range planning. Co-inventor of the SPIDERCHART management concept, he has lectured frequently on this subject before educational, industrial and governmental groups and is known for coediting nine technical books.

Research Leaders. AMMRC's Planning Directorate functions in solving the Army materials problems as effectively, efficiently and economically as possible—using the SPIDER (Systematic Planning for the Integration and Direction of Engineering and Research). This system was developed at AMMRC in the early 1970s and Planning Directorate members toured the country during this period to brief research groups from all of the military services on its principles. (See Fig. 6).

In general, SPIDERCHARTS permit management to relate more clearly investments in research and technology to the projected needs of the combat forces. The system employs graphic displays in a logical, engineering-type sequential system designed to aid the decision-making process.

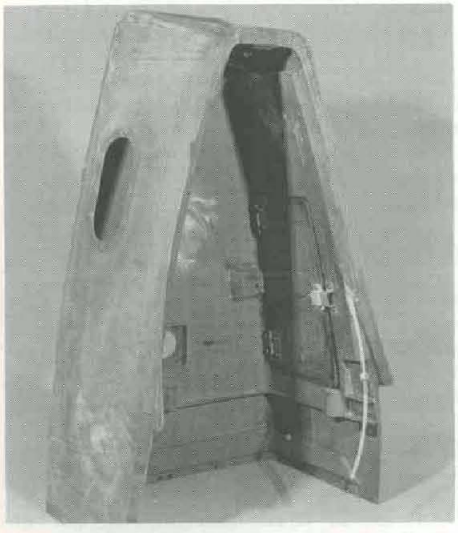


Fig. 5. Kevlar helicopter engine fairing, completed in cooperation with Hughes Helicopter Co., demonstrates low-cost use of hot lay-up tools to form composite structures.

The system goes from the more inclusive general objective statement to the identification of special problems which inhibit achievement of goals. Decisions in a step-by-step sequence provide the follow-on action basis. The SPIDERCHART method was presented to the Defense Department, and was incorporated into some of the DoD Technology Coordinating Papers (TCPs).

Vital Statistics. Facilities of the Army Materials and Mechanics Research Center in Watertown include 10 major buildings and 335,000 square feet of laboratory space. The total staff of 699 is divided into 336 technical and 363 support personnel.

In addition to a commander/deputy director, the military staff consists of six officers and five enlisted men, handpicked from throughout the Army for their advanced scientific qualifications, academically and in progressive assignments.

AMMRC's total funding for FY 1975 was nearly $31,000,000 and 56 percent of the funding was allotted to in-house research. Twenty-four percent went to supporting stations, and contracts accounted for 20 percent.

Participants in AMMRC's FY 75 R&D Program include TECOM, TACOM, MICOM, ECOM, TROSCOM, AVSCOM, ARMCOM, and other Corporate Laboratories and Development Centers of the Army Materiel Development and Readiness Command.

Other Functions. AMMRC'S materials research coordination efforts included the Structures Technology and Materials Technology Coordinating Papers; Quadripartite Technical Cooperation Program; Tri-Service apportionment briefings; inter-service/agency cooperation in materials R&D; DoD coordination of armor materials; and participation in numerous materials advisory and technical working groups.

Functioning as a DARCOM Corporate Laboratory, AMMRC participates in monitoring of DARPA (Defense Advanced Research Project Agency) contracts, evaluates proposals for the Army Research Office in Research Triangle Park, NC, manages Information Analysis Centers, and conducts conferences and symposia.

Technical management of five Department of Defense Information Analysis Centers is an important AMMRC function. They are the Metals and Ceramics Information Center at the Battelle Memorial Institute in Columbus, OH; the Thermophysical Properties Information Analysis Center at Purdue University, West Lafayette, IN; the Machinability Data Center of Metcut Research Associates, Inc., Traverse City, MI; and the Nondestructive Testing Information Analysis Center, located both in-house and at Southwest Research Institute, San Antonio, TX.

These centers are responsible for collection, storage, review, evaluation, synthesis, repackaging and dissemination of authoritative information in readily usable format for scientists and engineers. AMMRC reviews and approves all major documents prepared by the centers for general publication.

Long-range materials technology planning efforts of the AMMRC include sponsorship of conferences and symposia related to R&D interests of the U.S. Army for transfer of technology to aid materiel advances. Among these are the internationally known Sagamore Materials Research Conference series, the Army Materials Technology Conference series, and the Technology Assessment and Planning Colloquia.

The U.S. Army Materials and Mechanics Research Center prides itself—in America's Bicentennial Year Celebration—on a 135-year role in the nation's growth, remaining ever conscious of its responsibility to increase in value by achievement linked to goals of the parent Army Materiel Development and Readiness Command, and the Department of the Army.

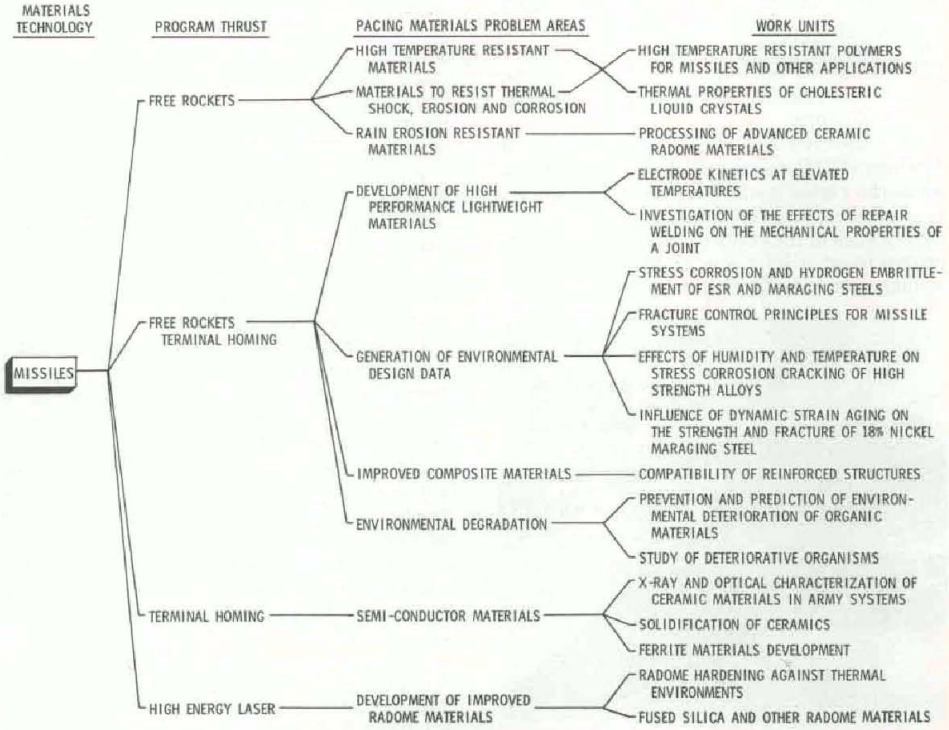


Fig. 6. SPIDERCHART

Speaking On . . . *(Continued from inside front cover)*

"That which is possible automatically becomes that which is required." It enables him to do this with relatively modest investments where his leverage is greatest - in the conceptual, proof-of-engineering-principle stage.

The nation and the Department of Defense need a DARPA, serving in the unique ways which I have just outlined, but it does not need a DARPA if DARPA conducts its R&D as a fifth Service. That is why all of our efforts are coordinated with the Services and the Director of Defense Research and Engineering to assure there is no unnecessary duplication and overlap....

There have been significant changes in DARPA during the past year. There have been major personnel actions and 61 programs (totaling $31 million) were modified or terminated as we formulated our investment strategy. The DARPA technical program has been focused around seven major thrusts selected on the basis of their potential for major impact on the defense of this nation.

These major thrusts are rooted in technological initiatives that may make unique mission initiatives possible. The technological risk is higher than the Services can tolerate at this early stage, but the payoff is great if we are successful.

DARPA serves in its multi-faceted role as catalyst, custodian of the cutting edge in defense technology, generator of quantum jumps in capability, and as an alternative to preordained production decisions even where technical feasibility is proved. These programs form the basis of an investment strategy that is designed to contribute to the retention of the initiative in defense technology.

THE KEY QUESTIONS. As one looks to the future, there are key technical questions which must be answered if we are to protect ourselves from technological surprise that could threaten our security - surprises that could be far less benign than Sputnik, which, incidentally, precipitated the formation of DARPA in 1958 with a charter to pursue initiative and prevent technological surprise.

The DARPA investment strategy is focused on providing the nation with the long lead-time and some of the background data which decisionmakers need in order to answer questions which could become the national security issues of the late 1980s. There are many questions of this nature, some of which are represented by:

1. Is a space-related use of high-energy lasers possible and could it threaten our vital satellite network and strategic deterrent capability? Conversely, could such a laser serve the United States in some other defensive way?
2. Are there technologies on the horizon that can provide space-based surveillance capable of detecting aircraft and warning us of missile launches?
3. Is a new class of undersea surveillance systems possible that could locate submerged submarines at great range with sufficient accuracy to target them? What are the limits of ocean hearing? Can the oceans really be made "transparent?"
4. What is the nature of armor on the battlefield of the future? Are there technologies that could permit unique trade-offs between mobility, agility, armor and firepower that could result in a new and better class of lower-cost armored vehicles?
5. What can technology do about the seemingly endless spiral of increasing costs? For example, can we dramatically reduce the cost of jet engines by making them out of new types of ceramics instead of costly metallic superalloys? Can the sophistication and low cost represented by the pocket calculator and digital watch be used to simplify the maintenance problems of our equipment and make it more reliable?
6. Are there technological initiatives in the command and control areas that could enable us to use our current forces more effectively?
7. Are there technological breakthroughs possible which could lower the cost or greatly increase the speed, range and endurance of undersea vehicles?
8. Is it possible for an adversary to sign nuclear test ban treaties and then covertly test such weapons.

If the answers to these questions are "yes" and others find the way before we do, our security will be gravely endangered and our ability to deter conflict greatly weakened. This is indeed a unique time for I cannot recall a period in the past decade when so many technological breakthroughs with potential major impact on national security were on the horizon.

The shock of Sputnik back in 1957 dramatically demonstrated to the nation that we were vulnerable to technological surprise. It also demonstrated that there were vital longer-range questions (whose answers are deeply rooted in technology) that could not be adequately addressed by those primarily concerned with planning for and assuring *today's* defense.

The Secretary of Defense is not unique in finding himself in need of an agency such as DARPA to formulate and address such questions. Indeed, this need is no less unique than that of the major corporations of this country who use their central research organizations to address and formulate the questions which fall outside the R&D activities of their product divisions.

The obvious difference between the private sector and national defense is in *the cost of inadequacy* (italics added). If a commercial organization is not sufficiently imaginative or farsighted in its R&D, then it may someday be closed out of lucrative new markets or, at worse, the company may fail because of obsolescence of its products. The cost to the United States of allowing a potential adversary to gain decisive technological advantages is immeasurable.

THE MAJOR THRUSTS. DARPA tends to select its programs based on the generation or emergence of a new technological approach or idea which, over the long haul, could lead to a major payoff in national security. In addition, we are sometimes the mechanism by which diverse technical specialties are brought together to focus on a problem while, at other times, we serve as a catalyst to take a fresh look at activities in older areas where initiative is needed.

We make no open-ended commitments nor are we a science-for-science-sake organization. We exist to generate, focus, catalyze, organize, execute, evaluate and transition to the Services proved concepts. These can form the basis of development programs that can make a major difference to national security.

I would like to outline the major thrusts of our program - a program that we believe represents our best investment strategy for the late seventies. Many of the details can be found in the chapters which follow, but I would like to sketch for you the technological breakthrough areas which are a major part of our program, together with mission initiatives which underlie their importance to our future security.

You will see how we focus our efforts to address key questions in the areas of space defense, undersea surveillance, undersea vehicles, battlefield vehicles, command and control, and lowering the cost of national defense, as well as seeding new technological ground.

Space Applications. Three major technological initiatives that DARPA has pioneered are the high-energy chemical laser; monolithic infrared sensor systems based on a silicon charge coupled device technology; adaptive optics.

The high-energy chemical laser, because of its higher mass efficiency and ability to produce laser power within a large electrical power supply, could lead to a device whose size and weight would enable it to be used in space. We pioneered high—energy chemical laser technology and are now exploring the technical problems of extending the concept to operation in a space environment.

In the area of infrared sensors, we believe that we have found the key to applying the same mass production technology of silicon integrated circuits that made possible the pocket calculator to the problem of infrared surveillance from space.

This means that it may be feasible to make space systems with millions of integrated infrared sensors instead of a few thousand hand-wired detectors. Such capability might lead to an ability to detect aircraft from space as well as strategic missile launches.

Fundamental to many types of surveillance and space laser systems is the need to assemble large optics in space or to compensate for atmospheric turbulence and optical system changes. In our pioneering work on adaptive optics, we are pursuing ways to compensate in real-time for atmospheric turbulence that can distort images or the imperfections of large optical systems which result from the incompatibility between large size and requisite precision.

The adaptive optics work has been very promising to date and we are currently assembling proof-of-principle models in large sizes.

Undersea Vehicles. DARPA has been responsible for a major breakthrough in undersea vehicle design - we have learned how to lower the drag (i.e., friction) on such vehicles and have demonstrated the principle. Drag is a fundamental, limiting factor on such vehicles because it determines the vehicle's speed, range and endurance.

Undersea Surveillance. Through DARPA-sponsored experiments, the ocean has been found to be a far more tractable under-

(Continued on page 20)

Speaking On . . . *(Continued from page 19)*

water sound environment than we had previously thought. Improved detection ranges appear to be achievable. These techniques were thought to be impossible with acoustic undersea arrays.

We are now attempting to demonstrate a revolutionary capability for finding submarines. This effort requires computers with capabilities that far exceed those used in existing systems. We, therefore, are applying the ILLIAC IV, one of the world's most powerful computers (which was previously developed by DARPA). If successful, these experiments could lay the groundwork for a submarine detection system and might also be suitable for localization.

Land Combat. The size of a tank and, hence, its cost is usually dominated by the size of the gun. Results from our gun programs, when coupled with an advanced rod-like penetrator, may enable the fabrication of an antitank "machinegun."

This high-risk program represents a breakthrough in gun technology. We are also attempting to quantify, by means of a test bed, the tradeoffs between mobility, agility, survivability and firepower that this gun development might make possible.

Perhaps in the late 1980s or early 1990s it will be possible to make more survivable armored vehicles of smaller size, lower cost and greater fighting capability. However, more data are needed and our program is designed to accomplish this task.

Command and Control. Command and control is the linkage by which we coordinate the effective use of our forces. Any weapon system, no matter how great its capability, needs to be coordinated with other battlefield assets if it is to realize its full mission capability. Fundamental to the command and control process are the building blocks of computers, data bases, data handling techniques, data security and networking.

We are exploring the technology which permits remote conferencing, effective interactions between computers, shared use of distributed computers, and simplified user-to-user message handling. We are also exploring techniques that make it more difficult for an enemy to locate our communications and either intercept, jam or target them.

Software is a pacing element in command and control. We are exploring ways to simplify the complex process of generating computer software by involving the computer itself more directly in the generation, verification and documentation processes, through a set of tools that can be made available by computer networking.

While the technology building blocks which we are exploring are important to any command and control system, the DoD needs better ways of understanding total system needs and management/technology/personnel tradeoffs in the process.

Thus, we plan to utilize some of our existent DARPA network technology (which we pioneered in the ARPANET) as a flexible test bed capable of exercising realistic command and control scenarios by the users, not the engineers.

This test bed will enable users to experiment with various system architectures and assess the impact of new technology, such as speech inputs to computers and intelligent terminals, in real command and control scenarios while injecting the human factors.

Lower Defense Costs. DARPA's past efforts have been almost exclusively focused on increasing capability and performance. In this era of tight budgets, however, we face a dual challenge of reducing costs as well as improving performance.

We are now attempting to apply some of the technological initiative and imagination which has always characterized DARPA programs to the objective of dramatically lowering the cost of materials, manufacturing and maintenance. Let me give you some examples of what we are doing.

The efficiency of gas turbine engines is determined by the temperature at which they operate. Today's highest performance jet engines use exotic and expensive superalloys to operate at metal temperatures of about 2000°F. We are exploring the use of ceramics as a substitute for superalloys in such turbines. Ceramic turbines use materials which are cheap, plentiful and easy to fabricate. In addition, they should be capable of operating at component temperatures of 2500°F.

The successful demonstration of a 2500°F. ceramic turbine could revolutionize the military engine business, thanks to its greater efficiency and ability to use a wider range of fuels. Indeed, it may have important implications for the entire nation. This is but one example of how we are applying the DARPA revolutionary versus evolutionary approach. Some others include:

- Rugged (boron nitride) tooling for machining superalloy parts for jet engines to reduce costs by an order of magnitude.
- Superalloy molds to replace sand molds in the casting of ferrous metals. This approach might make it possible to automate the casting processing (superalloy molds are reusable) and, in addition, result in a cast part that has a machined-like surface, thus obviating the need for further expensive machining in many applications.
- *Novel Quantitative* nondestructive inspection techniques to reduce the burgeoning costs of quality assurance on high-performance vehicles.
- Low cost mini-RPV (Remotely Piloted Vehicle) and distributed sensor systems. The cost of the vehicle and its sensor systems can be greatly reduced by decreasing the size of the vehicle, not requiring manned operation, and by placing critical components in a sanctuary or relatively safe areas and linking them via low-cost, secure, jam-resistant data links. Thus, only the relatively inexpensive components need to be exposed and proliferated.
- Focusing on some seemingly neglected areas of military manpower such as training and evaluating men as *teams* instead of as individuals, exploring novel ways to train maintenance personnel and exploring the limits of the computer in training and evaluation.

Further Technological Revolutions. The preceding six items represent technology focused at answering penetrating questions fundamental to our ability to prevent technological surprise and face an uncertain future. The answers lie in the exploration of high-risk/high-payoff technology that is often revolutionary.

DARPA continues to be an incubator for ideas in other areas as well. These include "seed" efforts in such areas as: Sensor and processor technology that would enable drones to seek out and attack specific classes of targets. Laser propulsion utilizing ground-based high-energy lasers that could lead to much lower launch costs for the relatively small space packages of DoD interest—X-ray lasers; organic conductors lighter weight, noncritical materials; exploring the world of electronic materials beyond the present silicon-based technology; binary semiconductors for microwave, night vision and electro-optic applications.

Other DARPA seed efforts are: Applying computer based artificial intelligence concepts to problems in antisubmarine warfare (ASW) and electronic warfare (EW). Speech input to computers. Biocybernetics - to integrate man with computers and control systems more closely. High-density computer memories (10^8 bits/cm^2 or 100 million pieces of information in a chip the size of a fingernail). Intelligent computer terminals that remember the protocols for use of various data bases, pursue goals over time and adjust to operator nuances, etc. Monitoring of treaty compliance via sensors that can detect tell-tale chemical effluents. Technology for detecting the emergence of new foreign nuclear powers with minimum reliance on oversea collection bases.

SUMMARY. DARPA is the cutting edge for the kind of new technology that can provide us with options for major increases in or retention of deterrence in the face of the Soviet challenge. It has a major role in maintaining the technological initiative. The United States is number one today because of our unique ability to put imagination, technology and mission focus together.

DARPA has a special role because of its unique charter, program, people and capabilities. This special role is clearly recognized by the Secretary of Defense and Director of Defense Research and Engineering. In an era of tight budgets in which there are strong pressures to trade R&D, which represents future capability, for badly needed items for today's forces, they have requested $246.4 million for DARPA in FY 1977. This represents a $32.2 million increase.

This increase is 11 percent of the total DoD technology base increase of $288.6 million. Over half, an estimated $18 million of the DARPA increase, will be sapped by inflation. One might ask why an increase should be granted. Why not do less or stretch it out?

There are several reasons why this is not a prudent course of action. First, technological surprises - or the breakthroughs about which we speak - could also be accomplished by an adversary. Breakthroughs that could alter the balance of power do not occur on schedules that can be controlled or regulated.

Secondly, if one would push the frontiers and obtain answers to key questions, it is necessary to have efforts reaching a critical mass. Fragmented, underfunded and unfocused efforts waste dollars in the long run because answers are always *promised* but never delivered.

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Thirdly, these programs, in terms of their importance to our security, merit timely investment. Adding urgency to each of these reasons is a very substantial Soviet effort which is characterized by increasing sophistication, a massive resource commitment, and a national policy to gain the technological initiative from the U.S.

In order to gain the greatest possible leverage and benefit from limited resources, DARPA has prioritized its program into seven major thrusts. This was not an easy task in that less essential programs, each with its own capable spokesman and technical merit, had to be modified or terminated.

We may not be successful in all our efforts, but we now have an investment strategy that maximizes opportunities for a high return on investment in terms of options for major new capabilities, even if we succeed in only a portion of our R&D efforts. We dare not preclude such options which could alter the military balance when they can be explored with minimal resource commitment and clear and discrete decision points concerning future full-scale development.

One should not be deluded, however, into believing that, because DARPA is exploring interesting options, the DoD should substitute such efforts for some of the ongoing development programs in the Services. We recognize that R&D in itself does not guarantee results or provide deterrence.

In the DoD, as well as in business, results are based on today's products, not future sales projections. Likewise, deterrence is provided by the systems that we deploy, not those which are still in the conceptual or proof-of-principle stage.

Nevertheless, our present capabilities will not endure forever and extensions of existing ways of doing things will not suffice for the long term. As I pointed out earlier in my statement, at DARPA we are focused on obtaining data that will help our decision-makers to answer some of the key questions that cloud our future security.

We think that the country needs the answers to these and other similar questions if it is to face an uncertain future with confidence in its own capability to respond to any threat to our security. DARPA is one of the mechanisms by which the answers are sought - not in rhetorical terms, but in terms of confirmed technological facts. If we choose to ignore these questions, they will not go away. Others will find the answers and may even choose to use them for aggressive purposes.

We have structured an investment strategy that is designed to retain the technological initiative. In this year of our 200th anniversary, it is a sound investment in America's future. We believe it deserves your full support.

DARPA Report to Senate Unit Lists FY76 Achievements

(Continued from page 7)

Results will permit study of such complicated situations as simultaneous multiple explosions such as those contemplated by the Soviet Union as part of their Peaceful Nuclear Explosion Program.

This development, together with parallel advances in seismic signal measurement and detection processing, will speed the achievement of high-confidence techniques for verifying compliance with current yield limitations under the proposed Threshold Test Ban, as well as with reduced thresholds which may follow on the path to a Comprehensive Test Ban Treaty.

Cost Reduction through the Development of Boron Nitride Machining Materials. Averaged over the production of an aircraft jet engine, the machining cost per pound of finished superalloy parts is approximately $350.

This high cost is due to the extreme hardness and strength of superalloys which render conventional machining methods extremely slow and laborious.

Various effective super-hard abrasive materials were available but no methods were known to form them into tool kits for machining purposes. DARPA recently developed methods of forming one of the best of these materials, cubic boron nitride, into machining tools and the results to date are impressive.

Machining speeds have been increased from five to ten times (depending on the particular superalloy) in laboratory applications. In one particular application, total machining costs for a given part were reduced by a factor of ten.

Plans in FY 77 are to complete the effort by conducting a full spectrum analysis of boron nitride tools for all types of machining.

Die Casting of Stainless Steel. The present method of casting ferrous materials requires the use of sand molds. Sand casting is labor intensive, results in many rejected parts, and yields parts which require surface machining.

DARPA has developed alternative casting technology, called thixocasting, which has been used successfully to die cast bronzes and stainless steels. In the process, the charge to be injected into the mold consists of a solid/liquid slurry similar to soft ice cream. Because the charge contains a small fraction of molten liquid, there is a significant decrease (by 400°C.) in the peak die temperature. This will significantly increase die life.

It is estimated that if 10 percent of the present number of small ferrous parts purchased by the Department of Defense are made by this technique, a yearly savings potential in the millions is possible. This program has progressed so well that it should be ready for exploitation in 1977.

Enlistment/Reenlistment Bonus Model. Two accomplishments during the past six months have been (1) the development of a dynamic bonus policy model that integrates the many purposes of reenlistment bonuses, and (2) the preparation of estimates of the effects of bonuses on first-term reenlistment.

These estimates have been accepted by the Defense Department and are not used in making bonus awards. One of the immediate implications of these results has been to increase the utilization of Bonus Levels 1 and 3.

Previously, it had been believed that these bonus levels were less effective than Levels 2 and 4; our work showed that on a per-dollar basis they were equally effective. Thus, DoD has been able to substitute a number of Level 3 awards for Level 4 awards, thereby reducing total bonus costs in FY 76.

Graphics for Training. Animated, interactive computer-based graphics were applied for the first time to training maintenance personnel, with greatly improved performance over traditional instruction methods.

Results indicated that three hours of instruction, using PLATO IV, a DARPA computer/graphic system, is more effective for training S3A crews than one day of studying from a workbook and one hour of practice in an expensive ($200/hour) airplane simulator.

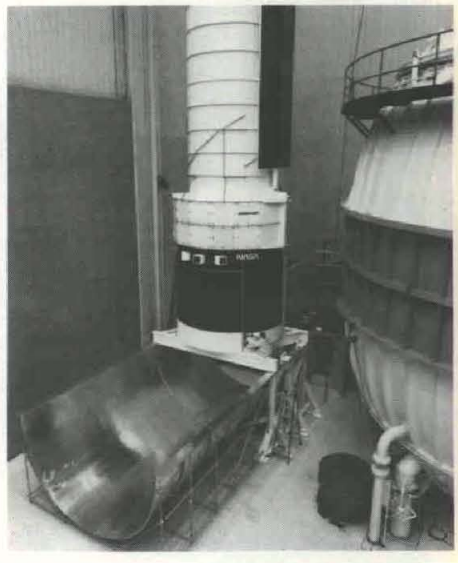
Further, results of individualized computer-based testing indicate broad application in reducing testing time in DoD training courses by 50 percent. Since testing in these environments constitutes 15-20 percent of total course time, such findings, if widely applied, would reduce course time and thus reduce costs.

Tactical Decision Aids. Near real-time decision problems characteristic of those which occur in tactical command and control pose special difficulties because of the stress on the decision-maker induced by the large stakes that are typically involved and the short time available in which to make the decision.

A prototype, real-time decision-aiding system for a Naval contingency, a surface-to-surface cruise missile attack, has been developed.

The decision aid displays options to the decision-maker and indicates when, based on a dynamically updated data base, it is appropriate to change from one course of action to another, given the decision-maker's assessment of the risks involved in making an incorrect choice.

Evaluations of decision aids carried out with Naval personnel have been successful.



ENGINEERING MOCKUP (full-scale) of NASA's Space Telescope, a multipurpose telescope planned for launch into Earth orbit in the early 1980s, is undergoing finishing touches at Boeing Aerospace Co. Space Center near Seattle, WA. Boeing is one of three firms conducting preliminary design and program definition of the Support Systems Module, under contract to the NASA/Marshall Space Flight Center. The curved plate in the foreground simulates a portion of the bay of the Space Shuttle.

Effects of ACV: Army Studies Ecological Impact in Improved Mobility Efforts

By Gunars Abele

Tests of air cushion vehicles (ACVs) to evaluate ecological impact of their operation on tundra and other organic terrains at Point Barrow in Alaska and in the Upper Michigan area of the U.S. have been conducted as part of an over-all ACV study since 1972.

Supported by the Advanced Research Projects Agency (ARPA) of the Office of the Director of Defense Research and Engineering, the Naval Ship R&D Center and the U.S. Army Corps of Engineers, the studies have produced a series of reports on potential effects.

ACVs, also known as SEVs (surface effects vehicles), have been under consideration as a means of all-weather transport in the Army's continuing effort to import mobility in regions where deep snow, thin ice, marshy wetlands, muskeg and tundra impede operations.

Tests in Alaska and Michigan used a 7-ton Bell SK-5 (Fig. 1) to determine effects of ACV traffic on various types of vegetation. Test parameters of consideration included the number of traffic passes, vehicle speed, length of hovering time, and terrain characteristics.

Traffic tests with a light tracked vehicle (M-29 Weasel) and a low-pressure tire wheeled vehicle (Rolligon) were made for comparison.

Extensive photographic coverage, visual observations on vegetation and terrain surface conditions, including thaw-depth measurements, were made for three years after the traffic tests.

To investigate effects of ACV pressures and air flow velocities higher than those of the SK-5, simulated ACV traffic tests were conducted on tundra, using a transparent box and nozzle with high pressure and air flow capabilities. A skirt-drag simulator also was used to study skirt-vegetation contact at various air gaps and numbers of repetitive passes. Detailed botanical measurements were made on effects on canopy structure and terrain microclimate. The effect of cushion pressure was found of no detectable consequence. Disturbance due to air flow of ACV traffic can result in the removal of loose, dead vegetation. However, no apparent damage, such as detachment of sedge or grass blades, mosses, leaves or blossoms, is done to live vegetation.

The effect from skirt contact can be more serious, resulting in progressive degradation of the organic terrain surface with repeated traffic. If there is skirt contact with the vegetation or the terrain surface, the effect increases with the number of traffic passes and vehicle speed.

Skirt contact with only the plant canopy does not damage or dislodge standing live vegetation such as grasses or sedges, but breaking of leaves or stems of broad-leaf plants and flowers is observed after several passes.

Skirt contact with the terrain surface (moss mat) results in gradual matting of the vegetation canopy and dislodging of mosses after a number of passes. No detrimental effect is produced during hovering.

The extent of damage inflicted on organic terrains by ACV operations depends to a certain degree on the vegetation characteristics (morphological and anatomical features and species composition). Mosses, having a weak root system, are less resistant to skirt abrasion than grasses.

Stiff vegetation is damaged more easily than soft or pliable vegetation. Traffic signatures are more pronounced in areas of high water content (water level near surface) than in dry areas.

Microrelief of the terrain is the most significant characteristic influencing the degree of degradation. Vegetation that survives 50 passes with the SK-5 when on level ground is removed during the first pass from certain raised features.

The most apparent effect of any vehicular traffic on tundra is the "signature" left by the vehicle. This disturbance to the terrain's natural condition can be caused by a variety of reasons: bending of the vegetation, removal of vegetation, matting of the vegetation into the organic layer,

Fig. 1. SK-5 Air Cushion Vehicle

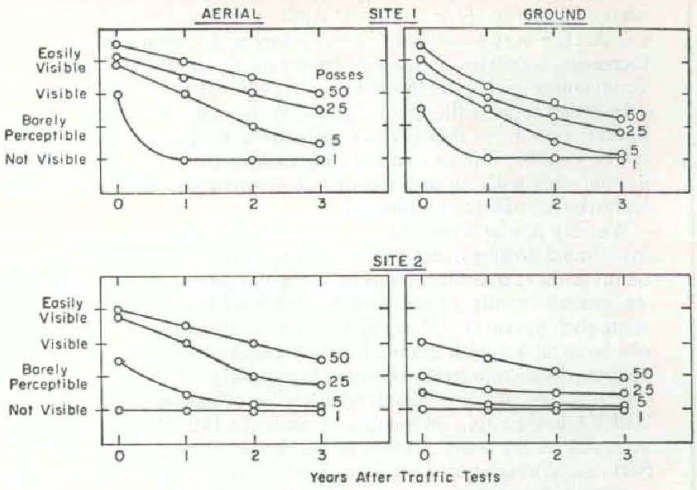


Fig. 2. SK-5 ACV Traffic Signatures on Tundra

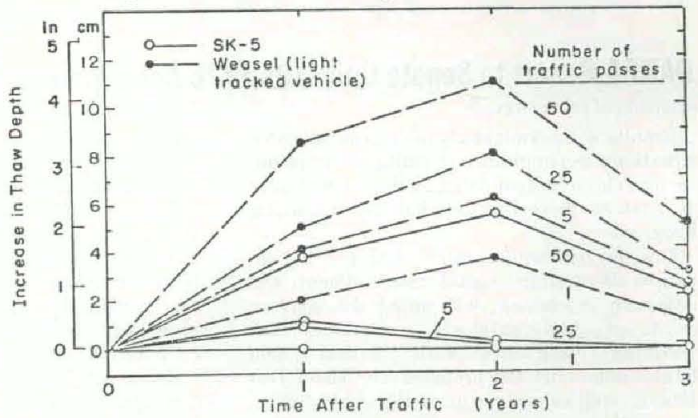


Fig. 3. SK-5 and Weasel Traffic on Thaw Depth of Tundra

depression of the surface, penetration of wheels or tracks into or through the organic layer.

In the case of the SK-5 ACV, the disturbance of the terrain surface is caused mainly by skirt contact due to a very low air gap, or no gap at all between the skirt and the terrain, i.e., skirt drag. Presence of a traffic signature does not necessarily imply a serious ecological impact, but it may sometimes be objectionable for aesthetic reasons.

The recovery trend of the visual impact can be expressed (as shown in Figure 2) by making a side-by-side comparison of the aerial and ground photographs (late July or early August). This involves an arbitrary grouping of signatures into four categories (not visible, barely perceptible, visible, and easily visible).

Three things are apparent: traffic signatures are more easily visible from the air than from the ground, traffic signatures on wet, level tundra (Site 1) are more easily visible than those on drier areas with more vegetative and surface relief variations (Site 2); and the traffic signature's visibility begins to decrease within a year and continues gradually.

Significant recovery is also evident in the light tracked vehicle (Weasel) "signatures," although they are still visible after three years.

The effect of traffic on the geometric and thermal characteristics of the terrain is of a more tangible and ecologically significant nature. The effect on the thermal regime in tundra cannot necessarily be assessed from a traffic trail's visual appearance alone. This becomes evident when the thaw-depth trend is compared with the traffic signature visibility.

Figure 3 shows the effect on tundra thaw depth (early August) of the ACV and Weasel traffic. Increase in thaw depth is the difference between that in the traffic lane and in the adjacent, undisturbed control area. Thaw depth below a trafficked area increases for one or two years, and then begins a recovery trend. The rate of recovery from signature visibility is slower than that of thaw depth recovery. Thus it may be that the aesthetic impact of ACV traffic on tundra is more serious than the ecological impact, when expressed as the effect on the thermal regime.

Where vegetation is removed or otherwise distributed by traffic, significant regrowth of some vascular species is evident during the following season. In some cases, surface disturbances (scraping, depression of dead

vegetation into the organic mat) actually stimulate growth of some types of vascular plants ("green belt" effect). Regrowth of mosses and lichens is considerably slower—three years or longer before new growth shows.

These studies indicate that ACV traffic, consisting of a few to several passes, does not result in any visible impact and does not cause any measurable effect on the thermal regime or damage to the tundra vegetation.

In comparison with light tracked vehicle (Weasel) traffic, the impact of 50 ACV passes is less pronounced than that of five Weasel passes, and the effect of 25 ACV passes less noticeable than that of one Weasel pass. The impact of wheeled vehicle (Rolligon) traffic was generally comparable to the Weasel traffic results in dry, polygonal areas, but more severe on saturated tundra. In some areas, penetration of tires down to the permafrost level occurred after only 10 passes.

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Stimulating Speakers Address 14th NJSHS

(Continued from outside back cover)

He then cited many federal controls.

Van Nort's clinching, if not convincing, conclusion was: "...For the past 12 years the Experimental Breeder Reactor II has been reliably generating electricity. Through a series of 9 facilities, 30 years and over $2 billion (for R&D expenditures), this country has developed this technology to the point of being a practical generator of electricity. Around the world, the liquid-metal, fast-breeder reactor technology is generating electricity in large plants, and is being actively pursued as the solution of those countries' energy problems....

"It is the technology which will generate electricity the most economically, with the least use of natural resources, with the least impact on the environment, with the greatest degree of safety, and the highest conservation of our precious natural resource—man."

LOCH NESS MONSTER...scientific fact or historical hallucination? Judged by the resounding ovation he received after an hour-long report on scientific expeditions he has headed during the summer seasons from 1970, Dr. Robert H. Rines appealed greatly to the scientific adventure spirit of his audience.

Speaking on "The Question Now—What is the Creature in Loch Ness?", the president of The Academy of Applied Science, Boston, MA, summarized the high points of the 1975 and earlier expeditions; also, plans for what he believes may provide the convincing answer this summer.

Replete with a great many photographs taken underwater as well as above the surface, the address was substantially a summarization of a report published in the Massachusetts Institute of Technology (MIT) Review, Volume 78, Number 5, March-April 1976, titled "Search for the Loch Ness Monster."

That 17-page report including numerous pictures of distinguishable objects, and the highly sophisticated equipment now being used by numerous scientific organizations cooperating in the Applied Academy of Sciences expeditions, states in part:

"Thus, Loch Ness has a long history of reputable, consistent sightings, much of it compiled by the British Loch Ness Investigation Bureau, and modern techniques have yielded some physical evidence of large aquatic animals. It was this extensive network of circumstantial data that led the Academy of Applied Science to begin investigations in the loch in cooperation with the Bureau."

Complicating the photographic problem in Loch Ness—even with the world's most advanced cameras, strobe lights and sonar equipment—is the inky black, peat-stained water, as well as its depth and the chances of a creature coming into camera range considering the size of the loch.

Dr. Jan-Olaf Willums, formerly of MIT, performed a computer study to determine the best spot for study, based on 258 "reliable accounts of sightings between 1961 and 1970."

Eighty-four percent of the sightings occurred during times of very calm surface conditions and principally during June, July and August. Seventy percent of the observers estimated the length of the object above the surface at about 20 feet or less; the mean of these measurements was 17 feet. Camera blockage at times from silt stirred up from the bottom was attributed to movement of the "denizens of the deep."

SESSIONS. Army Research Office Commander COL Lothrop Mittenthal opened the symposium as presiding chairman and Rev. Royden Davis, S. J., dean of the College of Arts and Sciences, Georgetown University, gave the opening address. Dr. Francis A. Ennis then spoke on "Influenza," a discussion of epidemics dating to the Victorian era, and the $135 million nationwide vaccination program scheduled this fall.

Dr. Edward J. Finn, Department of Physics, Georgetown University, chaired the afternoon session featuring the address by Dr. Robert H. Rines on the search for the Loch Ness monster. Twelve concurrent discussion panels followed, with the students participating in questions and answers after presentations by educators.

Discussion chairmen included: Dr. Paul Treado, professor of physics, Georgetown U.; Dr. Louis Baker, professor of chemistry, Georgetown U.; and Dr. George Chapman, professor of biology, Georgetown U. Each of their presentations was preceded by a tour of the departments.

"Plate Tectonics" was the topic of a panel consisting of Walter Brundage, Robert Feden and Henry Fleming, Division of Ocean Technology, Naval Research Laboratory, Washington, DC. "Bioethics" was discussed after presentations by Kenneth Casebeer, J.D., and Dr. Roy Banson, Kennedy Institute for the Study of Human Reproduction and Bioethics, Georgetown U.

Biology Topics were assigned to two panels, one comprised of Dr. Sigmund Norr and Dr. David Robinson, and the other consisting of Dr. Douglas Eagles and Dr. Donald Spoon, all of Georgetown University.

Food and Energy was the topic of a discussion chaired by Dr. David Bailey, director, Food Sciences Laboratory, U.S. Army Natick R&D Command.

"Natural Toxins: Study of the Killer Bee," a presentation by LTC James Vick, then with Edgewood Arsenal as chief of the Neurophysiology Section and since assigned to the NATO liaison staff of the Office of the Surgeon General, was highlighted by color slides of poisonous reptiles from all over the world.

"Engineering and the Energy Crisis" was presented by Dr. Robert B. Gaither, chairman, Department of Mechanical Engineering, University of Florida, and "Physics Research Through Dirty Engineering Problems," by Dr. Robert B. Oswald Jr., chief, Systems Research Laboratory 300, U.S. Army Harry Diamond Laboratories.

"Current Research in Dentistry" was chaired by Dr. Sherwood Wolfson, professor of dentistry, University of Iowa, and "New Frontiers in Geology and the Coming Mineral Crisis" was presented by Dr. Maynard M. Miller, dean, College of Mines, University of Idaho.

SCIENTIFIC TOURS. One of the most popular tours offered the students was a visit to the Smithsonian Institution. Presentations in the Baird Auditorium, National Museum of Natural History, featured Dr. Eric Kauffman, Division of Mineral Sciences; Dr. Douglas Ubelakar, Division of Anthropology; and Dr. Thomas Simkin, Division of Mineral Sciences.

Other tour offerings included the Goddard Space Flight Center; the new $45 million laboratory complex of the U.S. Army Harry Diamond Laboratories, Adelphi, MD; National Institutes of Health, Washington, DC; and the Naval Research Laboratory, Washington, DC.

BIOGRAPHICAL SKETCHES of winner of the trip to London for the International Youth Science Fortnight show their scientific achievements as follows.

David Trent Leighton Jr. Interested in science fairs since he was in the eighth grade, he has competed in "about 20 local, state, regional and national fairs." In the National Science and Engineering Fair this year he was selected to attend the Nobel Prize award ceremonies in Stockholm, Sweden. He also was a winner in the Westinghouse Science Talent Search, receiving a second-place $8,000 scholarship, and has earned numerous other awards.

Leighton's father is an engineer with the Energy Research and Development Administration, assigned as a program manager with the nuclear propulsion staff on Admiral Rickover's nuclear submarine staff.

Karen Sue Mikkelson also has competed in science fairs since she was in the eighth grade and her honor awards are too numerous to list here, starting with her freshman year and increasing progressively.

Among numerous awards she received this year in the International Science and Engineering Fair was that of being selected by U.S. Army judges to attend the 1977 Japan Student Science Awards Exhibit in Tokyo, Japan, in January as the U.S. Army representative.

She also is a winner of a Bausch and Lomb scholarship to attend the University of Rochester, a scholarship to California Institute of Technology, a scholarship to Central College in Pella, IA, and has accepted a scholarship at Reed College in Portland, OR, where she will major in biochemistry and neurophysiology.

Karen's father is an aerospace engineer with Convair Division of General Dynamics. her mother is a free lance writer, photographer and West Coast newspaper drama critic.

Michael A. Montgomery's scientific interest dates to the fifth grade when he built a variable electrical power supply system. In the sixth grade he built his first computer and in the eighth grade and freshman year designed a logic gate high-speed digital unit. Then he turned to dimensional vectors, winning honors in his sophomore year, and last year won a second-place award in the International Science and Engineering Fair with a high-speed data system exhibit.

Michael also has won various scholarships including a $12,000 National Elks Club award. He hopes to go to Georgia Institute of Technology, and plans to major in electrical engineering and minor in computer sciences. His goal is a doctorate in these fields. His sister, now in her sophomore year at the University of Tennessee, also has won numerous junior science awards.

Beth Lynn Potter did not become interested in science until this year when her father, a minister, was transferred from Brigham City, UT, to Aberdeen, ID. There she was required to study science, took two courses, and was stimulated by Dr.Robert Callihan of the University of Idaho to enter a science project in the Intermountain States Regional Junior Science and Humanities Symposium. That won her a trip to the National JSHS, leading to the London trip.

Miss Potter has not won any scholarships. The oldest of six children (three sisters, two brothers), she plans to work a year before seeking enrollment at the University of Utah. She is undecided whether she will major in science.

Cassius Scott is a tall, handsome, very serious young black youth who has been interested in science since his freshman year in high school but did not win any notable awards until this year. He credits his progress to a stimulating science teacher, Dean Chritacis, and is setting his sights on a doctorate in medicine including a surgical research career. He has won two $1,000 scholarships and various lesser awards. He is undecided whether he will seek enrollment at Stanford University or the U. of Chicago.

APPS Enhances Aerial Photography Mapping

By F. R. Norvelle

The Analytical Photogrammetric Positioning System (APPS), completed by the U.S. Army Engineer Topographic Laboratories (ETL) in November 1973 after 20 months of development and testing prior to system fielding, has greatly enhanced aerial photography in mapping.

APPS provides the means for determining the Universal Transverse Mercator (UTM) coordinates and elevations of any terrain point appearing on the aerial photographs of a "point-positioning data base" (PPDB).

PPDB is used to describe the aerial photographs and associated data required as part of the conventional map-making process by agencies such as the Defense Mapping Agency.

The flow diagram shown in Figure 1 outlines the steps required. Up to and including the block triangulation step, the mapping process is very accurate. Steps that follow, including compilation, registration and reproduction, severely degrade the accuracy of the original data.

Furthermore, the terrain definition of the aerial photograph is eliminated from the line map. The obvious solution to obtain the best accuracy from aerial photographs is to make use of the byproducts of the mapping process at a point prior to the introduction of extraneous errors. Such a solution is possible by using the APPS.

With reference to Figure 1, the mapping photography and its associated data are obtained early, forming the PPDB for the APPS. Triangulation procedures used by DMA provide the photo data, consisting primarily of angular attitude and camera position at the instant of each exposure.

With these data known, it is possible to make photo measurements on an image corresponding to a terrain feature and mathematically project a line from the image point, through the known camera-lens position, down to the ground.

Where the line stops is determined by computations on a second photograph that overlaps the first. Intersection of the two lines defines the ground position of the photo images which can be expressed in the conventional UTM and sea-level coordinate system.

Hardware used to implement the positioning capability is depicted in Figure 2, and consists, in part, of a Zeiss Stereotope used to view the two overlapping photographs. Photographs placed on holders are viewed under 6X magnification through a binocular optical train.

Two small, fixed-reference dots, superimposed over each photograph, appear within the field of view of the operator and are used to "point" to the image of interest. The image on the left photograph is brought into coincidence with the left fixed reference dot by moving the photocarriage as a unit. The corresponding image on the right photo is made coincident with the right fixed dot by adjusting x and y parallax screws. When the corresponding images of the two photos are coincident with the dots, the terrain detail will be seen in three dimensions and the two dots will appear as one positioned on the point of interest.

The steel baseplate on which the Stereotope rides has had removed from it a 7 x 13-inch rectangular area. The entire Stereotope, including the baseplate, rests on top of a Bendix Datagrid, essentially a ¾-inch tablet which has a matrix of wires protected by a formica covering.

Attached to the Stereotope is a cursor (coil of wire) which moves across the exposed surface of the Datagrid as the photocarriage is moved.

The Datagrid surface picks up a signal from the cursor and, with the associated electronics, trnasforms the analog signal into digital X and Y-coordinate values corresponding to the position of the cursor or, analogously, the position of the left-reference dot on the left photograph.

When removing the X and Y parallaxes for stereo viewing, the amount of X-travel, ΔX, the operator imparts to the right photograph, relative to the left, is measured by a shaft-angle encoder on the X-parallax screw.

This ΔX value, along with the X and Y values obtained from the Datagrid, is used, after a simple set-up procedure, to form mathematically the two intersecting lines which define the ground position of the image points beneath the reference dots.

An electronic interface unit is used to transform analog signals into digital values and enter them to the computational device. This transfer

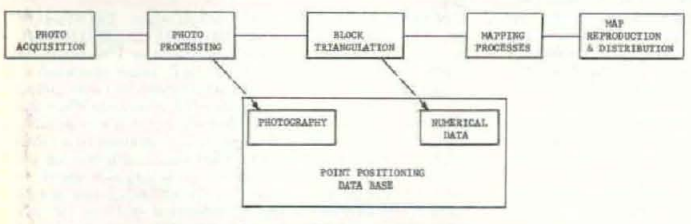

Fig. 1. Typical Map-making Process

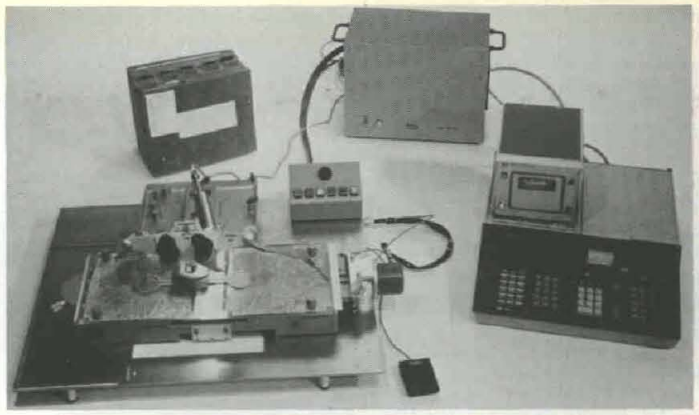

Fig. 2. Analytical Photogrammetric Positioning System

of data is accomplished when the operator depresses a foot switch, eliminating all data handling or manipulation by the operator.

The computation device consists of a Hewlett-Packard 9810A desk calculator and a magnetic tape cassette memory. Computations give the UTM grid-zone number, the Easting, the Northing and the elevation above sea level of the point measured on the photographs.

The tape cassette unit is primarily a storage medium for the data part of the PPDB. Data for up to 116 stereo pairs of photographs can be stored on the computer tape, and can be entered into the calculator as different

In general, the PPDB photos have a scale of 1:100,000. At this scale, 116 photographs cover an area of approximately 19,000 square kilometers and can be stored in a file with dimensions of 10 x 10 x 4 inches.

A typical operating procedure for the APPS is depicted in Figure 3.

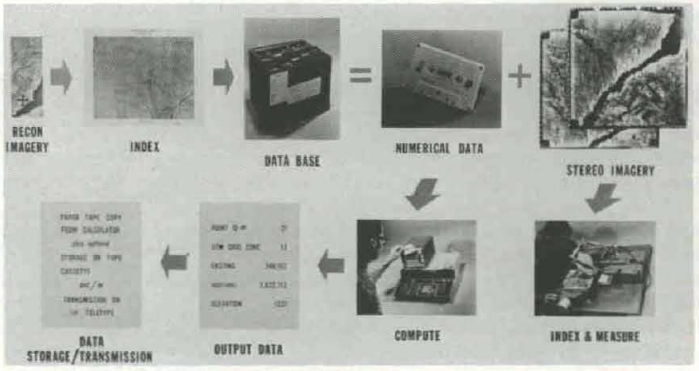

Fig. 3. APPS Systems Concept

First, a target is identified on a reconnaissance photograph. Based on general knowledge of where the photo was taken, the operator finds the area on an index mosaic and determines what two photographs cover it.

The operator then pulls the applicable photos from the PPDB file, places them on the stereotype, and loads the tape cassette containing the appropriate PPDB data. A short indexing or set-up procedure is used to measure the image point on the PPDB that corresponds, relative to surrounding identifiable features, the position the target occupies on the recon imagery. The coordinates of the point are automatically printed out.

Apart from the targeting function, the APPS was designed to provide survey-control data using a slightly different procedure than that just explained. The APPS operator can select a well-identified photo point and compute the coordinates much more accurately than when he has to correlate a reconnaissance photo with a "before-the-fact" PPDB photograph.

The APPS survey coordinates could be given to a field survey party which has, for example, the job of running a traverse from known control to the location of a mobile launcher. In effect, the APPS solution provides an appropriate starting point which greatly reduces the distance the field survey team must run the traverse. A significant time saving directly affects response time of the weapon system.

Only commercial off-the-shelf items could be used to configure the APPS because of 20-month development time limitation. Two of six prototypes went to DMA; one to the Intelligence School, Fort Huachuca; one to the Naval Air Engineer Center; and one on loan to the 649th Engineer Battalion, Schwetzigen, Germany.

The sixth instrument belonging to the ETL was subjected to and passed military potential tests (MPT) in the summer of 1972. In the spring of 1973, a contract was let for 13 production models of the APPS.

Seven units are deployed in Germany and the six have been delivered to

Atlanta III Continues Army-Industry Effort to Improve Materiel Acquisition

Secretary of the Army Martin R. Hoffmann, Under Secretary Norman R. Augustine and numerous top leaders of Army materiel development, acquisition and readiness joined with industry leaders in Atlanta III, a May 13-14 executive seminar sponsored by the American Defense Preparedness Association.

The purpose was to continue exploration and development of new ways of doing business for mutual advantage. Emphasis was on DARCOM's new organization, progress on management initiatives, some thoughts from materiel users, and integrating systems on the battlefield to insure superior combat performance, safer use, more reliability and ease of maintainability.

Moreover, the Army stressed its objectives of paying an "affordable cost" over the life cycle of equipment while assuring that its procurement planning is consistent with inflationary trends, and leaving room for industrial contractors to have a "reasonable expectation of a fair profit."

Atlanta I held in 1974 at Atlanta, GA, resulted in "21 Initiatives" directed to those difficult goals, the majority of which have since been implemented. Atlanta II in 1975 continued the progress toward improved business methods. Atlanta III was directed toward improved functioning with a new organization, and setting sights on future objectives.

About 350 industrial leaders and key executive Army representatives joined in responding to an open invitation from GEN John R. Deane Jr., commander, U.S. Army Materiel Development and Readiness Command (DARCOM), who extended opening remarks at the symposium.

Former U.S. Army Materiel Command (now DARCOM) Commander GEN Henry A. Miley Jr., retired and serving as executive vice president of the American Defense Preparedness Association (ADPA), gave the welcoming address.

LTG George Sammet Jr., DARCOM deputy CG for Materiel Development, shared the speaker's rostrum with GEN William E. DePuy, commander, U.S. Army Training and Doctrine Command (TRADOC), and DARCOM Deputy CG for Materiel Readiness LTG Eugene J. D'Ambrosio in making the principal Army presentations.

Other major Army speakers were Sammet's deputy, John D. Blanchard, who highlighted last year's "21 Initiatives" and presented some thoughts on new directions the Army management might be taking; MG Robert J. Malley, project manager for Munition Production Base Modernization and Expansion, DARCOM; and MG Ira S. Hunt, director, Battlefield System Integration, HQ DARCOM.

James F. Atkins, president, Bell Helicopter Co., moderated a panel discussion, opening the floor to a frank exchange between government and industry representatives. Government panelists included GEN Deane, Assistant Secretary of the Army (R&D) Edward A. Miller, LTG Sammet, LTG D'Ambrosio, MG Louis Rachmeler, deputy for Materiel Acquisition, Office of the Assistant Secretary of the Army (Installations and Logistics); and John D. Blanchard.

Industrial panelists were D. Brainerd Holmes, president, Raytheon Co.; James E. Knott, vice president, Detroit Diesel Allison Division of General Motors; and Dr. Wendell B. Sell, president, Hoffman Electronics Corp., who chaired the Army Materiel Acquisition and Review Committee (AMARC); Berge Thomasian, vice president and general manager, New England Operations, Maremont Corp.; and John A. Ulrich, senior vice president, Chamberlain Manufacturing Corp.

Much of LTG Sammet's address was devoted to an explanation of the manner in which under the DARCOM reorganization effected, from the recommendations of the AMARC report - the Materiel Development Commands (8 expected) and the Materiel Readiness Commands (5 expected) will complement each other in the materiel acquisition and readiness process.

"Today's R&D Command," he said, "will do more than just R&D. It will also have responsibility for initial procurement and fielding of an item. In other words, it will have to field a user-oriented item, backed up by a proven tech data package and a field-tested plan for integrated logistics support before transition will be acceptable to the Readiness Command.

"The R&D Command will also be responsible for such other functions as product assurance, value engineering, the planning of integrated logistics support (ILS), initial provisioning, and maintenance of the tech data package."

LTG Sammet explained that the Readiness Commands will be responsible for follow-on acquisition and materiel readiness, including execution of the ILS plan, new equipment training, and international logistics sales.

Primary engineering design will reside in the R&D Commands, he said, including all engineering functions that impact on equipment design integrity. The R&D commands also will have the capability to perform initial production engineering.

The Readiness Commands will accomplish minor materiel product improvements. When major product improvements are required, the Readiness Commands will retain management responsibility but will task the concerned R&D command to do the work.

One other aspect of this split of our commodity commands is that when the commands are collocated, the Readiness Command will be responsible for running all housekeeping and installation support activities. This is to ensure, in line with the AMARC recommendations, that the project managers and the R&D Command devote their full time to the hard-core acquisition business.

APPS Enhances Mapping *(Continued)*

CONUS-based organizations, such as Field Artillery School, Fort Sill; the Army Research Institute for the Behavorial and Social Sciences; the Hydrographic and Aerospace Centers of DMA; and the Defense Mapping School, Fort Belvoir.

Various independent tests have been performed on the APPS by some of the user organizations and, without exception, the equipment met the particular requirements against which it was tested.

In spite of the success enjoyed by the current APPS, several shortfalls and new applications have been identified by current and potential users of the equipment that require for resolution a second-generation system.

For example, some military intelligence operations use reconnaissance photographs to measure aircraft wing span, heights of objects, etc. The current APPS has, in concept, this capability but the typical reconnaissance photographs used for this purpose are not totally compatible in format, type and size with the APPS hardware and software.

Methods and types of photos used in the preparation of future point-positioning data bases will place greater accuracy and flexibility requirements on the APPS than the current system can meet.

The Field Artillery School at Fort Sill, OK, has been designated as proponent for a second-generation system. APPS II will be designed to interface with various peripheral and ancilliary components, so as to extend its utility and applications in support of planned surveying, targeting, and intelligence systems currently under study.

Figure 4 depicts a concept where a remotely piloted vehicle (RPV) continuously photographs the battlefield and transmits in real-time the scene viewed by the on-board sensor. When the RPV detects a target, the video display could be "frozen," correlated with the PPDB, and followed by a determination of the target coordinates using APPS II. The APPS II could also be used to determine the path and profile data for programing the flight of the RPV.

Since a single pair of PPDB photos covers such a large area, the pair covering the programed flight of the RPV could be counted on the APPS prior to the vehicle mission. The video transmission/correlation process then could be accomplished in near "real-time."

The concepts suggested by Figure 4 are just two of many that would require an APPS II as a subsystem. The APPS will be designed to meet as many Army, Navy and Air Force requirements as possible.

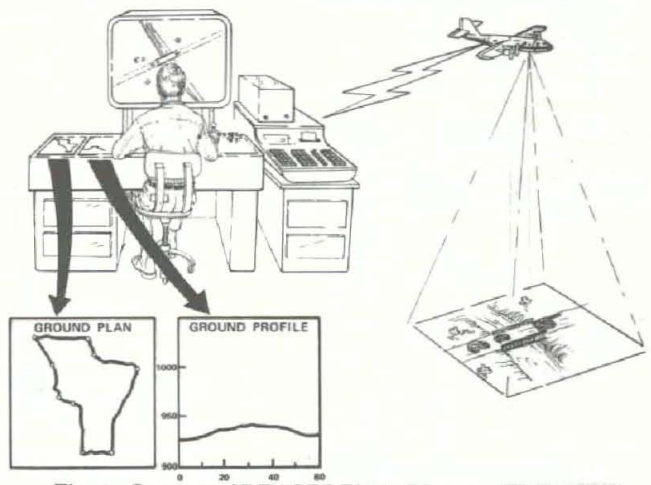

Fig. 4. Concept of RPAODS Flight Planning With APPS

FRANKLIN R. NORVELLE began his Civil Service career in 1962 with the U.S. Army Geodesy, Intelligence, Mapping, R&D Agency (GIMRADA), forerunner to the U.S. Army Engineer Topographic Laboratories (USAETL). In 1970 he was the recipeint of the Commanding Officer's Award for Scientific and Technological Achievement at USAETL for his work in developing and programing the mathematical solution for radar imagery on the AS-11A stereoplotter. Norvelle earned a bachelor of civil engineering degree from the University of Virginia in 1962 and did graduate work in photogrammetry at Syracuse University in 1965.

BRL Provides Analysis Model for Army Suppressive Shielding Program

By Dr. Norris J. Huffington Jr. and Frederick H. Gregory

Analytical and experimental support for the Army's Suppressive Shielding Program - an innovative concept to achieve improved protection for personnel and equipment in a blast environment, as reported in the Nov.-Dec. 1975 *Army R&D Newsmagazine* - is being provided by the Army Ballistic Research Laboratories, Aberdeen (MD) Proving Ground.

This support has resulted in modeling of the internal blast loading and structural response of the one-quarter-scale Category 1 Suppressive Shield (Figure 1). It was assembled and tested at BRL's Spesutie Island test facility.

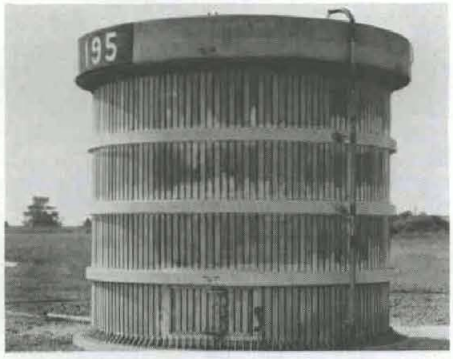

Fig. 1. One-quarter Scale, Category 1, Suppressive Shield

The structure is composed of 296 American Standard I-beams, each 3 inches deep and weighing 5.7 pounds per foot. Disposed in an interlocking cylindrical array, they support a disc-shaped concrete cap.

Outward movement of the I-beams is opposed by three steel bands, one located at each quarter height. Positioning of the explosive charge at the structure's geometric center results in an axisymmetric deformation. The model needs to treat only a radial slice, including one repeating pattern of the I-beam array (Figure 2).

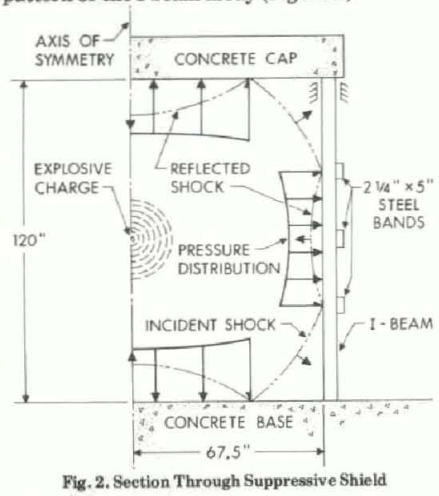

Fig. 2. Section Through Suppressive Shield

Response of this structural configuration was analyzed using an augmented version of the REPSIL[1,2] code which takes account of the following effects:

- Transient large deflection elastoplastic response of a typical I-beam (represented as a beam-column), including strain hardening and strain-rate dependent material characteristics.
- Coupled movement of the concrete cap as a rigid body (in the vertical direction only due to axisymmetry). The weight of this cap was distributed equally among the I-beams.
- Interaction of the bands with the I-beams, including their inertia forces and their elastoplastic resistance to radial motion.

The explosive loading which is imposed upon this structure was regarded as composed of two parts (Figures 2 and 3):

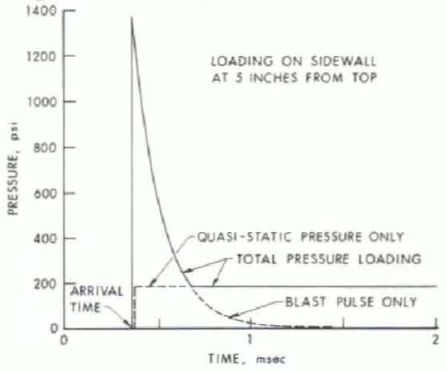

Fig. 3. Explosive Load Components

- A transient blast load traversing the top and sidewalls of this configuration followed by a uniform pressure corresponding to equilibrium of the explosion products within the enclosure.

To resolve a question as to which of these parts of the total loading produces the bulk of the response, the analysis model was employed to predict deflections and strains produced by the detonation of a 45.7 pound pentolite charge for (a) the blast pulse only, (b) the quasi-static uniform pressure applied as a step function, and (c) the composite explosive loading (Figure 3).

The transient radial deflection of the sidewall at mid-height (position of maximum displacement) is shown in Figure 4. The blast pulse acting alone produces a significantly greater deflection than the quasi-static load.

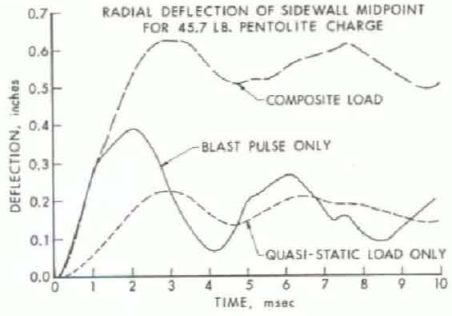

Fig. 4. Lateral Displacement of Sidewall

However, the total response is much larger than that induced by either load component acting alone and, owing to the nonlinearity of this problem, is not just the superposition of these individual responses.

No experimental measurements of deflections were made but the structure was extensively instrumented with strain gauges. Comparisons between REPSIL-predicted strains and experimental data[3] are reasonably good, the discrepancies being no greater than the shot-to-shot variation in the experimental data.

Based on the correspondence between model predictions and the BRL-established data base, it is concluded that significant technological benefits have accrued from this investigation which will permit the design of more efficient suppressive shields in the future.

The work reported here was performed for and funded by PA,A 4932 MM&T Project #5751264, Advanced Technology for Suppressive Shielding of Hazardous Production and Supply Operations for Production Base Modernization and Expansion Program.

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1. J. M. Santiago, Formulation of the Large Deflection Shell Equations for Use in Finite Difference Structural Response Computer Codes, U.S. Army Ballistic Research Laboratories Report No. 1571, February 1972.

2. J. M. Santiago, H. Wisniewski, N. J. Huffington Jr., A User's Manual for the REPSIL Code, U.S. Army Ballistic Research Laboratories Report No. 1744, October 1974.

3. R. N. Schumacher, C. N. Kingery, W. O. Ewing Jr., Air Blast and Structural Response Testing of a ¼ Scale Category I Suppressive Shield, U.S. Army Ballistic Research Laboratories Memorandum Report (in publication).

DR. NORRIS J. HUFFINGTON JR., chief of the Target Loading and Response Branch, Terminal Ballistics Laboratory, U.S. Army Ballistic Research Laboratories (BRL), received bachelor's, master's and PhD degrees in engineering from the Johns Hopkins University. Prior to joining the laboratory in 1967, he served as chief of dynamics research for the Martin Marietta Corp., and as professor of applied mechanics at Virginia Polytechnic Institute. He authored numerous reports and journal articles on structural dynamics.

FREDERICK H. GREGORY has been with the BRL for 15 years, most of which has been devoted to nuclear weapons effects research. His areas of interest have evolved from nuclear effects to the analysis of the structural response of structures to conventional explosive loads. Gregory holds bachelor's and master's degrees in engineering from North Carolina State University.

Army 5-Ton Truck Improvement

Product improvement of the U.S. Army's 5-ton truck, under way in the Systems Development Division, Army Tank-Automotive Command, Warren, MI, is directed to increased reliability, availability and maintainability.

The new vehicle will have a fully automatic 5-speed transmission, replacing the manual type. System Manager C. J. Vander Zon reports the new transmission will improve fuel economy and eliminate drive train shock, engine lag and overspeed. Other benefits, based on validated studies, include reductions in life-cycle costs and reduced vehicle operator training time.

Featured also is a fully air-actuated split-brake system to replace an air-hydraulic system. Split brakes provide a backup system in case of failure, improve performance, safety and durability. A one-piece hood designed to ease maintenance tasks and a wider 3-man cab insulated to meet federal interior noise level requirements will be provided.

Inside rather than outside-mounted batteries and radial-ply tires are expected to improve vehicle durability and fuel economy. Built by AM General Corp., the first prototype is undergoing cooling tests—expected to lead to completion of an additional seven vehicles for testing at various Army proving grounds. A production contract is expected in FY 1978.

Awards...

DARCOM Nominates 3 for Rockefeller $10,000 Public Service Awards

Three U.S. Army Materiel Development and Readiness Command (DARCOM) nominations for the 1976 Rockefeller Public Service Awards have been forwarded to the Department of Army Incentive Awards Board.

Although the number of awards may vary from year to year, five awards of $10,000 each are normally presented. The first presentations are programed for late fall 1976. Nonfederal employes are eligible for awards this year.

Final approval of nominees submitted from all Army and other federal activities/installations will rest with the U.S. Civil Service Commission. Designed to honor persons who have made outstanding public service contributions at the local, state or national level, the awards criteria list nine categories of selected problem areas of critical importance.

Deane B. Blazie

Dr. Mary Mandels

Dr. Joseph Sperrazza

Controversial issues are recognized as part of the defined problem areas. The RPSA Program seeks nominations of persons whose contributions are imaginative and thorough. Outstanding achievements not within defined problem areas may be submitted. Defined areas, DARCOM nominees and their achievements are:

Expansion of Employment Opportunities. **Deane B. Blazie,** a computer resources coordinator at the U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, was nominated for extraordinary efforts in designing and developing electronic devices for use by blind people.

His latest achievement, which earned him distinction as the first Army civilian employe to be named a National Junior Chamber of Commerce Outstanding Young Man (1976), is an Audio-Tactile Display (ATD).

ATD is described as "the world's first known system enabling blind people to use electronic calculators." An in-depth story on Blazie appears in the January-February 1976 *Army Research and Development Newsmagazine.* Blazie's nomination states, in part, that his achievements "will open to blind persons a variety of previously restricted career fields in business, mathematics, engineering, the sciences and other disciplines."

International Protection of Environments and Resources. Research microbiologist **Dr. Mary Mandels,** U.S. Army Natick (MA) Research and Development Command, is credited with contributions impacting worldwide upon energy, food and ecology problems.

Specifically, Dr. Mandel's nomination cited her achievements in demonstrating the feasibility of converting cellulose waste materials into sugar and glucose products or clean-burning fuels through use of enzymes - developed systematically over many years by mutation to improve Trichoderma viride as the source of a powerful cellulase capable of totally converting cellulose to glucose.

Considered an international authority in cellulose research, Dr. Mandels in 1975 introduced the production of a cellulase with three times the activity of its predecessors. Information on her scientific achievements appears in numerous issues of the *Army R&D Newsmagazine*, including a feature article in the July-August 1974 edition.

Redefining the Role of the United States in World Order. DARCOM's nominee in this category is **Dr. Joseph Sperrazza,** director, U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, MD. His citation praised his "diligence in instigating cooperation among free countries of the world to develop a better means of utilizing manpower and natural resources for mutual defense and survival."

Cited also were his investigations in wound ballistics leading to a rapid evaluation of many superior weapon systems and the development of improved body armor for soldiers. His efforts with the Joint Environmental Effects Program were credited with improving methods of estimating weapon requirements in jungle environments.

ARI Receives ASA (R&D) Award for Excellence

The Army Research Institute for the Behavioral and Social Sciences (ARI) was honored recently with an Assistant Secretary of the Army (R&D) Award for Excellence in recognition of its "noteworthy programs."

BG Hugh J. Bartley, director, Plans, Programs and Budget, Office of the Deputy Chief of Staff for Personnel, HQ Department of the Army, presented the award to ARI Commander COL W. C. Maus and to ARI Technical Director and Army Chief Psychologist Dr. J. E. Uhlaner.

The Award for Excellence is based on evaluation of performance of each eligible R&D laboratory. The criteria for evaluation include the degree to which each laboratory realizes its full potential impact in enhancing the capability of Army operational forces...during the prior calendar year.

ARI was evaluated as one of the top 10 Army laboratories. The citation commended ARI for "research and development in support of the Army's manpower procurement program and management program, training and education, and human factors program for systems and organizations. In each of these vital areas successes were attained which materially advanced the manpower and operational readiness goals of the Army."

ARI developed REALTRAIN, a method of small unit training which has been extended to armor and antiarmor and which has been implemented Army-wide. An ARI test manual was developed and distributed to TRADOC schools in support of Army-wide developments in training, skill qualification testing and evaluation.

BG Hugh J. Bartley presents lab award to ARI's COL Maus.

Deputy Chief of Staff for Personnel LTG H. G. Moore endorsed the Award for Excellence, stating that it signifies "ARI demonstrated the highest order of professionalism in improving performance of the individual soldier."

Mangion Earns Patriotic Civilian Service Award

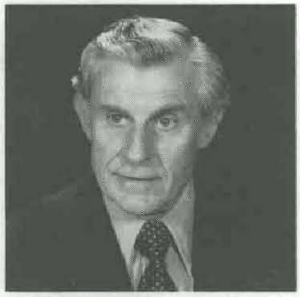
Cyril P. Mangion was recently presented with the Department of the Army Patriotic Civilian Service Award during ceremonies at the U.S. Army Natick (MA) R&D Command.

John V.E. Hansen, director of Natick's Clothing, Equipment and Materials Engineering Laboratory, praised Mangion's "outstanding personal service" in facilitating Natick's success in meeting commitments to the U.S. Army Uniform Board. Mangion is an employe of the Defiance Bleachery Co., Burrowsville, MA.

Mangion was cited specifically for providing developmental materials used in the production of protective clothing, including chemicals, water-repellents, ballistic items, camouflage, and thermal properties.

RESEARCH CHEMISTS (l. to r.) Hubertina Hogan, Richard Wells and Francis Hoffman joins Mrs. Mangion (r.) in honoring husband.

2 Recipients Selected for First Ernst Jung Prize



Dr. Lorenz E. Zimmerman

Dr. Lorenz E. Zimmerman, chief, Ophthalmic Pathology Division, Armed Forces Institute of Pathology, Washington, DC, and Dr. Donald A. Henderson of the World Health Organization are recipients of the Ernst Jung Prize for Medicine.

Initiated this year, the award honors the memory of the prominent German philanthropist who died in January 1976. It recognizes top ranking scholars for current research.

Dr. Zimmerman was cited for pioneering work in the pathology of eye diseases and for providing information for the education of other opthalmologists. He is noted for clinicopathologic studies of cancerous and precancerous ailments of the eye and orbital tissues.

Associated with the AFIP since 1952, Dr. Zimmerman has served as ophthalmic pathology chief since 1954. He is chairman of AFIP's Department of EENT Pathology and registrar of the Registry of Ophthalmic Pathology. He graduated "with distinction" from George Washington University and the GWU School of Medicine.

Listed among his numerous awards are the Alumni Achievement Award from George Washington University; Department of Defense Distinguished Civilian Service Award; Department of Army Decoration for Exceptional Civilian Service; and Legion of Merit for service in Korea.

Dr. McCroskey Honored for Fluidics Research

Dr. W. J. McCroskey

Dr. William J. McCroskey, U.S. Army Air Mobility Research and Development Laboratory was recently twice honored for research achievements in fluid mechanics of rotary-wing aircraft.

Assigned to AMRDL's NASA Ames Directorate, Moffett Field, CA, Dr. McCroskey was named the American Society of Mechanical Engineer's Freeman Scholar for 1976. This is an annual award recognizing high fluidics engineering achievement.

ASME will present Dr. McCroskey's critical review on "Current Research in Unsteady Fluid Dynamics" at their annual winter meeting, Dec. 5-10, in New York City. A $3,000 honorarium will be presented for publication of the work in the Journal of Fluids Engineering.

Dr. McCroskey was also honored with the "Outstanding Engineer Award" presented by the San Francisco Section of the American Institute of Aeronautics and Astronautics (AIAA).

Employed with AMRDL since 1968, Dr. McCroskey received his BS degree from the University of Texas and his MS and PhD degrees from Princeton University. He is a Fellow of the AIAA and a member of the American Helicopter Society.

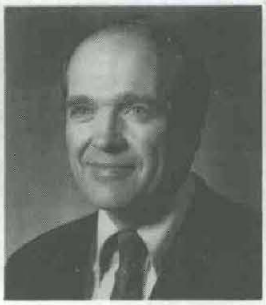
HDL's Dr. Oswald Honored as 'Outstanding Alumnus'

Dr. Robert B. Osward Jr., U.S. Army Harry Diamond Laboratories, has been named by the University of Michigan's Student Chapter of the American Nuclear Society, the 1976 "Outstanding Alumnus" of the Department of Nuclear Engineering.

Chief of HDL's Systems Research Laboratory, Dr. Oswald was cited for state-of-the-art advances in the effects of nuclear radiation on electronic components and materials.

Included among his accomplishments was his solution of radiation-caused damage to integrated circuits by a thermomechanical shock phenomenon. He is credited with development of low atomic number electrical leads and bonds for semiconductors.

Recipient of a 1971 Army Research and Development Achievement Award, Dr. Oswald earned all of his academic degrees from the University of Michigan, Ann Arbor. He is a member of the Institute of Electrical and Electronics Engineers.



Dr. R. B. Oswald Jr.

Urologist Earns Award for Cancer Research

First prize honors at the Washington, DC, Urological Society's Ninth Annual Residents' Conference were presented recently to MAJ Robert Vollero for discovery of a new means of detecting the spread of cancer.

A third-year urology resident at Walter Reed Army Medical Center, MAJ Vollero presented his findings in a paper titled "Serum Oncoproteins: New Markers of Testis Cancer." His paper was one of six presented by urology residents in the Washington, DC, area.

Intensive studies of the disease were initiated in 1973 by MAJ Vollero and others at WRAMC and the National Institutes of Health. Long-term studies were made of victims who were treated by removal of the testis.

MAJ Vollero indicated that testis cancer cells secrete proteins known as HCG (Human Chorionic Gonadotropin) and AFP (Alpha Fetoprotein). Detection through blood samples is achieved by radio-immuno assay.

Tests for HCG and AFP cannot actually detect the presence of testis cancer, but, on a long-range basis, can determine if it has spread elsewhere in patients previously operated on for the disease.

A graduate of Yale University's Medical School, MAJ Vollero completed his surgical residency at Boston's New England Medical Center prior to joining the Army in 1972. He was assigned to WRAMC following service in Korea as a general surgeon.

Aberdeen Branch Chief Elected ASNT Fellow

Robert L. Huddleston, chief, Physical Test Branch, Material Testing Directorate, Aberdeen (MD) Proving Ground, was recently elected a Fellow of the American Society for Nondestructive Testing.

C. J. Hellier, chairman of the ASNT awards committee, made the announcement, citing Huddleston's "professional contributions" to nondestructive testing.

R. L. Huddleston

Huddleston has been engaged in nondestructive testing at APG for 20 years. He has served as chairman of the Baltimore, MD, and Washington, DC, chapters and is a member of ASNT's national Technical and Educational Councils.

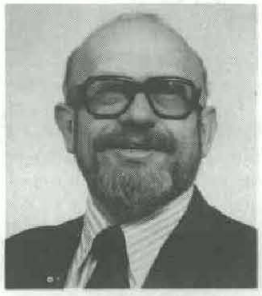
Graduated with a degree in metallurgical engineering from Virginia Polytechnic Institute, he holds a master's degree in liberal arts from Johns Hopkins University and is a member of the American Society for Metals.

Former USACSC Engineer Deputy Gets DECS

George M. Sokol, former deputy for Engineering, U.S. Army Computer Systems Command (USACSC), Fort Belvoir, VA, was recently presented the Decoration for Exceptional Civilian Service, the Army's highest award for civilian employes.

Now assigned to the staff of the U.S. Army Research and Standardization Group, London, England, Sokol was cited for his planning, coordination and direction of USACSC's highly complex data processing systems.

Graduated with a BS degree in electronic physics from Harvard College, he is a member of the Institute of Electrical and Electronics Engineers, the American Association for the Advancement of Science and the American Society for Public Administration.



George M. Sokol

MICOM's Dr. Rhoades Wins MIT Sloan Fellowship

Dr. Richard G. Rhoades, director of the Propulsion Directorate, Missile Research, Development and Engineering Laboratory, U.S. Army Missile Command, has been selected for an Alfred P. Sloan Fellowship at Massachusetts Institute of Technology.

Dr. Rhoades is one of 55 executives from government, industry and academia chosen to participate in this year's program. Candidates are nominated by their organizations and selected by MIT.

Initiated in 1931, the Sloan Fellowship Program provides mid-career executives a year of advanced study leading to a master's degree in management. Selectees normally have 10 to 15 years of executive experience.

Employed at MICOM's Redstone (AL) Arsenal for 12 years, Dr. Rhoades received his bachelor's degree in chemical engineering in 1960 and his doctorate in 1963, both from Renesselaer Polytechnic Institute.

Career Programs...

USUHS Selects First Four Academic Chairmen

Two civilians and three military personnel have been selected to serve as the first four academic chairmen and the assistant dean for Student Affairs in the School of Medicine, Uniformed Services University of the Health Sciences. Under construction at Bethesda, MD, the USUHS is scheduled to convene classes in September with a first-year enrollment of 36 students. Initial faculty selectees and their departments are:

Dr. Francis J. Haddy, professor and chairman, Department of Physiology. He has served as professor and chairman, Department of Physiology at Michigan State University since 1966, specializing in blood flow and pressure, respiration, and cardiovascular systems.

Dr. Randall K. Holmes, professor and chairman, Department of Physiology. Currently he is associate professor of Internal Medicine and Microbiology, and associate director, Infectious Disease Service, Universit of Texas Southwestern Medical School. His primary area of research involves the toxic effects from bacteria on various body organs and the development of chemical antibiotic agents to combat these effects.

COL James W. Bass, U.S. Army Medical Corps, professor and chairman, Department of Pediatrics. Since 1975, he has served as chief, Department of Pediatrics, Walter Reed Army Medical Center (WRAMC), Washington, DC.

He has served as chief of Pediatrics at Tripler General Hospital, and on the faculty of the University of Hawaii School of Medicine. He specializes in children's infectious diseases.

LTC Ronald R. Blanck, U.S. Army Medical Corps, is appointed associate professor of Medicine and assistant dean for Student Affairs. Since 1974 he has served as assistant chief, Department of Medicine, WRAMC.

An osteopath, LTC Blanck was a Fellow in Infectious Diseases at the Army Medical Research Unit in Juala Lumpur, Malaysia. He has authored publications on drug abuse and medical complications.

CPT Douglas R. Knab, U.S. Navy Medical Corps, is selected as professor and chairman, Department of Obstetrics and Gynecology. Since 1973 he has served as chairman of the Department of O&G at the National Naval Medical Center, Bethesda, MD.

He has made spectrophotometric studies of amniotic fluid, urinary infections in pregnancy, prenatal mortality, and has authored articles on cervical and endometrial cancer.

7 Interns Complete ECOM Procurement Training

Certificates recognizing completion of three years of intensive training in the Army Electronics Command's Procurement and Production Directorate were presented recently to seven Army Materiel Development and Readiness Command career interns.

ECOM Director of Procurement and Production BG William D. Lewis made the presentations. DARCOM's procurement intern program combines 600 hours of classroom instruction with on-the-job training for preparation at journeyman-level positions.

Graduates of ECOM's procurement training program are:

Timothy B. Ashley, a graduate of Temple University with a BA degree in economics, served for two years at a Philadelphia (PA) ECOM activity prior to his permanent assignment at HQ ECOM, Fort Monmouth, NJ.

Raymond L. Bail III holds a political science degree from Morris Harvey College, Charleston, WV. Prior to his ECOM assignment he received a year of training at the former Army Munitions Command, Joliet, IL.

Teresa G. Barnhart graduated from William Jewell College, Liberty, MO, with a degree in social studies and secondary education. She was formerly with the Army Aviation Systems Command, St. Louis, MO.

Wiley W. Horsley received a year of training at the Army Missile Command, was graduated with a degree in history from Georgia State University, and is working toward his master's at Fairleigh Dickinson U.

Aleta E. Egeland graduated with a bachelor's degree in history from Virginia Polytechnic Institute and State University and is now studying for a master's degree in business at Fairleigh Dickinson University.

Robert L. Cope Jr. holds a bachelor's degree in business from the University of Utah. Permanently assigned to Fort Monmouth, he received a year of training at an ECOM activity in Philadelphia.

David Borland, also previously assigned to an ECOM Philadelphia activity, has a bachelor's degree in industrial relations from Central Missouri State University.

FIVE OF SEVEN procurement interns recognized for completing three years of intensive training in the ECOM Procurement and Production (P&P) Directorate. ECOM Director of P&P BG William D. Lewis (above) presented certificates to (l. to r.) David Borland, Raymond L. Bail III, Aleta E. Egeland, Teresa G. Barnhart and Wiley W. Horsley. Not pictured are Timothy B. Ashley and Robert L. Cope Jr.

Rouse Picked for Executive Development Training

William G. Rouse

Demonstrated potential for managerial responsibility has earned William G. Rouse, an Edgewood (MD) Arsenal industrial engineer, selection for six months of training under the technical director's executive development program.

Employed at Edgewood since 1969, Rouse is the 17th employe chosen for this training since the program was initiated in 1971. Following three months on various assignments at Edgewood, he will go to HQ Army Materiel Development and Readiness Command, Alexandria, VA, for a similar period of managerial training.

Rouse has served as the Manufacturing Technology Directorate's coordinator for Edgewood's smoke screen program. Graduated from the University of Michigan (Ann Arbor) with a BS degree in industrial management, Rouse has a master's degree in administration and management engineering from George Washington University, Washington, DC.

A U.S. Navy veteran, he attended the Navy Submarine School, New London, CT, the Nuclear Power School, Mare Island, CA, and the Nuclear Power Training Unit, Idaho Falls, ID. He was division director and instructor at the Navy Nuclear Power School, Bainbridge, MD, until he joined the Edgewood Arsenal professional staff.

Rouse received a Department of the Army Special Act or Service Award in 1971 and is a member of the Society of Manufacturing Engineers and Alpha Pi Mu, a national industrial engineer honor society.

National Independent Study Center Initiated

Initiation of a National Independent Study Center in Denver, CO, designed for civilian federal employes seeking correspondence course instruction is announced by the U.S. Civil Service Commission.

Course offerings include management, supervision, management analysis, personnel management, labor relations, financial management, automatic data processing and communications, and office skills.

Each instructional unit, which is accompanied by an individual test, can normally be completed within two hours. Tests will be scored promptly by the NISC and returned to the student to reinforce learning.

Eligibility for course enrollment applies also to state and local governments seeking federal training for their employes. All employes must be nominated by their employing departments or agencies.

Cited advantages of using the center are: continuous enrollment without waiting for a course to convene; modest costs as compared to formal classroom training; elimination of per-diem expenses; and greater flexibility in work and training scheduling.

Film Examines Army Records Management Program

Four Tons of Canaries, a new 19-minute motion picture being distributed to Army audio visual support centers, is designed to acquaint personnel with the U.S. Army Records Management Program.

Poorly organized filing systems are compared with the performance of a 2-ton truck bouncing along with four tons of canaries. The driver pounds the sides of the truck to keep two tons of the canaries in the air and thus maintain the truck's stability.

Identified as MF 12-5904, the film explains benefits of The Army Functional Files System (TAFFS) and, in demonstrating how it works, shows how cumbersome systems can be purged of the excess "canaries" and made to "fly" with ease.

Distributed by the Army Training Support Activity, Tobyhanna, PA, the film is recommended for utilization by supervisory and middle management personnel, records management personnel, file clerks and Army Reserve and National Guard Units.

Conferences & Symposia . . .

TRADOC Hosts Combat Developments Conference

Techniques of Cost and Operational Effectiveness Analysis (COEA) and of performing the Family of Systems Studies (FOSS) were discussed by 10 generals, 38 colonels and high-ranking civilians at a Combat Developments Conference conducted at White Sands (NM) Missile Range.

Sponsored by the U.S. Army Training and Doctrine Command, headquartered at Fort Monroe, VA, the conference was hosted by the TRADOC Systems Analysis Agency (TRASANA), directed by Dr. Wilbur B. Payne. MG W. H. Vinson, deputy chief of staff for Combat Developments, was the top TRADOC representative.

Based on recommendations made in TRADOC and TRASANA studies, Dr. Payne and Leon F. Goode, his deputy for Technical Operations, discussed changes designed to improve the COEA and FOSS procedures.

Other topics included user testing of new or improved materiel, support requirements of systems such as remotely piloted vehicles, materiel acquisition procedural problem areas, and management of the scientific and engineering career fields.

Major generals in attendance included Morris J. Brady, commander, Combined Arms Center and commandant, Army Command and General Staff College, Fort Leavenworth, KS; Erwin M. Graham, commander, U.S. Army Logistics Center, Fort Lee, VA; Stewart C. Meyer, commander, HQ TRADOC Combined Arms Test Activity, Fort Hood, TX; and W. L. Mundie, Army Administration Center, Fort Benjamin Harrison, IN.

Participating brigadier generals were Glen K. Otis, deputy commander, Combined Arms Combat Development Activity, Fort Leavenworth, KS; W. B. Burdeshaw, assistant deputy chief of staff for Combat Developments, TRADOC, Fort Monroe, VA; Arthur J. Junot, assistant commandant, Army Transportation School, Fort Eustis, VA; Eugene Kelly Jr., commandant, Army Intelligence Center and School, Fort Huachuca, AZ; and Donald F. Packard, commander, Combat Developments Experimentation Command, Fort Ord, CA.

Current Approaches to Decision Making Discussed

Representatives from seven countries attended the Second International Conference on Current Scientific Approaches to Decision Making in Complex Systems, May 10-12, in London, England.

Sponsored by the Army Research Institute for the Behavioral and Social Sciences (ARI) and the European Research Office (ERO), the conference focused on new developments in decision making and implications of man/machine relationships.

U.S. participants included ARI Associate Director and Conference Chairman Dr. Joseph Zeidner, and Dr. Edgar M. Johnson of ARI's Educational Technology Training Simulation Technical Area. Dr. Zeidner also heads ARI's organization Systems and Research Lab.

Dr. Joseph Zeidner

Representatives from Sweden, Germany, Israel, Austria, the Netherlands, England and the United States presented, in panel format, discussions of their state-of-the-art approaches to decision making.

Topics included training in structured and unstructured situations; decision making as a skill; applications of decision making skills; what the decision maker needs to be taught; and "learning to learn".

ECOM Sponsers 30th Frequency Control Meet

Frequency control state-of-the-art advances and problems were considered by some of the world's leading experts from industry, academia and government agencies at the 30th Annual Symposium on Frequency Control, June 2-4, at Atlantic City, NJ.

Sponsored by the U.S. Army Electronics Command's Electronics Technology Devices Laboratory, the symposium is the only international gathering devoted solely to frequency control and timekeeping. Attendance averages about 600.

Primary discussion areas included quartz crystal resonator research and technology; quartz crystal oscillators; crystal filters; atomic and molecular beam tubes, masers and frequency standards; and precision timekeeping and time distribution.

25th Conference on Nondestructive Testing Planned

Applications of nondestructive testing (NDT) and potential solutions to problems will be discussed at the 25th annual Defense Conference on NDT, Aug. 31-Sept. 2, at the U.S. Army Materials and Mechanics Research Center, Watertown, MA.

Limited to DoD military and civilian scientists, engineers, technicians and managers responsible for military NDT activities, the conference is hosted on an annual rotational basis by the Army, Air Force, Navy or Defense Supply Agency.

Objectives are to encourage uniform practices in the application of NDT methods, provide a forum for the interchange of ideas and to disseminate and develop information relative to potential solutions of NDT problems.

Women in Army Science . . .

GS15 Analyst Provides Inspiration for Others

Lois N. Spruiell

Women determined to climb the Federal Civil Service career ladder might gain inspiration from the success of Lois N. Spruiell, a recently promoted GS-15 employe of the Ballistic Missile Advanced Technology Center (BMDATC).

One of the two highest ranking U.S. Government women employes in the Huntsville (AL) area, Mrs. Spruiell began her federal career in 1956 as a clerk-steno with the Department of Health, Education and Welfare, Social Security Administration, Birmingham, AL.

Following a 3-year break in service, she was rehired as a GS-3 typist with the U.S. Army Missile Command at Redstone (AL) Arsenal. Promotion to a GS-5 one year later was concurrent with her entrance into the program analyst field as an assistant.

A full-fledged GS-11 program analyst by 1967, she transferred to BMDATC the following year and by 1973 had risen to the GS-14 ranks. The recent temporary promotion carried with it the title of acting chief of BMDATC's Program Management Office.

Her GS-15 civil service status is shared in the Huntsville area with Dr. Irene Roan of Redstone Arsenal's Medical Department Activity.

A member of Federally Employed Women (FEW), and the Association of the U.S. Army (AUSA), Mrs. Spruiell attended Walker (AL) Jr. College in 1960-61 and is enrolled in the University of Oklahoma's Bachelor of Liberal Studies Program.

Chemist Compiles Explosives Data Library

Virginia Hogan

Virginia Hogan, a research chemist at Picatinny Arsenal, Dover, NJ, is testing a new technique directed to rapid identification of foreign, domestic and military explosive compositions. Assigned to the Feltman Research Laboratory, she is compiling a data bank of nuclear magnetic resonance (NMR) spectra of all known explosives.

NMR is a technique for detecting and estimating types and quantities of protons in hydrogen compounds. Molecular structures are verified by dissolving explosives in proton-free solvents and subjecting them to a magnetic and electric field.

Explosives data programed into a computer, including such items as TNT and RDX, can actually serve as "fingerprints" for federal and state police investigating a suspicious incident. Compositions need not be chemically separated to identify the nature and concentration of major ingredients. "Peaks" will show at various points in the pattern corresponding to individual explosives in a mixture.

Miss Hogan has tested and stored more than 160 compounds including 120 foreign explosives. Ultimately, the files will also contain impurity and solvent patterns and permit data retrieval within minutes.

Employed at Picatinny for 20 years, Miss Hogan holds a BS degree from St. John's University and an MS degree from Fordham University, both in chemistry. She has authored or coauthored 25 technical papers.

She is a Fellow of the American Association for the Advancement of Science, a member of the American Chemical Society, and a recipient of a Department of the Army Meritorious Civilian Service Award.

Personnel Actions . . .

Dr. Korkegi Appointed NATO AGARD Director

Dr. Robert H. Korkegi

Dr. Robert H. Korkegi, senior scientist, Aeropropulsion Laboratory, Wright-Patterson Air Force Base, OH, will take control in July as director of the North Atlantic Treaty Organization's Advisory Group for Aerospace R&D (AGARD).

Composed of eight technical panels, AGARD brings together NATO nation representatives in science and technology relating to aerospace. They recommend use of R&D capabilities, provide scientific and technical assistance to military committees, and stimulate technical advances through international cooperation.

Albert A. Berman, Office of International Research and Development, HQ U.S. Army Materiel Development and Readiness Command, is the Department of the Army project officer for AGARD.

Dr. Korkegi graduated from Lehigh University in 1949 with a BS degree in mechanical engineering and later earned an MS degree in aerospace engineering and his PhD in aeronautics and mathematics from California Institute of Technology.

During 1964-75 he served at Wright-Patterson AFB as director of the Theoretical Aerodynamics Research Laboratory, Aerospace Research Laboratories. He was credited with establishing in-house research activities on aerodynamic viscous phenomena.

Other prominent assignments have included technical director, von Karman Institute for Fluid Dynamics (NATO), Belgium; research associate, University of Southern California Engineering Center; and aeronautical engineer, Naval Ordnance Test Station.

Dr. Korkegi served during 1944-46 in England, France and Germany with the U.S. Army Combat Engineers and later worked briefly at the Grumman Aircraft Engineering Corp. He has authored more than 40 publications, and is listed in *American Men of Science, Who's Who in the Midwest,* and *Who's Who in Aviation.*

Hancock Takes Over Computer Systems Command

BG (MG designee) Jack L. Hancock is the new commander of the U.S. Army Computer Systems Command (USACSC), Fort Belvoir, VA, following the reassignment of BG Walter E. Adams as commander, Berlin Brigade, U.S. Army Europe.

USACSC deputy commander since 1975, BG Hancock was commissioned through ROTC in 1952. He holds an MBA degree from George Washington University, has completed graduate courses at American University and the Advanced Management Program at Carnegie-Mellon University, and has completed residence courses at the Command and General Staff College and the Industrial College of the Armed Forces.

Recent assignments have included: Management Information Systems Directorate, Office, Assistant Vice Chief of Staff, HQ Department of Army; commander, U.S. Army Computer Systems Support and Evaluation Command; and commander, Joint Technical Support Activity, Defense Communications Agency, Washington, DC.

BG Jack L. Hancock

WSMR Picks Bigelow as Quality Assurance Chief

Chief of the Quality Assurance Office and calibration coordinator are new titles recently assumed by Gus Bigelow, a supervisory general engineer at the U.S. Army's White Sands (NM) Missile Range.

Employed at WSMR since 1954, Bigelow served from 1957-75 as chief of a number of range branches and divisions, working primarily with electronic tracking and telemetry research. He was acting chief of QA prior to his new assignment.

Graduated with a BS degree in electrical engineering from the University of Texas at El Paso, he has authored numerous technical papers for the Institute of Electrical and Electronics Engineers and the North Atlantic Treaty Organizations' Aerospace R&D Group.

Slingerland Commands/Directs ECOM ADP Lab

COL Douglas A. Slingerland recently succeeded COL Donald R. Lasher as commander/director of the Communications/Automatic Data Processing Laboratory, U.S. Army Electronics Command, Fort Monmouth, NJ.

Graduated from the U.S. Military Academy in 1952, COL Slingerland holds an MS degree in systems engineering from the University of Arizona. He completed the Army Command and General Staff College, ADP Staff Officers Course, and the Signal Corps Officers Advanced Course.

Prior to assuming his new title, he was chief of the Production Engineering Division in ECOM's Research, Development and Engineering Directorate. He has served also in Washington, DC, and the Canal Zone with the Defense Communications Agency.

Other key assignments have included communications-electronics staff officer, Nike Zeus Project, Kwajalein, Marshall Islands; Combat Developments Command; and tours in Japan, Eritrea and Vietnam.

COL D. A. Slingerland

Wilson Heads Corps of Engineers Civil Works

COL (BG designee) Drake Wilson, former Mobile (AL) District engineer, has been selected to succeed BG Kenneth E. McIntyre as deputy director of Civil Works, Office, Chief of Engineers, Washington, DC.

Listed among COL Wilson's key assignments are commander, 14th Engineer Battalion, 45th Engineer Group, Vietnam; staff engineer, VI Corps, Germany; and staff officer, Office, Deputy Chief of Staff for Logistics, Department of the Army.

Graduated from the U.S. Military Academy in 1952, COL Wilson holds an MS degree in civil engineering from Princeton University. Has completed Command and General Staff College and Army War College courses.

His military awards and decorations include the Legion of Merit with two Oak Leaf Clusters (OLC), Bronze Star Medal with two OLC, Army Commendation Medal with OLC, Meritorious Service Medal, and the Air Medal with OLC.

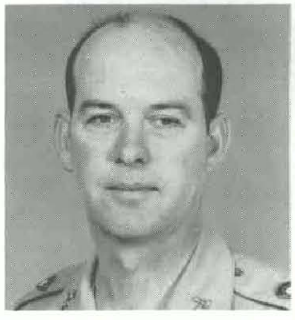
Stokes Named Communications Command Engineer

COL Eugene J. Stokes, former engineer president, U.S. Army Armor-Engineer Board, has been named the U.S. Army Communications Command (ACC) engineer, Fort Huachuca, AZ.

A veteran of nearly 24 years of active Army service, COL Stokes holds a bachelor's degree in engineering from the U.S. Military Academy, West Point, NY, and a master's degree in engineering from Princeton University.

Previous key assignments have included commander, 94th and 79th Engineer Battalions, Germany; NATO pipeline specialist, Allied Forces Center, the Netherlands; chief, Construction Division, Army Engineer Command, Vietnam; and engineer platoon leader, Korea.

A member of the Society of American Military Engineers, COL Stokes holds the Bronze Star Medal for combat service in Vietnam during 1967.



COL Eugene J. Stokes

McKinney Slated to Head St. Louis District

COL Leon E. McKinney has been selected to succeed COL Thorwald R. Peterson in July as St. Louis (MO) District engineer, Army Corps of Engineers.

Currently enrolled at the Industrial College of the Armed Forces, Fort McNair, Washington, DC, he is a 1955 graduate of the U.S. Military Academy, has a master's degree in nuclear engineering from the Air Force Institute of Technology, and has completed the Army Command and General Staff College course.

Listed among his key assignments are commander, 802d Engineer Battalion, Korea; chief, Legislative Liaison, Office, Secretary of the Army, Washington, DC; and assistant director of Civil Works, Office, Chief of Engineers, Washington, DC.

COL McKinney is a recipient of the Meritorious Service Medal with two Oak Leaf Clusters (OLC) and the Army Commendation Medal with OLC.

Robinson Named Los Angeles District Engineer

COL Hugh G. Robinson, former commander, U.S. Army Engineer School Brigade, Fort Belvoir, VA, has assumed new duties as Los Angeles (CA) District engineer, U.S. Army Corps of Engineers.

A 1954 graduate of the U.S. Military Academy, COL Robinson holds a master of science degree in civil engineering from the Massachusetts Institute of Technology and has completed the Armed Forces Staff College and National War College.

Listed among his key assignments are commander, 39th Engineer Battalion (Combat), Vietnam; staff officer, Deputy Chief of Staff for Operations, Department of Army, Washington, DC; and executive officer, 3d Regiment, Army Corps of Cadets, West Point, NY.

COL Robinson is a recipient of the Legion of Merit with Oak Leaf Cluster (OLC), Bronze Star Medal with OLC, Joint Service commendation Medal, Army Commendation Medal with OLC, and Air Medal (2 OLC).

Browne Succeeds Cockerham as PM for AAH

COL Edward M. Browne, project manager, Advanced Scout Helicopter, has been selected as the project manager for the Advanced Attack Helicopter, following reassignment of BG Samuel G. Cockerham to the Office, Joint Chiefs of Staff, Washington, DC.

Graduated with a bachelor's degree (summa cum laude) from St. Benedict's College and a master's degree in public administration from Auburn University, COL Browne has separate master's degrees in procurement management and systems management from Florida Institute of Technology, he is a "distinguished graduate" of the Air War College.

A career Army aviator, he was drafted into military service during the Korean War and was commissioned through Officer Candidate School. He earned his wings at Fort Sill, OK, in 1954.

COL Browne has served tours of duty in Vietnam and Korea; also, successive assignments as project manager for the Light Observation Helicopter System, and the Quiet Aircraft System. He is a recipient of the Legion of Merit for work on these systems.

Battle Assumes Duties as ECOM Inspector General

Inspector general of the U.S. Army Electronics Command (ECOM), Fort Monmouth, NJ, is the new title of LTC Frank Battle, following the retirement of COL John H. Van Eaton.

Commissioned through the U.S. Army Reserve Officers' Training Corps in 1952, COL Battle holds a BS degree from Southern University, an MBA degree in management from Fairleigh Dickinson University and is a graduate of the Northwest Institute of Medical Technology.

He has served as deputy depot commander/installation commander and battalion commander, 70th Transportation Battalion; and commander and staff officer, Military Air Traffic Coordinating Office; at Fort Benning, GA, Fort Eustis, VA, Fort Gordon, GA, Fort Meade, MD, McGuire Air Force Base, NJ, Dover (DE) AFB, and overseas tours in Germany, Japan, Korea and Vietnam.

LTC Frank Battle

Graduated from the Army Command and General Staff College and Air War College, COL Battle is a recipient of the Bronze Star Medal, Meritorious Service Medal and Army Commendation Medal.

Albright Caps 36 Years, Receives Second DSM

Capping more than 36 years of active Army service when he retired recently, MG Jack A. Albright, former commander of the U.S. Army Communications Command, received his second Distinguished Service Medal.

MG Albright was cited for "extraordinary" service from 1971 to 1976 which resulted in the "molding of ACC into a cohesive, dedicated military-civilian team despite the wide dispersion of manpower resources assigned in nearly a score of nations of the world," LTG John Vessey, deputy chief of staff, Operations and Plans, presented the award.

Army R&D — 15 Years Ago

The Army R&D Newsmagazine reported on...

Trudeau Stresses Government-Industry Research Effort

Representatives of many of the nation's major industries in the electronics and communications field heard Army Chief of R&D LTG Arthur G. Trudeau emphasize the critical importance of continuing expansion of basic research to meet the Army's long-range military requirements.

As keynote speaker at a conference of 200 members of the Armed Forces Communications and Electronics Association at Fort Monmouth, NJ, home of the U.S. Army Signal R&D Laboratories, Trudeau said, "both the Wriston Commission and the President's Science Advisory Committee stress the need to expand our national effort in basic research.

"In the Army, we are continuing to get modest increases in the monies we are allotted for this research, and a fair segment of the American industry consciously is expanding its effort in this critical area.

"Together, we must encourage this trend. Government, alone, cannot be responsible for, or do, the whole job in basic research. It cannot assume the entire cost of basic research in this country, now running about $1 billion a year. For the maximum in dynamic and realistic support, America must look to private enterprise, industry, and foundations...."

ARTS Analysis Shows Basic Research Emphasis

An analysis of the Army Research Task Summary (ARTS) reveals that basic research is being supported by nearly 30 percent of the Army's total research budget, while most major American industries are spending less than five percent of their research budgets on basic research.

Industrial emphasis is on applied research aimed at immediate profits, whereas the Army is "stockpiling knowledge" intended to insure technological supremacy in producing superior weapons and equipment.

Prepared by the George Washington University Task Group, the ARTS shows that Army funding of all research in FY 1960 totaled $188,487,949. Basic research accounted for $54,138,983.

Forty-one percent, or $77,225,258, of the total Army research funds, the analysis shows, were expended through the Ordnance Corps to support in-house activities in laboratories and arsenals and for work done under grants or contracts with universities, colleges, and nonprofit groups.

Army Tests Mobile Nuclear Power Plant

Announcment was made by the Atomic Division, Office of the Chief of R&D, that testing of the Army's ML-1 mobile nuclear plant had started at the Atomic Energy Commission's National Reactor Testing Station.

Initiation of the testing program on the reactor skid was termed a "major milestone" in the joint Army-AEC program to bring the benefits of virtually fuel-free (from a logistical view) nuclear power to the Army.

Until recently, a spokesman said, the Army Nuclear Power Program was limited, by technical consideration, to developing stationary and portable reactors to meet the needs of fixed military installations. Now it has become feasible to undertake construction of nuclear plants with sufficient mobility to support the Army Field Forces.

ASAP Hears Stahr Stress Army Modernization

Priority problems concerned with advanced air, surface and water mobility concepts occupied some 60 of the nation's leading scientists, industrialists, engineers and educators at the spring meeting of the Army Scientific Advisory Panel at Fort Eustis, VA.

Secretary of the Army Elvis J. Stahr Jr. called for acceleration of Army modernization, saying that scientists must respond to the President's appeal in this respect, particularly a major advance in ground mobility.

The Secretary asked panel members for a "continuous flow of new ideas and concepts" and for counsel in deciding "what is best to adopt, produce and procure as new Army material, and what should be cast aside..."

NASA, AEC, ARPA Join Advanced Power Group

An Interagency Advanced Power Group (IAPG) was established as successor to the Interservice Group for Flight Vehicle Power (IGFVP), to stimulate R&D in all areas of unconventional power sources.

Formed with the objective of increasing the over-all effectiveness of the government's advanced power sources program, the IAPG has the responsibility of insuring an informal exchange of information at the technical level on program goals, requirements and progress.

The new group is broadened by addition of voting members of the Atomic Energy Commission, National Aeronautics and Space Administration, and the Advanced Research Projects Agency, along with representatives of the Army, Navy and Air Force.

Soviet Fiber-Reinforced Metal Matrix Composite Technology

By William F. Marley Jr.

Modern technology has placed increasing demands on structural materials, particularly for aerospace structures requiring high strength and minimal weight consistent with speed and load-carrying objectives.

The mechanical property upper limits for homogeneous structural materials and their alloys such as aluminum, titanium and steel are rapidly being approached. We have neared a technological barrier that could prevent quantum jumps in strength and elevated temperature properties.

A technological innovation or "breakthrough" is needed to fulfill continuing requirements for improved materials. Development and application of composite materials, particularly metal matrix composites, offer opportunities for technological innovation.

This article will give consideration to fiber-reinforced metal matrix composites, although other composite types such as dispersion strengthened and directionally solidified composites are under widespread development.

Fiber-reinforced metal matrix composites are a sophisticated class of materials. Control of the reinforcement orientation and fiber length-to-diameter ratios can yield greatly improved mechanical properties of toughness, strength, stiffness and high-temperature service life.

Major attractiveness of this category of composites is in aerospace applications yet there is a definite place for them in many nonaerospace requirements, prompting material scientists and engineers throughout the world to initiate developmental programs.

In the United States these composites are of high interest although economic and engineering problems are hindering wide acceptance. One of the engineering problems relates to undesirable reactions between the reinforcement and the matrix. The Soviets are experiencing some of these problems and are devoting considerable resources to minimize their effects.

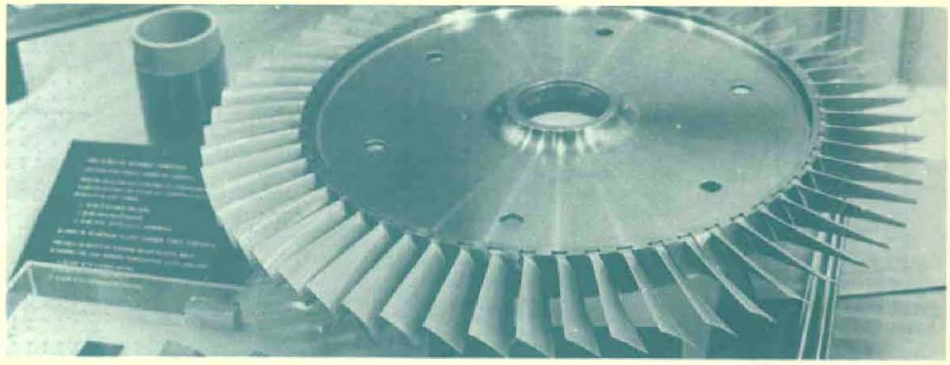
Soviet Programs. Soviet technologists are devoting considerable attention to development of fiber-reinforced metal matrix composites. Within the past decade extremely rapid advances have been made in fundamental aspects.

Research areas where the Soviets are making their more impressive gains include development of steel-reinforced aluminum alloy matrices; reinforced magnesium-lithium alloys; and diffusion-barrier coatings for graphite, boron, and refractory metal fibers.

While these areas seem to represent the most significant developments for the Soviets, other areas of near-equal importance are receiving increasing attention. These include tungsten fiber-reinforced nickel alloys; and titanium alloys reinforced with boron, silicon carbide, molybdenum, or monocrystalline filaments.

Reinforced Aluminum Matrices. The first documented Soviet attempt to reinforce an aluminum alloy was reported in 1953, and involved steel-reinforced silumin, an A1-12 percent Si alloy. Steel-reinforced aluminum continues to receive the greatest attention among the fiber-reinforced aluminum alloy composites under development. Soviet material scientists and engineers have had good success with these materials, employing a number of steels as reinforcements and many aluminum alloy matrices.

Technical reports indicate considerable progress in experimental production of steel-reinforced aluminum alloy sheet and that a pilot line is in operation in Kaluga. This line can produce composite sheet in lengths up to 1½ meters (about 5 feet) and attempts are in progress to extend this capability. The basic technology for establishing this production line was developed at the Baykov Institute of Metallurgy in Moscow, under M. Kh. Shorshorov's direction.



SOVIET aircraft engine compressor disc with carbon-reinforced aluminum blades.

While significant improvements in properties are possible with respect to reinforced aluminum alloys, an even greater improvement is possible when sintered aluminum powder (SAP) alloys are reinforced with steel fibers.

Soviet researchers have a long history of working on SAP-type alloys but little is known about their work on reinforcing fibers. Soviet research and test results are impressive; ultimate strengths can be increased about four times that of the unreinforced SAP alloys. Little has been published in Soviet scientific media on boron- and graphite-reinforced aluminum alloys, although one composite, VKA-1, a boron-reinforced aluminum alloy, has been developed.

One of the most impressive material exhibits at the 1975 Paris Air Show was Soviet carbon-reinforced aluminum compressor blades. Figure 1 shows a disc with these reinforced blades. Laboratory work is obviously well advanced. Research has been noted in development of barrier coatings for graphite, which would be a prelude for introduction of graphite- or carbon-reinforced aluminum alloy composites.

Reinforced Magnesium Matrices. In acknowledging Western research, the Soviets realize the excellent advantages of reinforced magnesium alloys, particularly reinforced magnesium-lithium alloy matrices. About 1970, they began to consider and appreciate the potential of these composites. The first Soviet reinforced magnesium-lithium alloy composites employed steel wire as the reinforcement. Studies of a steel-reinforced Mg-8 percent Li alloy have included determinations of the deformation, strain hardening and rupture characteristics.

Some two years after initiating research on steel-reinforced magnesium-lithium alloys, the Soviets began to consider titanium alloys as reinforcements. Titanium alloy AT-3 [Ti-3A1-1.5(Fe+Cr+Si+B)] was selected as the optimum reinforcement and, over the last three years, mechanical property data have been tabulated. The maximum strength achieved for a magnesium-8 percent lithium/AT-3 composite can vary, depending on the strength of the fiber; however, an ultimate strength level of about 40 kg/mm² has been reported for a 40-volume fraction percent (v/o) of AT-3.

Reinforced Titanium Matrices. Titanium may be used as the matrix material in composites with either metallic or nonmetallic reinforcements, as a component in sandwich-type composite structures, and in multicomponent composites prepared from powders.

The desire to increase the operating temperatures of titanium alloys has been a major reason for the increasing interest in titanium matrix composites. Titanium composites can replace the more costly nickel-base alloys for many turbine engine components.

The major Soviet effort to develop titanium composites involves molybdenum reinforcements. Studies to date include thermal expansion, electrical conductivity, and elevated temperature properties. D. M. Karpinos and colleagues at the Institute for Problems of Material Science, Kiev, are the principal Soviet proponents of molybdenum-reinforced titanium.

Reinforced Nickel Matrices. Heat-resistant nickel alloys have satisfactory short-term and long-term strength at temperatures up to about 1100°C. Reinforcing nickel and its alloys with fibers of tungsten, molybdenum and fibrous monocrystals of aluminum oxide permits an increase in the strength characteristics at high temperatures. These composites are excellent candidates for components of advanced turbojet engines. Reinforced nickel alloys can be used for long-term service up to about 1300°C.

Following the United States lead, Soviet scientists are developing reinforced nickel matrices composites. They have introduced a nickel composite, designated VKN-1, which contains 40 v/o tungsten fibers of between 0.3 to 0.5mm in diameter. This composite contains approximately 10 percent more tungsten fibers than similar composites developed in the United States by the National Aeronautics and Space Administration, which could account for its excellent elevated temperature properties.

The Soviets have also developed a titanium nitride diffusion barrier coating for protecting the tungsten reinforcement, which could be responsible for these improved properties.

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Flu Vaccine Program, Energy Crisis Solution, Loch Ness Monster Search...

Stimulating Speakers Address 14th National JSHS Participants

Return on Investment is a significantly selective term in Department of Defense R&D programing and funding these days. High caliber of about 235 teenage researchers in the 14th National Junior Science and Humanities Symposium evidenced a sound ROI potential for Army-academia-industry program support.

Hosted by Georgetown University, Washington, DC, and sponsored by the Army Research Office, Research Triangle Park, NC, the May 19-22 NJSHS was the climax of nationwide competition among more than 4,000 high school science students in 39 regional symposia. Six students from each region participated and one from each region was selected to present a technical paper.

Five winners of a trip to London, England, to participate in the International Youth Science Fortnight, July 28 through Aug. 11, were selected by a panel of senior scientists representative of the various disciplines. The students also were given an opportunity to vote and their judgment adhered closely to that of senior scientists. Winners and titles of papers are:

Karen Sue Mikkelson, 18, senior at Will C. Crawford H.S., San Diego, CA, "Development of the Visually Evoked Response as a Non-Invasive Technique for Early Detection of Opthalmological and Neurological Dysfunctions.

Michael A. Montgomery, 17, senior at Elizabethton (TN) H.S., "Experimenting with High-Speed Data Transmission."

Beth Lynn Potter, 18, senior, Aberdeen (ID) H.S., "Genotypic Response of Small-Grain Cultivers to Metribuzin and the Development of a Leaf-Disc Test for Metribuzin Tolerance."

Cassius Scott, 17, senior at Marquette H.S., Michigan City, IN, "The Immunological Roles of Satellite DNA and Interferon."

David T. Leighton, 17, senior at Washington-Lee H.S., Arlington, VA, "Development of a Radiocarbon Dating Process for Field Use."

The success formula for the NJSHS program each year varies only in the names of distinguished speakers, the noted educators who serve on 12 simultaneous discussion panels, and the scientific tour attractions. Invariably, the program is one that keeps students continuously "on the go," shuttled from one place to another by bus caravans.

Principal speakers this year included Dr. Francis A. Ennis, director, Division of Virology, U.S. Food and Drug Administration. He gave the opening address on the $135 million nationwide mass immunization program scheduled this fall to prevent repetition of a swine virus type influenza—such as occurred in 1918-19 when half a million U.S. victims and 20 million worldwide perished.

"What are the odds against such an epidemic?" Dr. Ennis said he is of the opinion that no one has a valid basis for reliable prediction, but that the potential is sufficient to warrant the tremendous effort now under way to prevent a national disaster.

In his opinion, the possibility exists that, without a preventive vaccination program, an epidemic could have a daily growth of 500,000 or 12 to 18 million monthly. Worldwide, the death rate in the 1918-19 epidemic ranged from about 10 to 20 percent.

Cooperating in the prevention program are the Food and Drug Administration's Center for Disease Control, the Institute of Allergy and Infectious Diseases of the National Institutes of Health, the Department of Defense, other federal and state agencies, and numerous academic institutions nationwide.

Serum reaction and the dosage required are being intensely investigated this summer, along with mass immunization methodology. Many elderly people subject to respiratory diseases will get "Victorian" type flu vaccination in addition to the A-Swine virus serum. One of the needless fears, Dr. Ennis said, is that pork products may serve as carriers of the so-called A-Swine virus, which does not grow (survive) in dead tissue.

BANQUET SPEAKER Peter S. Van Nort, 38-year-old general manager of Project Management Corp., Oak Ridge, TN, discussed "The Breeder—The Scientific and Humane Solution to the Energy Crisis." He said the Liquid Metal Fast Breeder Reactor is "the best over-all answer.... My work has shown me that without it we will not make it."

That view is hotly contested nationwide by environmentalists, concerned about safe atomic waste disposal, and by other energy spokesmen.

Introduced by master of ceremonies LTG George Sammet Jr., deputy commander for Materiel Development, U.S. Army Materiel Development and Readiness Command, Van Nort opened his address by saying:

"The relationship between science and the humanities is vital. Science, without reference to the human, is essentially irrelevant.... In looking for solutions to the energy crisis, we must consider equally the contribution that science and the humanities could make to this decision....

"The word 'humane' is defined by Webster as 'marked by compassion, sympathy or consideration for other human beings...relating to or exhibiting the methods of principles of science'....

"How do these definitions relate to the decisions in the energy field? One would show compassion, sympathy and consideration by providing adequate amounts of energy, keeping the costs of energy as low as possible, minimizing the impact on the environment from the generation of energy, and minimizing the risks to the everyday health and life of the public.

"One would establish a scientific basis for a decision by showing the depth of research supporting an energy form and by showing that there has been adequate review and evaluation performed of that energy form...."

Van Nort said the electricity portion constitutes 27 percent of U.S. energy use, by 1985 will increase to 35 percent, and that by the year 2000 is expected to be about 55 percent. "We must work in the energy arena on all aspects. We will not succeed by choosing one form of energy and dropping others or by dropping one and proceeding with all others...."

Even assuming a zero population growth and a zero energy growth, he said, the shifting from one energy form to another could raise electricity demand.

Comparison of 1,000 megawatt electrical plants fired by coal, light water reactors and liquid-metal fast-breeder reactors shows, he said, that in all categories the magnitude of the impact on the environment from nuclear power, and particularly the LMFB reactor, is "significantly less."

Turning to the economic considerations, Van Nort cited a series of studies by General Electric Co., Commonwealth Edison Co., and a Harvard economics professor, showing "immense economic benefits to the country of the LMFBR...."

Benefits are estimated, he said, "from $76 billion when examined from the standpoint of the nation as a whole to $200 billion from the standpoint of the consumer. If you were to evaluate these benefits over a period from now to (the year) 2050, they would range from 2.5 to 3.5 trillion dollars."

Van Nort contended that nuclear power is "without equal in its record of protecting the individual health and ultimately the life of humans. No member of the public has ever been injured or killed by the operation of commercial nuclear power plants.

"No other technology...can make such a claim. One of the basic reasons that nuclear power plants can make this claim is the degree of control and review imposed upon the technology."

(Concluded on page 23)

LONDON TRIP WINNERS, selected to attend International Youth Science Fortnight, July 28-Aug. 11, in recognition of the best technical papers presented at 14th National Junior Science and Humanities Symposium in Washington, DC, pose with banquet master of ceremonies LTG George Sammet Jr. and COL Lothrop Mittenthal, commander, U.S. Army Research Office, Research Triangle Park, NC. Shown (l. to r.) Cassius Scott, David T. Leighton, Karen Sue Mikkelson, LTG Sammet, Beth L. Potter, M. A. Montgomery and COL Mittenthal.

Science Bicentennial

The Army Research Office, Research Triangle Park, NC, has arranged for about 150 young science students in 15 nations to attend a "Bicentennial of American Science," Aug. 13-26, with the first week spent in the Washington, DC, area and the second in New York City. A detailed report will appear in our September-October edition.

Peter Van Nort
Energy Speaker