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WES Serves Nation Through Engineering RDA Facilities

By Edward M. Schmidt

Muzzle blast of today's cannon type weapons is causing concern in many of the Army's current test, development and production programs.

High performance cannons, mounted on aircraft as well as light ground vehicles, for example, are generating blast overpressures on vehicle surfaces that have resulted in structural damage or unacceptable vibration levels. It has also been noted that the use of muzzle brakes to reduce gun recoil tends to increase overpressure levels in gun crew areas.

In addition, the introduction of fin stablized, long rod penetrators as gun kinetic energy ammunition, gives rise to concern over the degradation in accuracy associated with the initial flight through the muzzle blast.

Furthermore, the growing public sensitivity to environmental issues as well as unacceptable weapon blast signatures, has often limited the use of Army proving ground test facilities as well as military firing ranges.

Scientists at the Armament R&D Command's Ballistic Research Laboratory (BRL) are addressing these problems with a vigorous 3-step approach. That approach includes characterizing the gasdynamics of the muzzle exhaust; examing interactions of this flow with the projectile and gun attachments; and developing techniques to treat the blast wave as it propagates away from the weapon.

Actually, two distinct blasts are generated when a gun is fired. The first, called the "precursor," develops before the projectile leaves the gun. It is formed as the air in the gun tube is forced out ahead of the accelerating bullet. The second, more familiar, blast wave develops as the propellant gases are expelled following projectile separation.

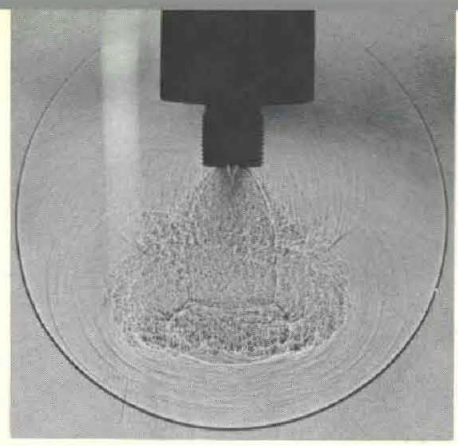
The precursor flow consists of a nearly spherical blast wave encapsulating the jet of air being forced out of the tube ahead of the projectile. Existence of shock waves within the jet indicates that it is supersonic.

When the base of the projectile clears the muzzle, the propellant gases are released. For typical gun firings, the pressure level in the propellant gases is one to two orders of magnitude greater than that in the air preceding the round.

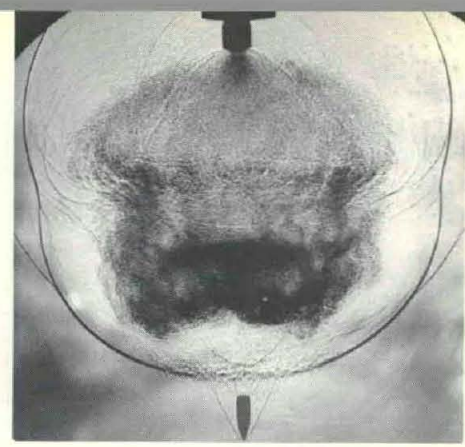
Sudden change in pressure at the muzzle results in the rapid expansion of the propellant gases over the projectile and through the boundaries of the precursor jet. Expansion is so sudden that a second blast develops behind the first. This wave overtakes and destroys the precursor.

Gas velocities within the propellant gas jet can reach values up to three times the launch velocity of the projectile. Thus, the round is exposed to a high speed flow from the rear, that is, it is effectively in reverse flight. Fin-stabilized projectiles are obviously unstable in such a flow, so BRL has conducted a study of the muzzle blast induced perturbations to the trajectory of a variety of finners.

The study showed that for a typical tank gun kinetic energy projectile, if the round to round dispersion produced a spread of impacts on target of 0.3 metres at a certain range, only 0.02 metres of the spread could be attributed to muzzle blast induced perturbations. Major contributions to dispersion were related to in-bore and separation mechanics.



Precursor Blast



Propellant Gas Blast

Two factors contribute to this result. First, the expansion of the propellant gases increase flow velocity by a factor of three, but drops the pressure and density by orders of magnitude. Thus, as the projectile moves away from the muzzle, the energy density within the reverse flow drops drastically.

Secondly, the speed of the projectile carries it through the muzzle blast so rapidly that little transfer of momentum occurs. To verify the calculations, a series of experiments were performed in which the strength of muzzle blast and its symmetry were varied artificially. Resulting alterations in projectile trajectory were measured and found to compare with predictions to within 10 percent.

Finding that muzzle blast does not significantly perturb the flight of projectiles, the BRL research effort has concentrated on the effect of blast on personnel and materiel. Two particular type systems of interest are medium caliber cannon mounted on aircraft and towed howitzers equipped with muzzle brakes.

Installation of 20mm and 30mm cannon on attack helicopters as secondary armament requires consideration of the effect of weapon blast upon the structure, avionics, flight surfaces, and engines. Parametric analysis of data from firings of guns with related performance characteristics has been used to successfully estimate the overpressure levels on various components of the helicopters. Additionally, the analytical technique has permitted the design of simple muzzle attachments to reduce overpressure to acceptable values.

However, such techniques require the existence of an extensive data base and are not capable of predicting the variations due to radical changes in the weapon performance and muzzle geometry; nor can they describe the effects of blast wave reflections.

The estimation of the blast field about a towed artillery piece is an example of a problem where the scaling analysis cannot be applied. For the determination of the pressure in the vicinity of the gunner, it is necessary to define the properties not only of the main blast pulse, but also of the reflected pulse(s). The ground reflection is of predominant concern, but other reflections occur from weapon gun tube, blast shields, trains, etc.

Analysis is further complicated by the presence of muzzle brakes which give rise to multiple sources of blast. Additionally, the requirement of firing artillery at various quadrant elevations significantly varies the relative geometry between the gun and the ground plane.

Preliminary investigations into the artillery blast problem have concentrated on definition of the flow field in the vicinity of the muzzle and muzzle brake.

A set of experiments were conducted which developed a description of the interaction between the muzzle blast and device itself. Based on this data, an analytical procedure has evolved to estimate the gasdynamic forces exerted on the brake during the weapon exhaust process. This type of information is valuable in the design of muzzle brakes, both in the analysis of recoil efficiency and of peak structural loads.

The particular research program is now moving toward investigation of the modifications of the blast field due to the muzzle brake and the propagation of this wave into the surroundings, particularly the crew stations.

BRL research efforts into the muzzle blast from guns has succeeded in dispelling some old wives tales regarding the effect of blast upon projectile trajectory. Experiments have pointed out the nature of the flow field both from weapons with a bare muzzle and those equipped with muzzle devices.

Models have been developed which permit treatment of certain aspects of the muzzle flow. However, the full range of real world, blast related problems experienced by the Army in the field continues to escape accurate analytical or numerical description. BRL objectives over the next few years are aimed at closing this gap.

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WES Continues Proven Reputation for Engineering Excellence

Fifty years ago just south of Vicksburg, MS, a surveying team began to lay the boundaries for a small government testing facility. No one realized at the time that this was the birth of a unique research center which would bring revolutionary changes to the science of engineering.

Indeed, the establishment of the U.S. Army Engineer Waterways Experiment Station (WES) was modest. When 1LT Herbert D. Vogel and his staff of 12 civilians began their studies, hydraulic model testing in America was in its infancy. Many engineers were skeptical, although scale models had been used for years in other countries to solve hydraulic problems.

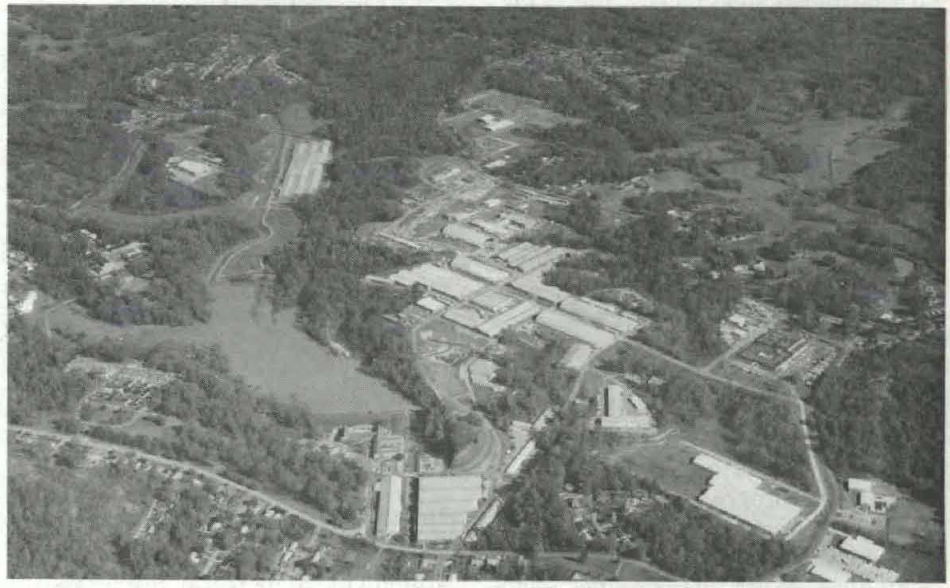
WES proved its worth with the very first model test. Engineers had carved a scale version of the Illinois River into the ground with grapefruit knives to determine the limit of Mississippi backwater. Congress used the results of the WES test to establish the limit as Mile 120. With this official endorsement, WES was off to an encouraging start.

In the years since, WES has built a reputation for engineering excellence in ever-broadening fields of research. The original mission, conceived in the aftermath of the 1927 flood, was to assist the Mississippi River Commission in developing a comprehensive flood control plan for the river. Expansion of research facilities began almost immediately, when engineers recognized a need for soils testing to aid in designing the levee system and to ensure the adequacy of foundations.

WES has continued to add and develop research facilities, becoming the largest and most diverse research and testing laboratory of the U.S. Army Corps of Engineers, supporting both civil and military missions of the Corps.

Today, the reservation covers nearly 700 acres and employs about 1,400 civilian and 35 military personnel. Over half of these are professionals, representing almost every discipline of science and engineering. Research is conducted within a 4-laboratory organizational structure.

The Hydraulics Laboratory is the world's largest, using basic and applied research to develop environmentally sound, economical solutions to water related problems. The principal tool of the laboratory is the scale model. However, an equally strong computer-based capability for solving certain problems has also been developed.



U.S. Army Engineer Waterways Experiment Station headquarters building is located between the main road and the lake on the left; other structures include administration buildings of the four technical laboratories, hydraulic models, and other test facilities required to carry out the station's mission in support of the Chief of Engineers and other agencies.

Investigations by the Hydraulic Laboratory fall into four basic areas: inland waterways, estuaries, wave action, and structures. Models take various forms as prescribed by the nature of the problem.

Inland waterways problems studied to develop flood control plans often require model reproduction of several miles of streams and backwater areas. These investigations use fixed-bed models which are molded in concrete. They are built to scale, usually with a much larger vertical than horizontal scale. This distortion reduces the area required for the model study while maintaining a measurable depth. Information derived from these studies primarily includes flood heights and total discharge.

WES pioneered in movable-bed modeling, using a granular material to give the model an erodible bed. This type of model, which requires a low degree of distortion, is used to develop and test river regulation plans. Movement of the material measures the effectiveness of the various plans. In addition to physical models, computerized simulation models are also used in planning and operation studies of inland navigation.

Estuary studies usually call for fixed-bed models. However, to reproduce predominating forces of nature, the model may include granular material to represent shoaling or beach sand, salt water to simulate the ocean, tide generators, and wave machines. One model even required rotary fans to simulate ocean breezes.

With these adjustments, the estuary model reproduces nature accurately to study shoaling, develop new harbors, control salt water intrusion, trace flushing patterns, and plan hurricane protection.

Problems created in nature by waves are solved by studying waves in miniature on scale models. Engineers can simulate the size, frequency, and direction of small, average, and storm waves to develop an adequate design for harbors or beach protection, or modifications to existing structures.

These studies are usually concerned with one or more of these three problems: harbor design, harbor protection, and inland and beach stability. In recent years, the capabilities of wave models have been expanded to include the effects of water on sediment transport.

When the focus of the study is a hydraulic structure such as a dam, lock,

or pumping station, the problem is usually investigated using a model with no linear distortion. This is because the free fall of water is usually involved; therefore, the true geometric shapes of the structure must be retained.

Sometimes two or more models of different scales may be used in the same study. Areas of special interest may be modeled in detail in a large scale, while a small scale model showing a more comprehensive area may be necessary to evaluate overall performance. Studies of hydraulic structures help to determine the adequacy of designs and develop improvements.

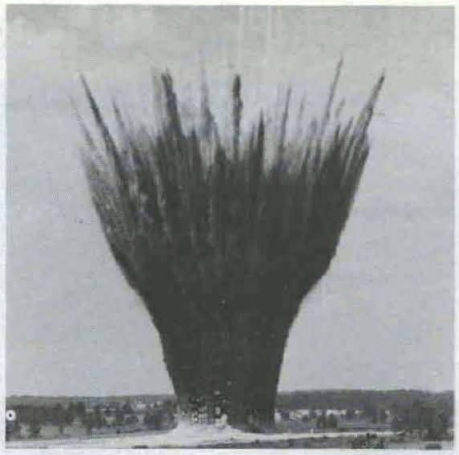
In addition to physical model studies, the laboratory also carries out a continuing program of research, development, and application of advanced mathematical problem-solving techniques. Work areas range from digital computer solutions of hydraulic and sediment transport equations to implementation of recently developed systems analysis, simulation, and optimization techniques.

The Geotechnical Laboratory was formed about two years after WES was established to provide capabilities in testing soils for design and construction of flood control methods. Initial tests were mechanical analyses of bed load and sediment samples from the Mississippi River.

Testing was soon expanded to include sieve analyses, hydrometer analyses, Atterberg limits tests, consolidation tests, direct shear tests, water analyses, and simple chemical tests as required. At the time, WES had the only soils testing laboratory in the Corps of Engineers with these capabilities.

World War II, the Korean War, and the Vietnam War brought significant changes to the work of the laboratory. Activities now include: research, investigation, and testing services in soil mechanics; structural foundation design; embankment design and slope stability; also, seepage analysis, airfield pavement design, engineering geology, rock mechanics, expedient surfacing, surface preparation, dust control, earthquake engineering, and mobility and trafficability.

Change and development in the field of ground vehicles and aircrafts have brought a necessary corresponding change in the quality of pavement required to accommodate them. WES has the latest and most sophisticated



PROJECT ESSEX (Effects of Subsurface Explosions), a series of small- and intermediate-scale high-explosive tests, was conducted at Camp Shelby, MS, and Fork Polk, LA, to investigate the effectiveness of low-yield nuclear munitions for neutralizing airfield runways in tactical warfare.

equipment to perform all necessary tests on materials used in pavement systems; also, for developing improved testing techniques.

Scale-model pavement tests use special carts equipped with specific landing-gear configurations and loaded to the desired weight to traffic pavement test sections. WES has also developed a portable laboratory for nondestructive testing of prototype pavements.

A new laboratory complex is under construction and scheduled for completion in 1981. The portion already completed is one of the largest and most modern facilities in the world for performing virtually any type of soil test. Capabilities include a cyclic triaxial load device for determining the liquefaction susceptibility of sands and other granular materials, Young's modulus, damping, and dynamic response of material tested.

Direct shear apparatus, also designed and constructed at WES, is used to determine the residual shear strength of clays and clay shales. Forty-two controlled-strain direct shear specimens can be set up simultaneously, with all test data recorded electronically.

WES has been, for many years, the principal developer and tester of landing mats for expedient surfacings for the Army and Air Force. Laboratory facilities are available for conducting tests to determine physical and mechanical properties of mats and panels. This research has reduced weight and cost of mats per square foot. These are important factors in production and transportation of materials.

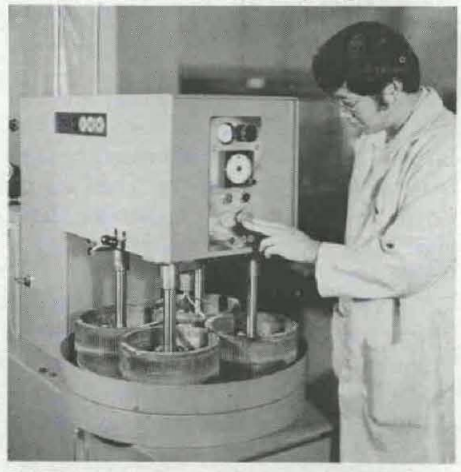
Effects of earthquakes on earth dams or other structures and the design of structures where safety of operations might be in question are of special concern. The laboratory is responsible for placing and maintenance of 3-component accelerographs, peak recording accelerators and seismoscopes on Corps of Engineers dams to assess safety of the structures in the event of an earthquake.

As part of this program, WES maintains an aftershock measurement team ready to respond to Corps Divisions and Districts needs and to collect research data on dam performance in the event of a major earthquake.

WES has also been engaged in aspects of mobility research for some 25 years, including the effects of the terrain-vehicle-driver system on vehicle performance in on- and off-road operational environments. A comprehensive analytical model has been developed to simulate speed performance of ground crawling vehicles in known conditions.

Many types of vehicle performance can be predicted by the model, including drawbar pull, slope-climbing and obstacle crossing abilities, fuel consumption, and cargo delivery capacity. One of the many useful forms in which model predictions can be depicted is a mobility map, which allows selection of the fastest route between two selected points.

Field studies, combined with theoretical analyses, of the impact of the environment on military operations



FREE ABRASIVE GRINDING MACHINE enables an operator to prepare concrete to a smooth flat surface that can be examined with a stereoscopic microscope to determine air content of the specimen at Waterways Experiment Station.

have led to development of quantitative classification systems for relevant terrain features.

Personnel use these systems to classify and compare geographic areas of the world. They are used also to relate the environment to such specific aspects of military operations as mobility, munitions deployment, and airfield construction.

The Structures Laboratory conducts research to determine the effects of nuclear and non-nuclear explosions and the response of surface and subsurface structures to natural and explosive disturbances. The laboratory also determines the effectiveness of various design concepts in withstanding such disturbances, evaluates the behavior of soils under dynamic conditions, and develops information on construction materials and structural systems.

Another aspect of explosives research is development of practical, cost-saving applications to general excavation problems, including spillways, railroad cuts, and highway cuts.

Structures research began when the Corps of Engineers' concrete testing capabilities were consolidated at WES in 1946. This research includes physical, chemical, and mineralogical properties of concrete and concrete materials, the processes used in concrete construction, and the structures capabilities of concrete when incorporated in a structure.

WES has studied use of discarded concrete as aggregate to conserve natural aggregate and to reduce solid wastes. This recycled concrete compares favorably with normal concrete. Based on results to date, the concept appears feasible and desirable.

Another aspect of concrete research is more economical methods of construction. One promising technique appears to be roller compacted zero-slump concrete. Tests to investigate durability and erosion resistance are underway. It is estimated that the cost of concrete construction in this manner would be one-third to one-half that of conventional placement.

This laboratory is also interested in earthquake effects. Models and prototypes of concrete dams were subjected to low level vibration tests to determine dynamic response characteristics. These tests, combined with dynamic materials properties tests and supplemented with modern computer methods of research, have significantly increased the capability of predicting the linear response of concrete dams to earthquakes.

Other studies consider the environmental hazards posed by conventional demolition blasting of obsolete facilities and prediction of possible damage to dams, as well as to other large hydraulic structures by earthquakes. The goal is development of safer and more rational design procedures for large structures in earthquake-susceptible areas.

A recent survey of Corps Districts and Divisions identified over 50 structures which have experienced concrete damage due to abrasion erosion. A majority of these have been repaired, many with limited success. Consequently, a laboratory research program was initiated to evaluate the abrasion erosion resistance of selected repair materials. These materials included conventional concrete, fiber-reinforced concrete, polymer-impregnated concrete, and various coatings for concrete.

The concrete testing facility consists of over 90,000 square feet of working space, equipped with many types of unusual apparatus. The laboratory also maintains an exposure station at Treat Island, ME, where specimens can be subjected to alternating cycles of freezing and thawing, or wetting and drying.

Explosives testing became a part of WES capabilities in 1961 when the Station was asked to study underwater explosion phenomena and effects for the Office, Chief of Engineers. Since then, the laboratory has developed theoretical, analytical, and experimental methods to provide information and prediction techniques for assessing the effects of explosions on personnel, materiel, and military operations in general.

Investigations are concerned chiefly with studies of underground and underwater explosion phenomology and effects, the assessment of radiation hazards that are associated with buried nuclear explosions, the design of protective structures to resist such effects, and assessing the vulnerability of a variety of military targets.

The laboratory operates a number of special testing and blast simulation facilities to support research programs in the field of explosion effects, protective structure design evaluation, and basic explosives research. The large blast load generator is a unique device for simulating blasts from kiloton and megaton weapons and to evaluate the response of underground structures.

A dynamic friction testing apparatus is used to provide data on friction for various combinations of construction materials and earth materials. The apparatus is currently being used to determine friction parameters for dynamic soil structure interaction studies and rock slides analyses.

The Big Black River test site, a 40-acre test facility, is located on the Big Black River about 10 miles southeast of Vicksburg. It is used primarily for small- and intermediate-scale explosion effects tests. The site is sufficiently remote to permit detonation of explosive charges up to several hundred pounds.

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

Basic missions of the Environmental Laboratory are to predict the effects of man's activities on the environment and to develop methods to minimize or mitigate these effects. Also included are determining and controlling the interaction between military and civil activities and materiel and their environment. Emphasis is on biological and chemical effects, but all aspects pertinent to environmental policy, legislation, and regulation are included.

Research is supported by some of the most innovative and complete environmental laboratory facilities in the world for analytical chemistry and ecosystem modeling. Facilities include equipment capable of detecting contaminants in parts-per-billion concentrations; laboratories for microbiological, chemical, and radioisotopic tracer studies; climate controlled greenhouses; and environmental chambers.

The laboratory has recently completed a 5-year study to determine the environmental impact of dredged material disposal and to develop alternative methods of disposal. Final conclusions, recommendations, and guidelines from the program were included in published reports.

A continuation of the program called Dredging Operations Technical Support (DOTS) was organized to as-

sist Corps Division and Districts in applying these results to particular problems. DOTS will provide assistance in such activities as Environmental Impact Statement review, permit evaluation, project design, briefings and seminars, plan of study formulation, and establishment of project monitoring requirements.

This laboratory is also managing the research portion of the Corps' Aquatic Plant Control Program. The program emphasizes identification and development not only of new control agents, but also of necessary methods and techniques for their proper use on an operational scale.

Agents under study are in the general categories of biological, chemical, mechanical, and integrated approaches. A predictive capability is also being developed for determining the effect of agents under a variety of conditions before actually applying the agent.

A 6-year program of Environmental Water Quality Operational Studies was initiated in 1977. The study will provide new or improved technology to solve certain environmental quality problems associated with Civil Works activities of the Corps of Engineers.

A similar program for Recreation Research is aimed at improving the Corps' effectiveness in providing recreation opportunities at its water resource development projects.

In addition to these special programs, the Environmental Laboratory also develops, evaluates, and applies state-of-the-art mathematical modeling techniques for predicting water quality and ecological effects of engineering activities.

These models are also used for evaluating operational and management alternatives for meeting environmental quality objectives at existing water resource projects. Models are evaluated and improved for practical application to field problems.

Other studies are concerned with developing pollution control technology, particularly in the following areas: wastewater treatment in recreation areas and roadside facilities, solid and hazardous waste management, and urban and regional wastewater management. Investigations are performed to quantify pollutants, identify sources of pollution, and improve pollution abatement techniques.

Engineering modifications to riverine systems are investigated through environmental inventories and impact assessment studies. WES also conducts programs to determine how wetland areas affected by construction activities can be developed for wildlife habitats.

A different aspect of environmental study is the interaction between military and civil activities and materiel and their environment. Investigations include fixed-installation camouflage, military hydrology, environmental constraints on surveillance equipment, natural resources management, river basin simulation studies, and terrain data management.

Military camouflage work is directed toward advanced sensors for surveillance, target acquisition, and terminal homing systems.

In 50 years, WES has made major contributions to the nation's growth and development in its role as the principal research, testing, and development facility of the U.S. Army Corps of Engineers. Many WES projects have worldwide significance while others have smaller scope. However, each is a response to the special needs of the American people.

Careful planning and comprehensive study go into each project, whether it serves a small community or the whole nation. Perhaps this dedication to service is best described by the Corps of Engineers' motto "Essayons"—let us try.

CE Releases Moth for Control of Waterhyacinth

The U.S. Army Corps of Engineers' Waterways Experiment Station and the Corps' New Orleans District has released the moth, *Sameodes albiguttalis,* as part of a large-scale operations management test (LSOMT) of insects and pathogens for the control of waterhyacinth in Louisiana.

Personnel of the U.S. Department of Agriculture (USDA) Aquatic Plant Management Laboratory, Fort Lauderdale, FL, and the Louisiana Wildlife and Fisheries Commission is assisting the Corps' scientists. The moth was released in selected areas in New Orleans and Houma to determine its ability to control waterhyacinth in heavily-infested areas.

Control of the waterhyacinth has been difficult due to the enormous growth rate of the plant. Biological organisms have been receiving increased attention as agents for controlling waterhyacinth and other aquatic plants because they increase in number, disperse to new areas, and have long-lasting effects on the plants.

For example, the amount of alligatorweed in the southeastern United States has been significantly decreased due to the importation and release of three insects that feed on the plant.

Small-scale tests of two weevils and a fungal disease, *Cercospora rodmanii*, in Florida and Louisiana have demonstrated that the growth of waterhyacinth can be reduced by certain combinations of organisms. Further testing of these combinations is scheduled to be conducted next year in Louisiana.

Sameodes, a moth found in Argentina that attacks waterhyacinth plants, was brought to the United States and studied in quarantine by the USDA to insure that it would not damage crops and native plants. Based on data from these and other studies, *Sameodes* was approved for release in this country in 1977. Since that time, scientists have been developing techniques for establishing moth populations in the field, and as a result, *Sameodes* is now established in numerous locations across southern Florida.

The moth depends on waterhyacinth for its existence. Adult moths lay eggs on the leaves and the resulting larvae feed on the leaves. After the larvae have tunneled extensively throughout the plant, the leaves take on water through the holes bored by the larvae and the plant sinks.

On small plants, extensive feeding will occur on all leaves, but on larger, older plants, the larvae move directly to the newest, tender leaves, where they usually destroy the growing tip.

This combination of feeding damage, destruction of the growing tip, and submersion causes the plant to die. Mature larvae pupate inside healthy leaves for approximately one week, emerge as moths, mate, lay eggs, and the cycle repeats.

Release and subsequent evaluation of *Sameodes* in Louisiana reportedly represents an important step in the eventual large-scale reduction of waterhyacinth in the state through the use of biocontrol agents. Information resulting from these releases will be used to make recommendations for the use of *Sameodes* in long-term waterhyacinth management programs that are environmentally compatible.

Aquatic plant control research for the U.S. Army Corps of Engineers is conducted through the Aquatic Plan Control Research Program at the Waterways Experiment Station in Vicksburg, MS.

Fuel Cells for Silent Power

By Richard T. Sale

The need for silent, or quiet, electric power generation equipment has long been recognized within the Army. The tactical requirement is to reduce the likelihood of enemy detection due to aural signature. A substantially lower power source noise level would help prevent identification or location of critical military installations, such as command posts, communication centers, etc.

A secondary, but very significant peacetime need, is to reduce the sound level of electrical power sources so that they do not become a noise pollutant for the surrounding civilian community. Operation of noisy generator sets, particularly in the European theater, has generated numerous complaints over the past decade.

Unfortunately, at present, the Army is completely dependent on either reciprocating or turbine engine generator hardware for its mobile electric power supplies. Most of this equipment was designed in the 1950s or 60s without the requirement for noise suppression. Therefore, their noise level is in the 75 to 90 DbA range at a distance of 7 meters. To put this in perspective, the sound level of a conventional power lawn mower is approximately 75 DbA at 7 meters.

This noise level is not only a nuisance factor, but it also impedes verbal communications and, in the most extreme cases, creates a health problem relative to loss of hearing for operators and maintenance personnel.

As early as June 1966, the Army identified the need for silent power generators during an in-depth study by the user representative agency (Combat Developments Command). This study, supplemented by additional high level correspondence from HQDA and USAREUR, led to approval of a requirements document for silent power plants ranging in electrical output from 0.5 through 10 KW.

The Army's officially expressed need for a "Silent Lightweight Electric Energy Plant" took form when the Required Operational Capability (SLEEP ROC) was approved on 1 May 1975. Among the essential characteristics of this ROC are aural nondetectability at 100 meters (which translates to approximately 52 DbA at 7 meters), and the minimum practical IR detectability. Such power plants must have electrical performance consistent with that of the Military Standard Gasoline Engine Driven Generator Sets which they will replace, as defined in MIL-STD-1332.

The SLEEP ROC is intended to primarily fulfill the need for silent equipment in the brigade and forward environment. However, if power plants developed against this requirements document prove to be life cycle cost effective, they would be considered for all Army applications.

To satisfy the established ROC, the U.S. Army Mobility Equipment R&D Command (MERADCOM) investigated numerous alternative technologies as well as foreign equipment. Analysis of hardware in the UK, Germany, and Japan revealed the existence of foreign power sources with lower noise levels than our generator sets. However, they did not approach the rigorous noise constraints of the SLEEP ROC, nor did they provide the required interoperability.

Quiet power source developments in Germany and Australia are being monitored under an International Materiel Evaluation (IME) Program. However, preliminary results show sound levels and other characteristics are incompatible with the SLEEP requirements.

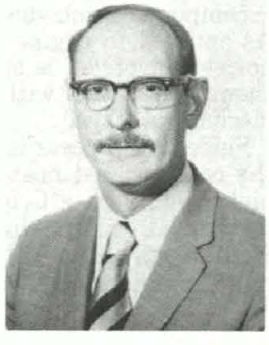
Silencing of conventional hardware, such as gasoline and diesel generator sets, was considered. However, the additional size and weight associated with silencing techniques for this type hardware prevented them from meeting physical characteristics of the ROC.

The Stirling cycle engine and thermoelectric approaches also suffered from large volume, high technical risk, and excessive IR signature due to inefficiency. Evaluation of Wankel engine driven generator equipment indicated this approach could not provide necessary reliability or efficiency.

The two most promising concepts, i.e., fuel cells and Rankine cycle engine generators, were investigated in-depth in order to select the technology offering the best combination of performance, cost and probability of success. Disadvantages relative to volume, maintenance, and reliability resulted in elimination of the Rankine approach.

Despite minor technical difficulties associated with fuel conditioners, the fuel cell approach was determined to be the most viable candidate for satisfying the requirement for .5 through 5 KW silent power plants.

A fuel cell is an electrochemical device which converts chemical energy directly into electrical energy and is, in this respect, analogous to a battery. However, in a battery, as power is produced, the electrodes are consumed. In a fuel cell, the fuel being supplied



RICHARD T. SALE has served since 1977 as chief of the U.S. Army Mobility Equipment R&D Command's Electrical Power Laboratory. He has worked on development of turbine generator sets, vehicle engine driven generator systems, and was associated with management of MERADCOM's support for the Patriot Missile System. He holds a BS in mechanical engineering from Virginia Polytechnic Institute, and an MBA in management science from the University of Colorado.

to the anode and the oxygen being supplied to the cathode react, with the electrodes remaining unchanged.

Fuel cells considered for military use ultimately involve the electrochemical reaction of hydrogen (H_2) from fuel and oxygen (O_2) from air. Figure 1 illustrates the reaction within a single, acid electrolyte cell where H_2 and O_2 react catalytically at the respective electrodes to produce a DC voltage output and water as the reaction product.

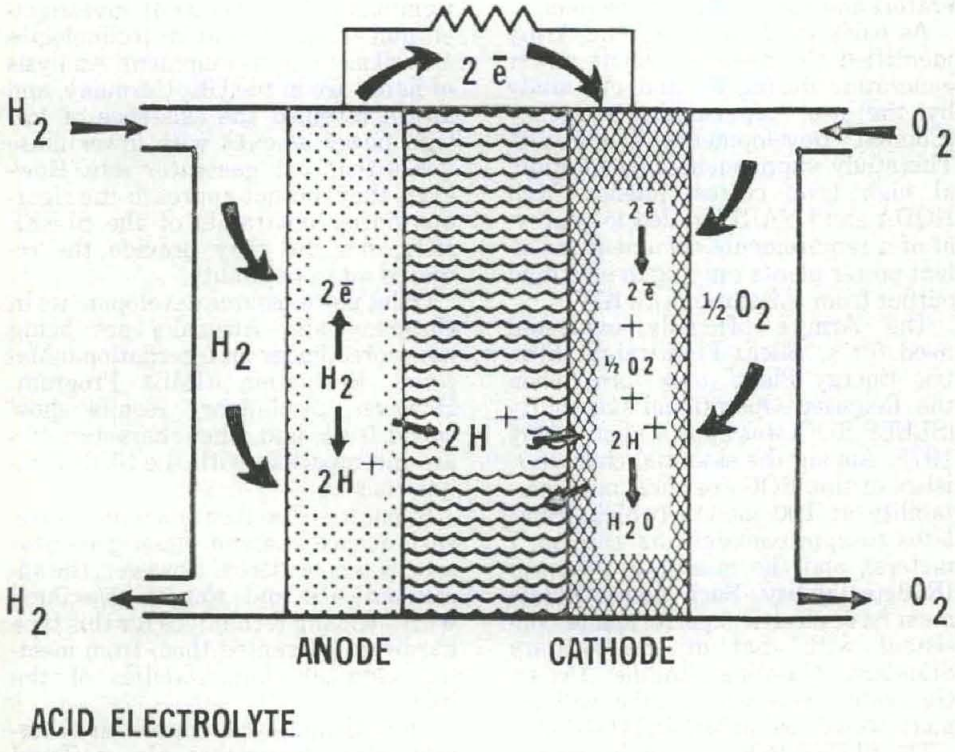


Fig. 1. Fuel Cell Reaction Diagram

To obtain the desired voltage level in a given power plant, a number of these single cells are connected in series. For example, in the development model 1.5 KW power plant, 80 cells were used in series to achieve the desired output voltage and current. The buildup of cells into a power producing section, or stack, provides one of three major subassemblies within a fuel cell power plant.

The second major subassembly is referred to as a fuel conditioner. This is a device which converts available fuel into a hydrogen rich fuel stream which can be utilized by the fuel cell. Fuel conditioners vary in size, complexity, and concept depending on the fuel being treated.

Simple fuels, such as methanol and ammonia, can be converted into a hydrogen rich stream by steam reforming or catalytic cracking. However, to obtain hydrogen from more complex fuels, such as gasoline or diesel fuel, requires higher temperatures, increased volume and greater fuel conditioner complexity.

The final subsystem is a power conditioner which takes the unregulated DC voltage produced by the fuel cell stack and converts it to either a regulated DC output or an AC output at the required voltage and frequency level. This power conversion is accomplished by solid state electronic devices.

The fuel cell power source, as described above, is basically a static system with the only moving parts being small fans or blowers to cool electronic components and supply process air. As opposed to engine generator sets, power conversion is accomplished by chemical reaction without an interim mechanical stage.

Since this process is not limited by the conventional heat cycle, it has a higher inherent efficiency. It is also theoretically more reliable due to a reduced parts count and because power is generated without dependence on moving parts.

The ability to produce electric power without combustion helps make fuel cells a silent power source. Improved efficiency of the chemical reaction concept, combined with the low temperature operation of this device, provide a minimal thermal signature and low pollution level.

Fuel cell technology has been an acknowledged approach for producing electric power for over a century. However, the concept was not seriously considered until the early years of the space program. During the mid and late 1950s, the need for self contained power plants precipitated extensive development of the basic hydrogen/oxygen fuel cells.

During the early 1960s, this technology received more emphasis as ARPA and NASA provided substantial funding for development of space qualified hardware. Recent space oriented applications of fuel cells were as components of the Gemini and Apollo space crafts. All spacecraft power sources operated directly from a supply of pure hydrogen and oxygen, thus eliminating the need for a fuel conditioner.

During more recent years, and at present, this technology has been funded almost exclusively by the electric utilities and the Federal Government. The Department of Energy and the Electric Power Research Institute (EPRI) have several ongoing projects primarily associated with stationary power plant size units. For instance, the most significant activity is in support of a 4.8 megawatt power plant to be installed in New York City.

There is considerable relevance of this development to the Army's small fuel cell requirements since both employ the same basic technological approaches. However, the Army has unique needs and requirements associated with mobility, fuel type, and tactical design considerations.

The military fuel cell must be compact, lightweight, able to start in a minimum time period and be capable of multiple on/off cycles. These constraints, plus other unique military requirements, dictate a thorough design, evaluation, and test program prior to fielding this type hardware.

MERADCOM's initial development effort to satisfy the ROC is to produce a family of methanol fuel cells in the 1.5, 3 and 5 KW sizes. The 0.5 KW requirement will be satisfied by using a 1.5 KW unit, and due to size and weight constraints, the 10 KW SLEEP unit will be a sound suppressed turbine generator set. Methanol offers the least complex approach to this technology since fuel conditioning can be accomplished at a relatively low temperature.

Advanced development has been completed on the first member of this family, the 1.5 KW power plant. All

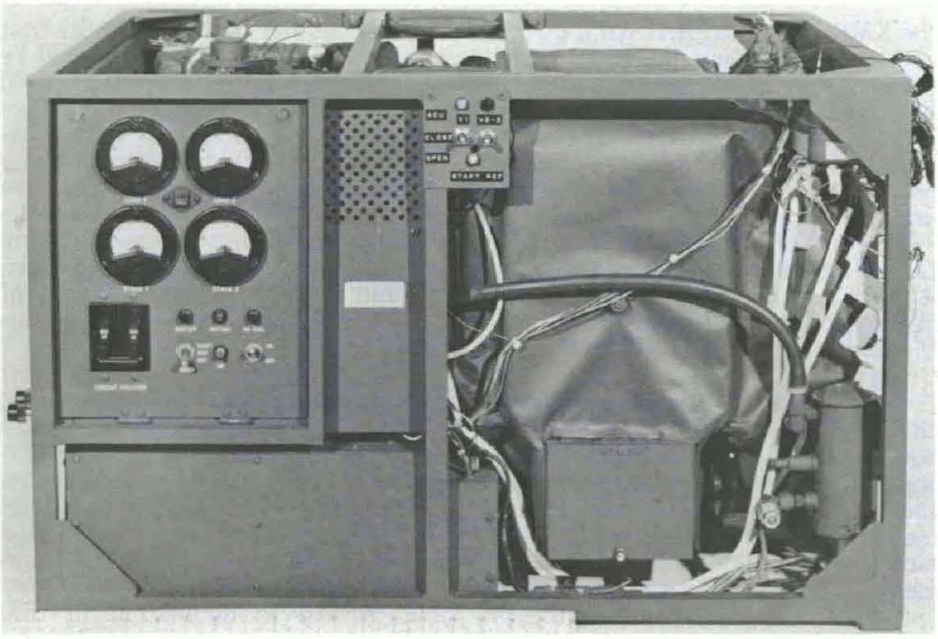


Fig. 2. 1.5 Kw Methanol-Air Fuel Cell

previously identified technical concerns have also been resolved. Present plans call for initiation of an engineering development program for this unit beginning in October 1980.

Selection of the 1.5 KW unit was based on the high field density of this size power plant and the anticipated phase out of the engine for the 1.5 KW gasoline set. Present projections indicate a critical need for 1.5 KW replacement power plants in the late 1980 time frame.

Engineering development of the 3 and 5 KW units will not be initiated until FY82 in order to take advantage of feedback from the development and test of the initial power plant.

Since fuel cells will represent a totally new and unique technology to military users, it is considered desirable to expose the initial member of the family to operational type testing prior to settling on a final design for other family members. This exposure will offer the Army its first opportunity to evaluate and determine the operational effectiveness of a militarized fuel cell.

Troop testing should demonstrate equipment capability and shortcomings which will help refine future designs, solidify the logistic philosophy, and help determine proposed operational concepts. This sequential approach to the development of the entire family should enhance the ability to field well designed power plants at a minimum expenditure of funding.

At present, the methanol family of fuel cells is considered an interim solution, with a second generation of hydrocarbon fuel cell power plants being investigated to satisfy the ROC requirement for multifuel operation. Hydrocarbon units will provide the opportunity to use logistically available petroleum base fuels, such as gasoline and diesel fuel; however, this requires a sacrifice in efficiency, reliability and cost effectiveness.

Since methanol is not commonly used by the Army, its application for fuel cells could create a severe logistic burden. The magnitude of this problem is now being assessed as part of the Cost and Operational Effectiveness Analysis for the entire SLEEP Family. Off-setting the possible adverse logistic impact of methanol are the numerous advantages of this type fuel cell. A simple fuel conditioner provides higher reliability, reduced size and weight, and lower procurement and operating costs.

Lower fuel consumption with the methanol approach is of particular interest and importance. The 1.5 KW methanol fuel cell will require approximately .25 gallons per hour to produce rated output, which is only 40 percent of the fuel required by the comparable size gasoline generator set and substantially better than the projected fuel consumption of the hydrocarbon fuel cell.

In addition to the cost savings from lower fuel consumption, there is the difficult to quantify logistic impact of reduced fuel handling and, of equal importance—energy savings.

The fuel cell approach is even more impressive in a fuel consumption comparison at partial load, which is the normal operating condition. From a purely energy consumption comparison, there is an even more significant improvement since the BTU content of methanol is only 50 percent that of gasoline.

Thus, the fuel cell power plant is consuming less than ¼ the BTUs of a comparable size gasoline generator set. This energy savings, coupled with utilization of a nonpetroleum base fuel, make the methanol power plant totally compatible with the Army's energy goals.

The 1.5 KW fuel cell, pictured in Figure 2, is the advanced development model which was evaluated by MERADCOM to determine if all major technical barriers had been overcome. Based on successful operation of this power plant, MERADCOM is confident the essential characteristics of the ROC can be satisfied.

Design characteristics for the engineering development models are: a reliability (MTBF) of 500 hours, mean operating life of 6,000 hours, volume of 7.1 cubic feet, and a weight of 165 pounds for the DC output unit. The AC output power plant, due to its increased power conditioner size and complexity, will weigh 205 pounds.

Assuming the engineering development program for the 1.5 KW fuel cell progresses according to schedule, this power plant should achieve type classification in FY83 with an anticipated IOC date of FY85. Present plans reflect type classification of 3 and 5 KW methanol units in 1987 with the fielding of production hardware two years later. Concurrent with the development of methanol fuel cells, MERADCOM is pursuing an extensive technology base program for hydrocarbon fuel cell components.

In summary, the Army has a well documented requirement for silent power plants which will reduce detectability in the combat zone and help eliminate noise pollution for the civilian sector during peacetime. Methanol fuel cells have been identified as offering the best approach for early fielding of the 1.5, 3 and 5 KW silent power plants.

In addition to satisfying the low noise requirement, methanol fuel cells offer a cost effective and efficient substitute to existing generator sets. Development of these methanol units is consistent with the Army's energy goals. If the program remains on schedule, fuel cells will begin to provide an improved electric power generation capability in the late 1980s.

Army R&D Achievement Awards Recognize 73 Personnel

Seventy-three scientists and engineers from Army in-house laboratories will receive U.S. Army R&D Achievement Awards in recognition of their scientific achievements that have advanced capabilities of the Army and contributed to the national welfare during the past year.

Winners of the 19th annual awards, consisting of a wall plaque and a 2-inch cast-bronze medallion, include 67 personnel (25 awards) attached to activities of the U.S. Army Materiel Development and Readiness Command; 5 to the U.S. Army Corps of Engineers (3 awards); and 1 to the U.S. Army Research Institute for the Behavioral and Social Sciences.

High-ranking Army R&D leaders will present the awards to the winners during the next few months, at appropriate ceremonies at the activities where the selectees are employed.

Listed within their major commands, subcommands and/or installations, the award winners and brief excerpts from their nominatic justifications and citations are as follows:

U.S. ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND (DARCOM)

U.S. Army Armament R&D Command (ARRADCOM), HQ, Dover, NJ. Eight members of the 105mm Advanced Tank Gun Technology Program will receive the Army R&D Achievement Award for their research and exploratory development contributions that culminated in demonstration of a new round for the 105mm tank gun.

The superior performance of this round in the current U.S. tank gun, as well as its implications for the 120mm tank gun, is expected to give this nation an effective defense against armor tank units for many years to come.

• The team members are *Dr. William J. Gillich, Dr. Calvin T. Candland, Mr. E. Louis Herr, Dr. Joseph J. Rocchio,* and *Mr. Fred J. Brandon* of the Ballistic Research Laboratory (BRL) at Aberdeen Proving Ground (APG), MD; and *MAJ Bruce L. Howard* of the Armament Concepts Office, *Mr. Victor Guadagno,* formerly of the Large Caliber Weapons Systems Laboratory (LCWSL), Dover, NJ, and *Mr. Ralph Campoli* of the LCWSL.

• A 7-man team of engineers and scientists from ARRADCOM were commended for their contributions to advancement of self-forging fragment technology required for various exploitations of the Improved Sensing Munitions Program, which includes the XM84 Mine, the SADARM (Sense and Destroy Armor) submunition, and the STAFF (Smart Target Activated Fire and Forget) projectile.

"These successful demonstrations have materially enhanced the defense posture of the United States," according to the citation.

Members of the team, all from the LCWSL, are *Messrs. Joseph A. Dubin, Alfred J. Fiorentino, Glenn Randers-Pehrson, James T. England, Joseph H. Harris, Robert I. Fatell* and *Oscar C. Gaffney.*

• A 5-man team from the BRL was cited for significant achievements in development of a fundamental understanding of a unique military concept, the analytical models to predict equipment vulnerability to a novel damage mechanism, as well as in the development of appropriate instrumentation and in performance of experiments and analyses required to establish validity of the models.

These models will be of use to Program Managers in assessing vulnerability of equipment and in evaluating protective measures. They also will prove useful in the design process for military equipment.

Members of this team are *Messrs. J. Richard Moore, John A. Morrissey, Russell D. Shelton, Lawrence J. Vande Kieft* and *E. Michael Vogel.*

• Another 5-man ARRADCOM team will be honored for scientific and engineering contributions to development of the 155mm Smoke Projectile, XM825. In the course of this effort, they were responsible for important advances in technology in a number of areas including projectile ballistic simulation and stability, munition design, and smoke/obscurant technology.

The team of engineers includes *Messrs. James L. McKivrigan, Richard D. Belmonte,* and *James E. Norton* of the Chemical Systems Laboratory (CSL), APG; *Mr. Miles C. Miller,* Weapon Systems Concepts Team, APG; and *Dr. William P. D'Amico Jr., BRL.*

• Four members of the CSL, *Messrs. Charles A. Senseney, Charles M. Dahlgren, Orville C. Bowersox,* and *Charles E. Mick Sr.,* developed the principle of biological cloud neutralization in the ambient atmosphere.

This achievement represents a major advance in the concept of contamination avoidance by destruction of the oncoming toxic biological cloud. "This work," the citation states, "is of major importance to the Department of the Army and the U.S. Government because it has demonstrated for the first time that a biological cloud could be neutralized in the open air under field conditions."

• Studies by *Drs. Barry D. Fishburn, Pai-Lien Lu* and *Norman Slagg* of the LCWSL at ARRADCOM have led to greater understanding of the relative importance of chemical and physical processes occuring in the detonation of heterogeneous mixtures of fuel particles or drops and a gaseous oxidizer.

These processes play an important role in the performance of munitions, propellant combustion, and have importance for evaluating civilian hazards due to accidental release of hydrocarbons such as gasoline and liquid natural gas. They have performed detailed studies on the behavior of individual particles in supersonic flows and growth to detonation in controlled dispersion of fuel particles.

Results of their efforts will aid the improvement of munitions through more efficient use of available energy and increasing design options.

• Cited for outstanding ingenuity and persistent efforts to reduce vulnerability of Army helicopters to the effects of combat damage are *Mr. Roland G. Bernier, Dr. Donald F. Haskell* and *Mr. Thomas F. Erline,* all with BRL.

According to the citation, their research and engineering analyses have led to a design capability for substantially increasing the survivablity of helicopter tailbooms to the antiaircraft threats postulated for the 1980s.

"These efforts mark a significant step forward in capability for enhancing the overall survival of Army aircraft, crew and passengers as well as the defense posture of the United States."

• Three BRL employes, *Mr. Richard D. Kirkendall, Dr. William H. Drysdale* and *Mrs. Louise D. Kokinakis* designed and developed a strong, lightweight sabot for a kinetic energy projectile in close continuous collaboration with personnel responsible for the entire round.

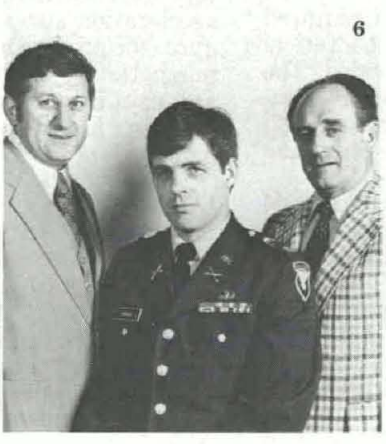
This design required a fundamental knowledge of mechanics and stress analysis, strength characteristics of certain metals and other materials, and a thorough knowledge of the interior ballistic environment and geometric constraints imposed by the existing gun configuration.

In addition, the citation states, "a scientific design methodology was synthesized which should expedite the

(Continued on page 10)

R&D Achievement Award Winners

U.S. Army Armament R&D Command (ARRADCOM), HQ, Dover, NJ. (1) Front—Joseph A. Dubin, Joseph H. Harris; Rear—Alfred J. Fiorentino, Glenn Randers-Pehrson, James T. England. (2) Robert I. Fatell, Oscar C. Gaffney. (3) John K. Domen. (4) Richard D. Kirdendall, Louise D. Kokinakis, Dr. William H. Drysdale. (5) Fred J. Brandon, Dr. Joseph J. Rocchio, Dr. William J. Gillich, E. Louis Herr and Dr. Calvin T. Candland. (6) Victor Guadagno, MAJ Bruce L. Howard, Ralph Campoli. (7) Dr. Charles H. Murphy. (8) Dr. Walter B. Sturek. (9) Dr. Pai-Lien Lu, Dr. Barry D. Fishburn, Dr. Norman Slagg. (10) James L. McKivrigan, James E. Norton, Dr. William P. D'Amico Jr., Richard D. Belmonte, Miles C. Miller.



R & D Achievement Awards Recognize 73 Personnel

(Continued from page 8)

development of future kinetic energy rounds for the United States and NATO inventories."

• BRL scientists *Dr. Philip M. Howe* and *Dr. Robert B. Frey* will receive the Army R&D Achievement Award for discovering ways to make explosives and propellants safer, and applying this knowledge to the manufacture, storage, transportation, and usage of explosives and propellants.

"The work will not only save the Army money, but also will make more survivable and efficient all military vehicles that carry people and energetic materials."

• *Dr. Charles H. Murphy,* BRL, is commended for outstanding scientific contributions to the theoretical flight mechanics of projectiles and missiles.

"His work on the effect of moving payloads and aerodynamic asymmetries significantly improve the design process of future Army projectiles. By means of his theory, design tolerances can be set and so insure good flight performance for projectiles with sophisticated payloads.

• *Dr. Walter B. Sturek,* BRL, is cited for his efforts to develop techniques for computing the projectile Magnus effect.

"This achievement, which required a combined experimental-theoretical research effort, has provided the Army with a new computation capability for the aerodynamics of shell and will lead to improved aerodynamic design of future Army shell."

• *Mr. John K. Domen,* ARRADCOM Product Assurance Directorate, will receive an award in recognition of his successful development of the first Laboratory Ballistic Simulator (the Dynagun) which accurately duplicates the Pressure-Time-Travel performance of cannon propellant in Large Caliber Weapon Systems.

"His imagination, scientific acumen and dedication has led to a significant advancement in the field of propellant evaluation and promises to revolutionize the Army's method of accepting manufactured lots of gun propellant as well as evaluating new formulations and propellant designs."

U.S. Army Missile R&D Command (MIRADCOM), Redstone Arsenal, AL. Two team awards and three individual awards will be shared by 12 personnel employed at MIRADCOM.

• A 5-man team from the Technology Laboratory will receive an award for a major breakthrough in infrared guidance for indirect fire antiarmor missiles.

A summary of achievements states that they independently originated an automatic acquisition infrared seeker concept, developed hardware and successfully demonstrated, through captive flight tests, the ability of their concept to provide a major advance in lock-on-after-launch technology. Their seeker development greatly enhances the United States' antiarmor capability.

Cited for these efforts are *Messrs. Frank A. Briglia, Charles T. Jennings, Wayne D. Jordan, Larry J. Murphree,* and *Ronald C. Passmore.*

• A 4-man team from the Technology Laboratory will receive the award for advancing the Army's technical capability in the design and development of unique seeker systems for use in high-acceleration applications.

The team of scientists and engineers is directly responsible for the unprecedented development of the compliant air bearing gyro technology proposed for applications on laser semiactive weapons systems such as Copperhead or the Navy 5-inch guided projectile.

The summary states, in part, the product of this work provided significant technical improvements and established scientific data bases in high-acceleration survivability techniques, gyro torquing concepts, optical and magnetic position sensing devices, and exotic materials applications for low-cost, highly reliable inertial components.

Team members include *Messrs. E. Lynwood Bailey, William G. Robertson, Aubrey Rodgers,* and *David L. Jones.*

• An individual award will go to *Mr. David H. Lacy,* Technology Laboratory, in recognition of the development of infrared imaging seekers for heliborne missile guidance. "As a result of his efforts," the citation states, "the Army now has a fire-and-forget missile guidance option to successfully engage and destroy the projected tank threat."

• The second individual award will be presented to *Mr. Victor W. Ruwe,* Engineering Laboratory, for outstanding achievements in project management of microelectronic technology and its application to missile systems.

"His visionary approach to project management produced notable advanced in the state-of-the-art of the overall technology base. These lasting contributions were achieved through the judicious application of resources and resulted in maximum benefit to the U.S. Army at minimum cost."

• The third individual award honors *Dr. Robert C. Sepucha,* Army High Energy Laser Center (Provisional), for outstanding achievement in high- energy laser research and development.

In summary, "The quality and timeliness of the theoretical and experimental results of the Joint Army-Navy Repetitively Pulsed Effects Program and the Joint Army, Navy, Air Force Repetitively Pulsed Vulnerability Effects and Hardening Program are significant contributions to the continuing evaluation and assessment of the potential of the high-energy laser to future Army roles, missions and advanced weapon technology."

U.S. Army Electronics R&D Command (ERADCOM), Fort Monmouth, NJ. Physicists *Drs. John R. Vig* and *Raymond L. Filler,* with the Electronics Technology & Devices Laboratory (ET&DL), will be commended for a significant breakthough in quartz crystal resonator technology.

"As a direct result of this breakthrough, the production of high-stability quartz crystal resonators which can survive the total impacts experienced during high-velocity gun launch and ground emplacement (16,000g shock followed by 5,000g shocks) is now possible," the citation states.

"Although this effort solved the difficult problem of survival of gun- emplaced sensors for REMBASS, their achievement makes possible new plateaus of reliable quartz crystal resonator performance for such evolving Army systems as SINCGARS, GPS, and JTIDS. These new capabilities are unattainable with crystals commercially available today."

• *Dr. John N. Helbert,* a chemist at the ET&DL, successfully conceived, synthesized and tested new high-sensitivity resist polymers for the lithographic fabrication of large-scale integrated circuits (IC).

The summary of achievement states: "By application of basic principles of radiation chemistry, he has modified the structure and composition of polymer molecules to produce materials with the fast writing rate needed for advanced ICs with ultra-small size, fast response, and low power consumption.

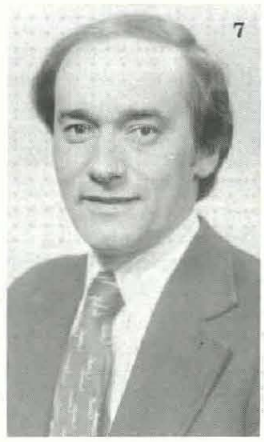
"His research successes have paced the progress of the U.S. technical community and have reduced a major barrier to production of next-generation EW, ISTA and C^3 systems."

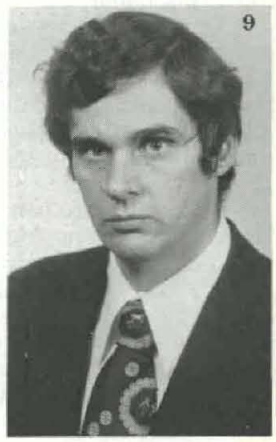
• *Mr. Paul D. Travesky,* of ERADCOM's Night Vision & Electro- Optics Lab (NV&EOL), is recognized for his significant achievement in technical

(Continued on page 12)

R&D Achievement Award Winners

U.S. Army Armament R&D Command (ARRADCOM), HQ, Dover, NJ. (1) Front—Russell D. Shelton, J. Richard Moore; Rear—E. Michael Vogel, Lawrence J. Vande Kieft and John A. Morrissey. (2) Dr. Philip M. Howe and Dr. Robert B. Frey. (3) Roland G. Bernier, Dr. Donald F. Haskell and Thomas F. Erline. (4) Orville C. Bowersox, Charles M. Dahlgren, Charles A. Senseney and Charles E. Mick Sr. U.S. Army Missile R&D Command (MIRADCOM), Redstone Arsenal, AL. (5) Front—Ronald C. Passmore and Wayne D. Jordan; Rear—Frank A. Briglia, Charles T. Jennings and Larry J. Murphree. (6) William G. Robertson, Aubrey Rodgers, E. Lynwood Bailey and David L. Jones. (7) Dr. Robert C. Sepucha. (8) Victor W. Ruwe. (9) David H. Lacy.





R & D Achievement Awards Recognize 73 Personnel

(Continued from page 10)

and managerial leadership in directing and guiding programs which have resulted in the incorporation of thermal imaging technology into Army combat vehicles.

"His superb technical judgment combined with outstanding managerial talents have resulted in the highly successful, timely and cost effective integration of the FLIR technology into Army combat vehicles."

• *Mr. Charles W. Bruce,* Atmospheric Sciences Lab (ASL), White Sands Missile Range (WSMR), NM, ERADCOM, will be honored for development of unique spectrophone systems for the measurement of atmospheric particulate and gaseous absorption.

The development constitutes a significant contribution for obtaining measurements critical to the development of electro-optical systems on the battlefield. The spectrophones will be used to determine effectiveness of electro-optical and high-energy laser systems under natural and battlefield environments.

U.S. Army Natick R&D Command (NARADCOM), Natick, MA. Three research chemists will receive the Army R&D Achievement Award for their pioneering research on the effects of irradiation of food.

This particularly includes studies on the formation of radiolytic species, on their reactions with components of food, on the influence of irradiation parameters on these reactions, and on the identity of stable products formed.

"The results of these researches provide an understanding of the irradiation process and place the safety evaluation of irradiated food on a firm basis."

The researchers are *Drs. Charles Merritt* and *Pio Angelini* with the NARADCOM Food Sciences Laboratory, and *Dr. Irwin A. Taub,* Food Engineering Laboratory.

• An individual award will be presented to *Mr. Leo G. Holmes,* research chemist with the NARADCOM Food Sciences Lab, for his development of a simple, sensitive, specific method for determining soy protein additive in ground beef.

Soy proteins are being used to an increasing extent as additives to foods, particularly to ground beef, for economic, nutritional or other purposes. Since soy protein is considerably less expensive than beef protein, determination of the soy protein content of ground beef procured by the military is important to insure compliance with specifications and price structure.

U.S. Army Aviation R&D Command (AVRADCOM), St. Louis, MO. *Dr. Dewey H. Hodges,* Aeromechanics Laboratory, was nominated and selected for developing a unique new computer program (FLAIR) for bearingless rotor helicopter aeromechanical stability analysis.

This program represents an important advance in rotorcraft aeroelastic stability analysis developed to help resolve uncertainties that arose during development of the Boeing Vertol Bearingless rotor helicopter under contract to the RTL Applied Technology Laboratory.

Using the FLAIR program, Dr. Hodges was able to provide invaluable assistance in conforming and optimizing design parameters of the Boeing Vertol design.

U.S. Army Materials & Mechanics Research Center (AMMRC), Watertown, MA. *Drs. Dennis J. Viechnicki* and *Jaroslav L. Caslavsky,* of the Metals and Ceramics Laboratory, have developed a new method of producing Nd:YAG single crystals. The Nd:YAG crystals resulting from this development are the largest known to have been produced.

They will receive the Army R&D Achievement Award for their work that will afford a considerable cost reduction in producing laser rods of the Army's range finding and laser guidance systems.

U.S. ARMY CORPS OF ENGINEERS

U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. *Drs. Mosaid M. Al-Hussaini, Lawrence D. Johnson* and *Edward B. Perry* will be honored for research leading to an improved capability for evaluating the use of reinforced earth for constructing earth structures. They conducted field and laboratory tests and developed a computer code giving an improved design procedure for reinforced earth retaining walls.

"Potential cost savings in the millions of dollars in initial construction can be projected as reinforced earth is utilized in various applications (reinforced earth costs are about one-half conventional construction costs)."

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH. *Mr. Frederick E. Crory,* research civil engineer, was recognized for outstanding achievement in providing expert advice on design and construction practices for the trans-Alaska oil pipeline. According to his citation, "His advice played a key role in the successful design and construction of this major engineering project."

U.S. Army Engineer Topographic Laboratories (ETL), Fort Belvoir, VA. *Mr. Frederick M. Gloeckler* will receive the award for the design, fabrication, test and evaluation of a revolutionary new approach to field survey. As project engineer for the Position and Azimuth Determining System (PADS), Gloeckler adapted an aircraft inertial navigation system with a computer and sophisticated software to function in a ground vehicle, the Army's jeep.

According to COL Daniel L. Lycan, commander and director of the labs, "with this remarkable system, survey time is reduced by 84 percent, while using only one-third the manpower, compared to existing field survey."

OTHER COMMANDS

U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), Alexandria, VA. *Dr. John E. Germas* will receive the Army R&D Achievement Award, posthumously, for devising and developing Embedded Training System Technology and successfully applying it for effective operation of the Army's computerized tactical data systems.

According to his citation, "Dr. Germas' work has saved the Army over 10 million dollars, substantially increased combat readiness, and, through secondary applications in government, industry, and the university community, contributed significantly to the national welfare."

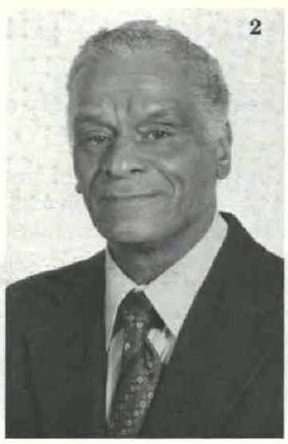
ERADCOM Awards Contract For STANO Design Models

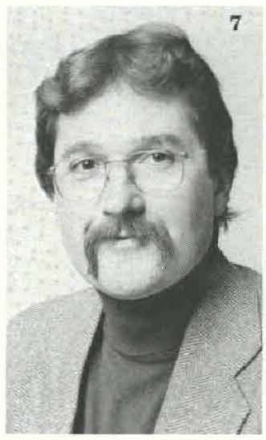
Design and development of four Stand-Off Target Acquisition System (SOTAS) engineering development models is called for in a $54,887,275 contract announced recently by the U.S. Army Electronics Research and Development Command.

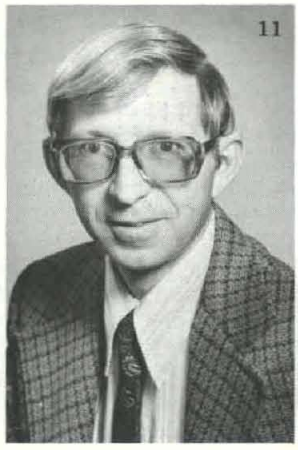
Prime contractor is Motorola's Government Electronic Division, Tempe, AZ. The major subcontractor is Lockheed Missile and Space Co., Sunnyvale, CA, and Computer Science Corp., Morristown, NJ. COL August M. Cianciolo is Army SOTAS Project Manager.

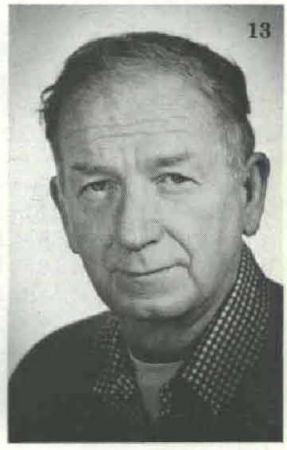
SOTAS is an airborne radar surveillance and target acquisition system. It consists of a Moving Target Indicator (MTI) radar system mounted in a YEH-60B Blackhawk helicopter. The SOTAS concept was demonstrated during the 1978-79 REFORGER European exercises.

The new engineering development models will each consist of two helicopters, and one primary and one secondary ground station. Subsequent production systems will contain four helicopters and one primary and five secondary ground stations.









Army R&D Achievement Award Winners

U.S. Army Natick R&D Command (NARADCOM), Natick, MA. (1) Dr. Charles Merritt, Pio Angelini and Irwin A. Taub. (2) Leo G. Holmes. U.S. Army Electronics R&D Command (ERADCOM), Fort Monmouth, NJ. (3) Drs. Raymond L. Filler and John R. Vig. (4) Dr. John N. Helbert. (5) Paul D. Travesky. (6) Charles W. Bruce. U.S. Army Materials & Mechanics Research Center (AMMRC), Watertown, MA. (7) Dr. Dennis J. Viechnicki. (8) Jaroslav L. Caslavsky. U.S. Army Aviation R&D Command (AVRADCOM), St. Louis, MO. (9) Dr. Dewey H. Hodges. U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. (10) Dr. Mosaid M. Al-Hussaini. (11) Lawrence D. Johnson. (12) Edward B. Perry. U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH. (13) Frederick E. Crory. U.S. Army Engineer Topographic Laboratories (ETL), Fort Belvoir, VA. (14) Frederick M. Gloeckler.

Why the Army Should Use Diesel Fuel in its Helicopters

By Anthony E. Finnerty and James T. Dehn

The U.S. Army currently uses two kinds of fuel in its combat vehicles—diesel fuel for ground vehicles such as tanks and personnel carriers, and JP-4 turbine fuel for helicopters. Diesel fuel is much less volatile than JP-4 and therefore safer. For example, the flash point for a typical Army diesel fuel is about 145°F, while for the JP-4 (like gasoline) it is below 0°F.

The volatility of JP-4 offers some advantages such as easy engine starting in cold weather. It also burns with less exhaust smoke and fewer contaminants than diesel type fuels. However, these advantages have their price not only in cents per gallon but also in increased helicopter vulnerability. This is especially true under combat conditions. In Vietnam, the records show that JP-4 fuel fire was the leading cause of Army aircraft combat losses.

Commercial airlines prefer to use Jet A or Jet A1. Jet A1 is identical to the military turbine fuel, JP-8. The flash point of this fuel ranges from about 100°F to about 130°F, so it is much less volatile than JP-4 (or Jet B as it is called in the civilian economy). Because it is less volatile, Jet A1 (or JP-8) is safer. Civilian airlines will use Jet B (or JP-4) only if Jet A is not available.

The Federal Aviation Administration has shown that when fuel is spilled during crashes the probability of fire and fatalities is less with Jet A than with Jet B, although it is still significant. Because of the extraordinary hazards of fire at sea, the Navy uses JP-5 turbine fuel in its aircraft. The flash point range and safety of JP-5 fuel is about the same as diesel fuel.

The Navy also qualifies its aircraft to operate on JP-4 fuel. Land-based as well as ship-based operations must be possible in a combined arms scenario. Since the Army uses relatively little turbine fuel compared to the Air Force or the Navy (about 3 percent of the Air Force usage), it has designed its aircraft to use the Air Force fuel, since both services engage in land-based operations.

Currently, the Air Force is considering changing its aircraft to JP-8 fuel, at least in Europe. Safety advantages are a consideration, but the driving force is greater availability of JP-8 (or Jet A1) in Europe. Civilian and the military European aircraft use JP-8 type fuel. Obvious advantages of interoperability would accrue from such a change.

If the U.S. Air Force switches to JP-8 in Europe, logistical considerations will eventually force the U.S. Army to drop JP-4. Now is the opportune time for the Army to consider switching to the only other low volatility fuel readily available worldwide, namely, diesel.

The obvious advantage of this change would be cost savings in buying fuel. Currently in Europe, the Army pays about 74 cents a gallon for JP-4. If it switched to JP-8, at today's price, it would pay $1.09 per gallon. If it switched to diesel fuel instead, it would pay about 65 cents a gallon. This would mean a savings of 44 cents a gallon. Since Army aircraft use about 125 million gallons of fuel annually, this is a savings of about 55 million dollars a year.

Diesel fuel is not only less expensive now, but is likely to remain so in the future. With projected savings of this magnitude the costs of conversion could be met. In addition to direct savings on the price of fuel, there could also be savings in logistical simplifications.

Separate storage tanks, tanker trucks and flexible pipelines must now be maintained for turbine fuel and diesel fuel to avoid contaminating one with the other. If the Army used diesel fuel in its helicopters, it could use common equipment for helicopters and ground vehicles. There is always empty or idle time in any equipment usage. However, when one set of equipment is used to handle one fuel, this idle time is bound to be less.

Certain tactical options might also become available. Today's highly mobile battlefield requires provisions for forward area refuel and rearm points (FARRPS). A typical helicopter FARRP might be set up in about 20 minutes, perhaps 20 kilometers behind the forward edge of the battle area (FEBA) to avoid enemy artillery strikes.

The tactical situation determines the location, with the goal of minimizing turnaround time and maximizing time spent over the FEBA, subject to the safety requirements. Hot refueling (engine running) is the ideal and is somewhat safer with a less volatile fuel. For example, the fear of ignition by static electricity, generated by liquid flow, is much less with diesel fuel.

Ground combat vehicles also have their FARRPS entirely separate from helicopter FARRPS. Ground vehicles have other options however. For example, highly mobile GOER tanker trucks can meet a battle tank perhaps a kilometer or two behind the FEBA for refueling. Converted armored personnel carriers, loaded with ammunition instead of people, will be able to resupply armored vehicles at the same distance behind the FEBA.

If helicopters ran on diesel fuel they might also have the option of near-FEBA resupply by GOERS and armored ammunition carriers (which also operate on diesel fuel).

The Army has adopted crash worthy fuel systems. They include safety devices such as breakaway fuel lines and fire resistant clothing to eliminate thermal hazards of survivable crashes. Foam barriers have also been incorporated to reduce the threat from rapid-fire 23mm weapons systems and missiles.

While all of these features are very helpful, there is little disagreement that a less volatile fuel, such as diesel fuel, would increase combat survivability. This would be especially true if the Army succeeds in its current effort to field a fire-safe diesel fuel. Such a fuel would contain water (and perhaps antimisting or other agents) to prevent fuel fires from destroying combat aircraft.

Such fuel, which is self-extinguishing in a spilled-fuel pool-fire situation yet operates engines efficiently, would increase survivability in war and peace. At present it is only feasible to make diesel fuel fire-safe by such techniques. Even if a fire-safe fuel cannot be fielded, diesel fuel is still a safer fuel in combat.

Another reason for switching Army helicopters to diesel fuel is because we may eventually be forced to anyway. Predictions on future fuel availability have been made by people knowledgeable in the petroleum field. They feel that in 10 to 20 years there will be a severe shortage of turbine fuels we now use, JP-8 (Jet A1) and JP-4 (Jet B).

Eventually, synthetic crude oils from shale or coal might dominate the scene. Such syn-crudes have a lower hydrogen-to-carbon ratio than the crude oils we are accustomed to. Fuels produced from syn-crudes also have a

higher aromatic content as well as other chemical differences. Basically, this means that the composition of future fuels will be closer to today's diesel fuel than to today's turbine fuel.

As the supply of high quality turbine fuel shrinks, the question will arise as to who, civilian or military, gets it. The Army must be prepared to operate helicopters on lower quality fuels. Fortunately, Army fuel handling equipment is already compatible with lower quality, more acidic fuel such as diesel fuel. However, engine modifications would have to be made.

Some modifications may have to be made soon if the Army is forced to change to JP-8 fuel in Europe. If modifications are made once, so that helicopters can operate on diesel fuel, then the costs will be incurred once. If the Army first modifies its helicopters to operate on JP-8 and later modifies them to operate on future fuels resembling diesel fuel, then capital costs will be incurred twice.

We advocate a gradual shift of the entire helicopter fleet to diesel fuel with provisions to operate also on other more volatile fuels if necessary. Navy turbine aircraft currently operate on either JP-5 or JP-4. It is well known that turbine engines can be designed to operate on almost any fuel (even powdered coal).

A program of gradual change, perhaps during regular overhaul operations, should minimize costs. These might be financed by savings on fuel prices and logistical simplifications. It is also possible that a net savings could occur if the changeover program is carried out efficiently and fuel prices continue to rise rapidly.

To someone with little knowledge of turbine engines it may seem strange to suggest operating turbine-powered aircraft on a fuel normally associated with trucks and buses. However, the Army's new tank, the XM1, is powered by a turbine engine with diesel as the fuel of preference. It is also important to note that some aircraft turbine manufacturers routinely test their engines on diesel fuel to insure they can operate at the somewhat higher temperatures generated by diesel fuel.

To someone more familiar with turbine engines, other objections may come to mind. An engine designed to start on JP-4 fuel may have trouble starting on diesel fuel (or JP-8) in cold weather (or restarting in case of a flameout at higher altitudes). This is a fair criticism, but there are solutions involving things like heated fuel lines and/or more positive ignition systems.

The Navy has solved a similar problem for its turbine aircraft which use JP-5. Cold-start requirements for Army helicopters should be no more stringent than for the XM1 tank.

Similarly, critics claim that diesel fuel leads to higher operating temperatures and more exhaust smoke. Again, these are valid objections but pose no problems that cannot be overcome by suitable engine design.

Combustors designed to burn diesel fuel efficiently, as in the XM1, have no objectionable temperature or smoke problems. If the Army succeeds in fielding a fire-safe diesel fuel containing a water additive, this would have the added benefit of lowering operating temperatures and reducing exhaust emissions.

Additionally, it is contended that most diesel fuels contain contaminants such as sulfur which can attack the metal of turbine blades and drastically shorten engine life. Normally for this to happen both sulfur and sodium are required so that the problem usually arises only near salt water. Thus, the Navy would have more cause to worry than the Army.

Sulfidation may not be a problem for Army operating conditions. However, if it is a problem, it too is soluble since turbine powered ships are designed to live with it. There is also some evidence that fuel additives exist to eliminate or reduce sulfidation problems.

Finally, critics claim that extensive modifications or a complete redesign of engine combustors and associated parts is just too expensive. Indeed, it could be very expensive. However, the required R&D is minimal since the technology involved is already very well known.

A major expense would be requalifying each engine type to operate on diesel fuel once it was modified or redesigned. This could cost 10 million dollars per engine type. It might, however, be offset by a year's savings in fuel costs, as mentioned above.

Installation costs in each aircraft would be another major expense. This also could be minimized by a long range program which takes advantage of overhaul periods, fuel cost savings, and logistical simplifications.

At this point it should be clear that a trade-off study is needed to weigh, in detail, the various advantages and cost savings that might occur. Such a cost-effectiveness study could easily take a year or two. It ought to be started soon if a preliminary assessment suggests that switching Army helicopters to diesel fuel might have merit. Such a study might bring to light factors which have not yet been considered. The authors would be grateful for comments from interested readers of this article.

In summary, the following advantages should result from switching the Army's helicopters to diesel fuel: operational costs should be lowered because of savings in the price of fuel and logistical simplifications; a reduction in vulnerability and an increase in survivability should be realized. This will be further enhanced if the Army succeeds in fielding a fire-safe diesel fuel; certain tactical options might become available; and a gradual, orderly program aimed at utilizing a diesel-like fuel-of-the-future will be less expensive than a crash program 5 or 10 years from now.

Objections involving cold starts, higher operating temperatures, smoke, sulfidation or compatibility requirements in general pose no problems which cannot be solved by a transfer of existing technology. Real problems are managerial, namely, deciding to act soon enough and carrying out a large enough program for a long enough time.

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ARI Multi-Faceted Programs Respond to Practical Army Needs

The following article on the Army Research Institute for the Behavorial and Social Sciences (ARI) was written by Mr. John R. Gorman, a contract employee of that agency. The article provides an overview of ARI's current mission and scope of effort. With its headquarters in Alexandria, VA, ARI has a 1979 budget of $22 million, is commanded by COL William L. Hauser, and has as its Technical Director Dr. Joseph Zeidner, who also serves as Chief Psychologist, U.S. Army.

The U.S. Army's principal agency for research and development concerning personnel performance and training is the U.S. Army Research Institute for the Behavorial and Social Sciences (ARI).

The chartered mission of ARI is to support Army decision-making through research, development, testing and evaluation programs dealing with personnel and manpower, training, training devices and simulation, and human factors in training and operational systems.

Among the current major concerns of DOD and ARI are people-related issues demanding special response in FY 80. DOD's special concerns include soldier problems such as adapatability and first tour attrition.

As the Army becomes more and more equipment oriented, new personnel and training goals impose new requirments. Three major ARI thrusts responding to people-related problems include research in personnel "affordability," skill retention and attrition/retention.

THE THRUST OF PERSONNEL "AFFORDABILITY" is a recognition that many major new weapons systems will be introduced into the Army inventory during the next decade. Also facing a decline in military manpower, the Army is challenged to maintain sufficient manpower and the skills and aptitudes necessary to operate highly complex weapons systems.

SKILL RETENTION is being given increased emphasis because skill deterioration is a critical problem in training. Levels of readiness depend upon continuously sustaining high-level proficiency. The Army's challenge is to add to skills and to improve skill retention for specific Army jobs.

THE PROGRAM IN ATTRITION AND RETENTION is directed at getting and keeping an adequate number of qualified soldiers in both the active and reserve force. Along with a declining military age population, a large number of enlistees are not staying to complete their first tour of duty.

How can the Army improve methods of personnel recruitment, selection, assignment and retention?

THE CRUX of the program is reviewed each year in ARI's program planning and operations. Four recent directions of Army human factors research-in-practice are a new concept of evaluation, the "manned systems" approach, incorporation of computers, and more methodological research.

CONCEPT OF EVALUATION. Fundamentally, science requires objective observation. In applied research, especially where man is a key variable, it is becoming increasingly important to have better measurement tools.

Do the end products of the man-weapons system meet the user's requirements in terms of percentages of accuracy, completeness and rate of output for a given cost?

Is it sufficient for the commander to know that Company A can probably take a certain parcel of terrain, given specified personnel, specified amount and type of training, specified work methods and specific equipment to be operated?

"MANNED SYSTEMS" APPROACH. This is the logical outgrowth of seeking better selection and training techniques, as well as more effective and sophisticated measures for evaluating performance. The "manned systems" approach takes in the whole picture. The goal of such research—the measurement of the total man-machine output—is fast becoming the concern of all military behavioral and social scientists.

The ultimate product application/payoff potential of such an approach is the cost-effectiveness of projected weapons systems and reduced lead time in the design, development and acquisition process. Due to the rate of change in scientific development, systems are often obsolete before they are completed.

One solution is to use simulations, often with the aid of computers. Simulation requires system interaction and recasting among other scientists to find general principles applicable to whole families of systems.

Personnel affordability is another logical product outcome of the "manned systems" approach. If researchers project affordable weapons systems accurately, one can project the personnel and training requirements to man them.

INCORPORATION OF COMPUTERS. Computers contribute both to experimentation through simulation and data processing, and to the evaluation of results. Computers can be used to train individuals, to maintain skills and to provide hands-on experience. When scientists integrate these programs into the target computer systems by means of computer-assisted instructional packages to reinforce learning and actual performance, the term "embedded" training, the use of the system itself to train operators in performing their duties, applies.

This type of training generates three savings factors: hands-on familiarization and learning reinforcement which prevents loss of perishable skill; reduction of personnel needed as instructors; and reduction in the number of computers needed and associated maintenance costs.

MORE METHODOLOGICAL RESEARCH. This type of research is continuously needed to effectively treat a huge number of variables that must be considered together. In addition, it is crucial in simulating environmental factors to achieve "real world" situations. Such practice breaks research into different but related elements for the purpose of analysis.

The trend is in the direction of "real world" experimentation. Newly developed product-applications include collective training or training without using a job or school model; organizational effectiveness in such areas as sensing, decision-making, communicating decisions to the people, and perceiving people's responses within the organization (including social behavior and personality); 2-sided, free-play, realistic engagement simulation/battle simulation; and operations research and testing/evaluation under maximum recreation of battlefield conditions.

The main program framework of research planning and development at ARI consists of basic research, exploratory development and advanced development, categories similar to those used in materiel development.

THE BASIC RESEARCH program typically consists of fundamental research needed to support scientific practices and professions. This program provides a reference base for the exploratory and advanced programs which draw upon it and shape its evolutionary development.

EXPLORATORY DEVELOPMENT, along with the basic research category, addresses identified areas in which there is insufficient scientific knowledge. Scientists formulate scientific principles and identify factors which limit research. As the exploratory development program succeeds in advancing the outer limits of knowledge and techniques, scientists implement products directly into advanced development research needs or use products to support and facilitate research methodology and technology.

ADVANCED DEVELOPMENT applies scientific knowledge gained from basic research and exploratory development to current or potential field problems and to demonstration or validation of operation-

al utility. Research, in part, is responsive to a user requirement as stated in (1) the Sciences and Technology Objectives Guide (STOG), (2) a Human Research Need (HRN Advisory Statement), or (3) a jointly approved DOD program.

Any project may begin in any one of these program areas, or have an impact upon or spin off into others. This depends upon DOD requirements, Congressional guidance, user needs, stages of R&D, and payoff potential. Recycling and recasting of program/projects, along with interdisciplinary overlap, is a way of life in military behavioral and social science. This daily vision and revision process is necessary to keep pace with the timely needs of Army users and sponsors served by ARI, and to secure cost saving from the most up-to-date research.

THE SPECIFIC FY 80 mission in personnel performance and training stresses better Army-wide training and troop management. To address these human factors, ARI conducts its advanced and exploratory development RDTE in four primary areas recommended to Congress by DOD: Human Factors in Training and Operational Effectiveness; Education and Training; Manpower and Personnel; and Training Simulation.

HUMAN FACTORS IN TRAINING AND OPERATIONAL EFFECTIVENESS is particularly systems-oriented. It includes enhancement of aircrew tactical performance, problems of rotary wing flight training and performance—especially nap-of-the-earth flight—and increasing man-machine capability for future battlefield command and control systems. Projects in this area include:

• *XM1 Tank.* The Fort Knox field unit supports the Armor Center in developing training simulations for the XM1 tank. The main research tasks are directed at how to maximize the value of simulation in XM1 training programs and how to identify needed modifications or major deficiencies in proposed simulation concepts. This effort includes detailed analyses of training capabilities, design of evaluation concepts, and specifications of prototype training programs. Also included is a review of planning and reporting documentation for tests. Projects will be rigorous and comprehensive test designs and improved training simulators in XM1 training programs.

• *TACFIRE.* Computerized fire control of field artillery represents an important innovation in how artillery will be controlled in the modern battlefield. Operators and users of the system must be able to interact with the TACFIRE computers. TACFIRE operators learn with equal or better results through "embedded training" rather than through traditional classroom methods. The payoff is savings of over $14 million in classroom instructors planned for use at Fort Sill.

• *Antitank Guided Missiles.* Integrated with ARI research in human factors, research on selection and training is a key part of the Army's antitank missile gunnery program. The Army must choose qualified gunners who can best "track" an enemy tank and accurately point the tracker while simultaneously firing the missile and "holding to" target for the 10 to 20 seconds it takes the missile to strike.

Payoff application of antitank gunnery selection and training lies in the savings of the extremely high cost of one missile—$4,000—and in maximizing efficiency in performing the extremely difficult tracking and gunnery task.

EDUCATION AND TRAINING seeks to improve "efficiency and economy" of enlisted training, readiness posture of active and reserve forces, use of the computer as a delivery system, and the Army's capability of delivering effective training to units. These projects include:

• *Basic Skills Education Program.* When do basic skills need to be taught, and how should they be taught to improve the performance of military duties? Many of our soldiers are not prepared to meet basic skill requirements of training and post-training. Traditional "three R's" is the job of the schools. Army skills are needed now, and where they are lacking, there must be training. Therefore, the Army conducts computer-assisted training research to cut the cost of teaching these basic skills and to make better use of the less skilled enlistee.

• *Nap-of-the-Earth.* The danger of flying a helicopter among trees and foliage especially at night, is self-evident. Skillful manipulation of the aircraft is required. Such flight must also take into account special perceptual considerations under restricted visibility. Current research compares the perceptual effect of vision with the naked eye with that of goggled vision. The most effective training between these two methods will be packaged for initial pilot training. Saving one UA-1 helicopter and its crew amounts to $1.22 million.

MANPOWER AND PERSONNEL concerns are summed up in the following general research questions: How do doctrinal and technological change impact with adaptability of personnel, acquisition and utilization? What motivates individuals with potential to enter and stay in career military service? How does the Army integrate organizational requirements with the individual's career progression needs? Some current research projects in this area are:

• *Military Applicants Profile* (a paper and pencil selection test designed to screen out "motivational failures" before they enter the Army). Preliminary tests have been given to several thousand soldiers who are now in initial stages of basic training. Preliminary research results indicate that motivational failures can be reliably identified before enlistment. A 20 percent reduction of "flunk outs" in initial training and a savings of $12 million is projected.

• *Command Group Performance.* ARI supports the Combined Arms Combat Development Activity in developing methods of measuring training readiness. Ultimately, this will be used to predict combat effectiveness of battalion and higher command groups. The research issue is how command post group performance in battle simulations relates to battlefield success. Projects will be a methodology for determining the effects of command group proficiency on combat outcomes, and a basis for rapid screening of new tactics and doctrine.

TRAINING SIMULATION programs help develop general concepts that are testable for whole families of automated systems, simulated systems and training devices. These include engagement simulation/battle simulations, training effectiveness analyses, and plans for applying "embedded" training to units.

One example is the *Multiple Integrated Laser Engagement System (MILES).* ARI supports the Training and Doctrine Command System Manager for Tactical Engagement Simulation to improve the quality of tactical training for combat units. MILES represents a significant advance over existing engagement simulation techniques and will permit tactical training of all types of combat units through battalion size. ARI scientists are developing a MILES exercise control system (involving personnel, procedures, and equipment) to be tested in the field along with the MILES equipment. After refinement, further testing will be conducted. The product of this research will be an exercise control system which, along with MILES equipment, will be implemented in all Army divisions starting in June 1980.

As an organization, ARI has been structured to correspond to the above major thrusts; two technical areas have been reconstituted to reflect training and simulation, and two to reflect personnel and manpower problems. In addition, a tenth field unit has been opened up to focus on personnel management and personnel issues. Concurrent with the reorganization, the staff has been redistributed so that half of ARI scientific personnel resources are in the field to facilitate a continuous dialogue with the user. Field units are located at Fort Hood, TX; Fort Leavenworth, KS; Fort Rucker, AL; U.S. Army Europe; Fort Sill, OK; Fort Benning, GA; Fort Bliss, TX; Fort Knox, KY; the Presidio of Monterey, CA; and Fort Benjamin Harrison, IND.

ARI's expertise is available to the Army in the field, as well as in headquarters elements, through an increased emphasis on Technical Advisory Service (TAS) which

promotes enhanced transfer of technology. At the present, up to ten percent of ARI's applied program is devoted to such TAS, particularly in its contributions to systems under ASARC (Army System Acquisition Review Council) review. During 1978, ARI made significant contributions to 15 major ASARC actions regarding manpower and personnel issues.

In addition to the above-mentioned influences on ARI's program development, an accomplished historical tradition underlies Army human factors research. Research in military behavioral and social sciences began through a chance event. On 16 April 1917, in Emerson Hall of Harvard University, a group of experimental scientists was in the midst of a meeting called to assist the defense effort. A messenger burst in with a grave announcement—the country had just entered the war. Dr. Yerkes and his colleagues suspended the meeting. There followed a series of actions laying the foundation for the future of military behavioral and social science.

Organized efforts in this field began under CPT Yerkes of the Sanitary Corps in the spring of 1917 with the problem of classifying skills of enlisted men. This practical and timely action became the cornerstone of the efforts still characteristic of military behavioral and social science today.

The day when events determine the direction of major research programs is probably over. Many disciplines have been brought together in an integrated attack on broad problems. Many different research organizations have developed, each devoted to an isolated segment of Army human factor problems—selection, training, rehabilitation, human engineering, operations research.

Organizational changes began. Agencies applied broad concepts to achieve more comprehensive solutions through the use of integrated scientific approaches. A full-fledged program of research planning began, fostering orderly development. Cross-discipline exchanges helped bring about a much more sophisticated systems-oriented approach, pervading all elements of management research.

Structurally, organizations whose main concern is human factors research have clearly been upgraded since World War II. The oldest group—now known as the U.S. Army Research Institute for the Behavioral and Social Sciences—started in July 1940 as a unit, later becoming a section of the Army's Classification and Replacement Branch. This section became the Personnel Research Branch in 1953. In 1961, it became the U.S. Army Personnel Research Office, under the Chief of Research and Development, and in 1966, it became a laboratory.

Three years later, three new groups formed: the U.S. Army Manpower Resources R&D Center (MANRRDC), the U.S. Army Motivation and Training Research Laboratory and the U.S. Army Behavior and Systems Research Laboratory. Then, in 1972, the U.S. Army Research Institute for the Behavioral and Social Sciences put all operational behavioral and social science R&D efforts of the Office of the Chief of R&D under one unified headquarters.

Aligned with command and direction at ARI are the scientific coordination offices of TRADOC, FORSCOM and Europe. Directly descending from the command and direction of ARI are the Administrative Support, Comptroller's, Technical Standards and Plans/Programs and Operations offices, and the research laboratories and field units. ARI's research laboratories consist of the Organizations and Systems Research Laboratory and the Personnel and Training Research Laboratory.

The people staffing the HQ Army Research Institute combine a most interesting range of diversity, background, and scope of professional/technical and administrative experience.

Although army research in military behavioral and social science is less crisis-determined today than at its inception, the Army's research programs continue to be shaped primarily by actual Army needs. All research programs in military behavioral and social science lend critical support to individual readiness and mission effectiveness. No matter what the degree of urgency, ARI's research and development is always related to the Army's practical needs and problems.

Continuous programs at ARI to meet the complex needs of the Army it serves, and those of the wider research community, are essential to providing the United States with an efficient and effective military force with high morale, ready and able to defend our country.

XV15 Makes First Flight in Airplane Mode

The XV15 tilt rotor research aircraft, being developed by Bell for NASA and the U.S. Army Research and Technology Laboratories (AVRADCOM), made its first in-flight conversion from helicopter to the airplane mode on 24 July.

The historic flight was made by Aircraft No. 2 at Bell Helicopter Textron's Arlington, Texas, Flight Research Center.

Lasting approximately 40 minutes, the flight included forward speeds of up to 160 knots at altitudes of up to 3,500 feet above ground level. Climbs and descents, accelerations and decelerations, and turns were also demonstrated during the flight.

Flight testing of the second XV15 began on 23 Apr. 1979. Conversion of the nacelles from helicopter mode to the airplane mode was performed gradually during a series of flight tests. These tests included conversion from 90 degrees (helicopter mode) in increments of 5 degrees to 0 degrees (airplane mode). Approximately 15 flight hours were logged on Aircraft No. 2 before it made its first full conversion.

Aircraft No. 1, which made its initial hover flight on 3 May 1977, completed six weeks of successful wind tunnel tests in June 1978 at the NASA-Ames Research Center, Moffett Field, CA.

"These tests defined the initial envelope for flight tests on the second XV15," said Mr. Kenneth G. Wernicke, tilt rotor project engineer at Bell.

According to Wernicke, envelope expansion of Aircraft No. 2 will continue for the next several months. Cruise speed demonstration of up to 300 knots is planned.

The tilt rotor is expected to combine the best features of helicopters and conventional airplanes for fast point-to-point transportation. Research on the tilt rotor concept began in 1953 when Bell received a joint Air Force/Army contract to build the XV3 convertiplane. This early model proved feasibility of the concept, operating in both hover and forward flight modes, and demonstrated the ease of conversion.

XV15 in Airplane Mode *Photo by Bell*

TECOM Scientists Measure Radiation Protection of XM1

The first experimental determination has reportedly been made of the initial radiation protection of an operational XM1 pilot vehicle. "An accurate determination of the personnel protection or shielding is basic to all other nuclear survivability, vulnerability and hardening analyses," according to Dr. A. H. Kazi, project engineer of the Radiation Shielding Program at the Pulse Radiation Division, Materiel Testing Directorate, U.S. Army Test and Evaluation Command (TECOM), Aberdeen Proving Ground, MD.

The measurements were made by two teams of TECOM scientists at the Army Fast Burst Reactor Facility at White Sands (NM) Missile Range, and at APG, respectively. WSMR tests were directed by Mr. J. H. O'Kuma, with technical support from Dr. T. F. Luera of WSMR, and Prof. J. L. Meason of the University of Arkansas. The APG team consisted of Dr. A. H. Kazi, Mr. R. C. Harrison, and Dr. C. R. Heimbach, all of MTD.

Reactors were operated outdoors and thus provide a good simulation of the neutron and gamma radiation environment produced by tactical nuclear weapons. These reactors are operated at low steady state power. They can simulate the type, and energy and angular distribution of the radiation found in tactical nuclear environments, but not the magnitude.

Simulating the magnitude is neither permissible from a safety point of view nor necessary for shielding measurements. These reactors are laboratory devices which do not contaminate the environment or the test vehicle. Furthermore, their operations pose no threat to either the general public or the operating crews.

The APG reactor is operated 14 meters above ground to simulate an air-over-ground tactical burst. According to Dr. Kazi, considerable care is necessary to assure the test environment is properly characterized and represents a realistic simulation of an actual burst.

According to O'Kuma, it was necessary to test the tank as far from the reactors as instrumentation sensitivity and reactor steady-state power would permit. This was done to simulate the weapons spectrum and neutron arrival angles as closely as possible. A distance that met these conditions, and for which a detailed computer calculation existed (170 meters), was used at each reactor facility.

Additionally, measurements were made at WSMR at distances of 635 and 1,010 meters to determine the effect of range on protection factors. At APG, measurements were also made on an M60A1 and M60A2. These are compared to the XM1.

Different dosimetry or radiation measurement techniques are used at WSMR and APG. This is to increase confidence in the results. The environment can have significant effects on the shielding properties of a vehicle. These are difficult to estimate theoretically.

"The terrain and weather at APG are not that different from Western Europe," observed Dr. Kazi. "One should make measurements in adverse weather conditions such as snow," he adds. Similarly, WSMR offers ideal desert terrain and weather.

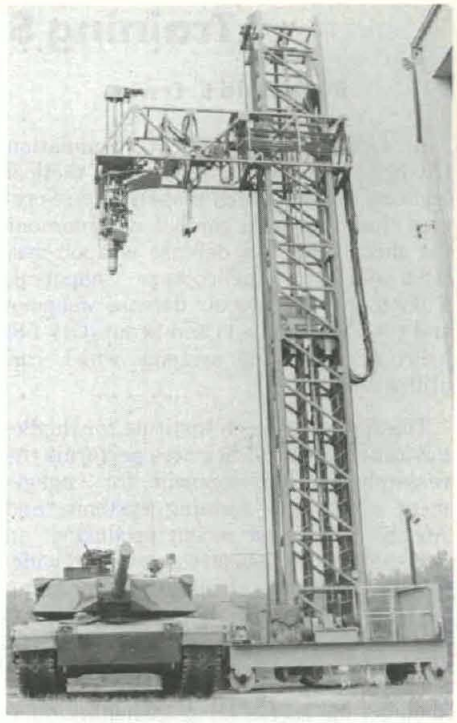
The TECOM team is working in close cooperation with Dr. A. E. Rainis and his team at BRL, who are modelling the reactor experiments. It is thus possible to validate theoretical models used to calculate initial radiation transport and shielding. It is also possible to identify key variables which require experimental tests.

Additional spectrum and protection factor measurements are being performed this summer. During the same time frame, WSMR is determining the survivability and vulnerability of the electronics of the XM1 to a radiation environment.

The initial radiation protection afforded to the crew will be determined. Also, the theoretical models presently used will be tested, and the nuclear susceptibility of the electronics will be established.

"Nuclear survivability" says Dr. Kazi, "is a growing concern of worldwide proportions, which prudence dictates us not to avoid. There is increasing cooperation with West German and Canadian scientists, and considerable progress has been made to understand the problem and find solutions."

Dr. Kazi concludes that "the first step has been completed. Radiation protection afforded by several armored vehicles has been determined and will be analyzed in some depth. At this time, crew survivability is the controlling factor and probably will remain so. We can and must improve the chances of crew survivability and I believe this can be done in a practical and cost effective manner."



XM1 pilot vehicle is positioned underneath reactor that simulates the initial radiation environment produced by tactical nuclear weapons, during tests to determine survivability and vulnerability of Army weapons systems at Aberdeen Proving Ground, MD.

Army to Test Wooden Windmill

In June 1980, at a site to be selected, a giant windmill capable of producing 2,500,000 watts of power will be operational, as part of a Department of Energy initiated research program looking at wind power as an alternate energy source. The windmill, almost as tall as a 40-story building will have 300-foot wooden rotor blades weighing about 45,000 pounds.

Full-scale wooden blade sections have been fabricated under a NASA contract. The Applied Technology Laboratory (ATL), U.S. Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, VA, has supported NASA in research on the fatigue behavior of these blade sections.

Recently, ATL completed testing of the blade sections to determine the effectiveness of the root end attachment, which consists of 24 studs arranged in a circular pattern. After a simulated operational load, the studs failed from apparent bending fatigue. Modifications and additional testing will be necessary to eliminate the stud failure.

The construction of blades for a windmill of this magnitude presents challenges to fabrication and cost, with wood appearing to be a strong contender to meet these challenges. Epoxy impregnation and laminating techniques, developed over the years for the boating industry, have eliminated many of the problems experienced with wood in the past.

Wood is basically an excellent structural material; however, it is subject to rot. It can be dimensionally unstable and variations within a single tree, can provide difficult quality control problems. Fortunately, the epoxy impregnation and laminating techniques are conducive to low-cost windmill construction.

In addition to contributing directly to energy research, this effort may have spin-offs in the design of low-cost blades for helicopters. Wood was used for many years in helicopter blades, but they too were plagued with the same quality control problems. If the problems can be solved, wood may regain a place in helicopter technology.

Training Simulations for Air-Ground Combat

By Donald E. Erwin

Air-Ground Engagement Simulation (AGES) is a newly developed tactical training system which realistically re-creates the air-ground combat environment for short range air defense weapon systems and attack helicopters. Chaparral, Vulcan, and Redeye air defense weapons and the Cobra (AH-1) and Scout (OH-58) helicopters are the systems which can utilize AGES.

The Army Research Institute for the Behavioral and Social Sciences performs the research and development for engagement simulation training systems, and AGES is the most recent product of an R&D effort that has already yielded widely used engagement simulation training systems for infantry squads (SCOPES) and combined arms units (REALTRAIN).

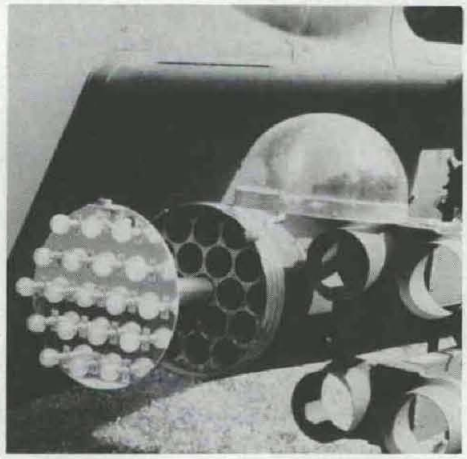
The sponsor is the TRADOC System Manager for Tactical Engagement Simulation in the Training Support Center at Fort Eustis, VA. Primary proponent of AGES has been the Directorate of Training Development at the U.S. Army Air Defense School, along with the Armor Aviation Directorate at Fort Knox, KY. Engagement simulation training systems have three important components: signature simulation; near to real-time casualty assessment in realistic free interplay with the "enemy"; and after action reviews.

AGES trainers equip air defense weapons and attack helicopters with devices to simulate weapon firing. The Cobra attack helicopter has simulators for its 2.75-inch rocket, 7.62mm minigun, and TOW missiles. Camouflaged air defense weapons have simulation devices primarily to realistically disclose their positions when firing. Helicopters have the same devices to disclose position while unmasking and firing during nap-of-the-earth flight.

Authentic position disclosure is important for realistic interplay between air and ground elements. Realistic interplay means air defenders and aviators have to execute the correct tactical behaviors to "kill" rather than "be killed."

Alert helicopter pilots seeking targets will see the brief flash and smoke of a simulated Chaparral missile launch when the AGES simulator is fired. Unless the Chaparral quickly displaces to an alternate location, fire from a Cobra can be brought to bear on the disclosed position.

Similarly, the air defender scanning the horizon may not see the Cobra hovering at tree level 1,500 meters away. However, if alert, he will see the flashes simulating rocket-launch. He can then have Vulcan rounds put on that location.



FLASHBULBS are used to simulate firing of 2.75″ rockets on the Cobra attack helicopter. The signature simulator is installed in a rocket pod in less than 15 minutes.

Casualties are assessed via a network of controllers that communicate with a centralized ground control station, consisting of an air defense controller, an aviation controller, and a senior controller. Using an exercise map with marked locations of ground and airborne weapon systems, the controllers in the ground control station process acquisition and kill information according to rules.

The controllers then designate air defense weapons as suppressed (firing suspended) or dead (smoke grenade ignited and activity suspended), or, helicopters as dead (via a smoke grenade ignited on the skid of the aircraft).

The senior controller uses the acquisition and kill information that comes into the ground control station to conduct an after action review. Air defenders and aviators exchange information on what went wrong or right, and why. The senior controller facilitates, but does not control, this discussion with a chronological list of critical exercise events.

From the after action review, trainees learn what error caused them to be "killed." They learn what to do in the next exercise where they will have a chance to try out, and to practice more proficient tactical behaviors. They also learn from mistakes and successes of other crews they were unable to observe.

AGES passed its first field test at Fort Bliss, TX, in 1977. This test evaluated engagement simulation for short-range air defense squads and rotary wing aviation. Casualty assessment and exercise control procedures, data collection and performance measurement methods, and signature simulators were all evaluated. ARI scientists and Air Defense School training developers determined what system components required refinement.

ARI, with support from the 8th Infantry Division, conducted a second, more comprehensive test of AGES in USAREUR in 1978.

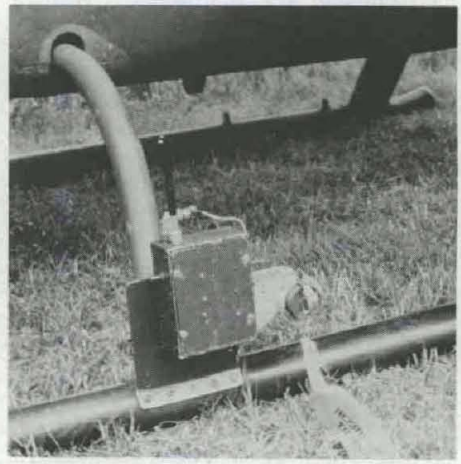
The USAREUR test compared tactical proficiency attained, with and without AGES training, through a program of eight exercises. Four Chaparrals, four Vulcans and four Redeyes constituted the total air defense force in the field. Scientists assigned two squads of each air defense weapon system to the AGES training program, and two to conventional training.

AGES and conventional squads shared the same scenario, mission orders, and aggressor team of three Scouts and two Cobra-TOWs. However, the conventionally trained squads had neither signature simulators, casualty assessment, nor after action reviews. For aviation, scientists assessed the impact of AGES exercises on Cobra-Scout cooperation and tactical coordination.

Field exercises were characterized by 2-sided, free play and realistic interaction. Air defense squads were randomly chosen and assigned to either conventional or AGES training for each of two successive weeks. Aviation aggressors came from a pool of 10 aviators. They remained with the test the entire 2-week period.

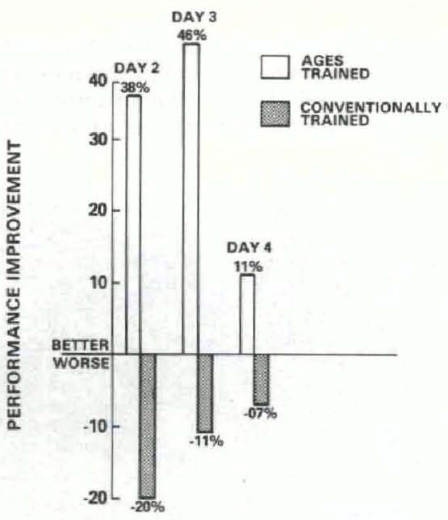
Both the air defense battery commander and the aviation team leader were briefed using a simulated operations order. This tactical plan allowed unit leaders to exercise their own tactical initiative and judgment. It also created a realistic air defense of a critical asset against the aviation aggressor moving through that zone. AGES and conventional squads received the same tactical input.

Each Cobra-TOW and AGES air defense



SMOKE GRENADE, mounted on the skid of an aircraft, is ignited via a coded radio signal to immediately confirm the "kill" to the engaging air defense squad.

TABLE 1



CREW PERFORMANCE CHANGE (%) AFTER THE FIRST DAY OF TRAINING

weapon had signature simulators, allowing authentic position disclosure.

Enlisted men and junior officers from air defense and aviation battalions controlled operations and assessed casualties and collected data on each AGES exercise. Controllers estimated when the target aircraft was in range and determined whether the squad achieved a "kill." They used a probabilistic method based upon characteristics of the different weapons system. If the air defense controller received a "kill" message, he informed the senior controller who then activated a smoke grenade on the "killed" helicopter.

After each exercise participants were brought together for an after action review led by the senior controller. Using the data gathered, the senior controller reconstructed the exercise and asked individuals and squads involved in the action what they might have done right or wrong.

Such free exchange of information between sides, accompanied by the friendly spirit of competition developed in the exercises, allowed the soldiers to recognize correctly executed tactical behaviors. In turn, this friendly exchange later discouraged the repetition of those behaviors that were ineffective.

Controllers with both AGES and conventionally trained air defense squads used a combination behavior checklist and rating form that focused their attention on over 50 specific behaviors associated with proficient tactical performance. These behaviors ranged all the way from planning air defense, e.g., "Did the squad know its tactical mission?" to conduct sustaining operations, e.g., "Did the squad displace to alternate locations after firing?"

Behaviors selected for these checklists came from the appropriate training and doctrinal literature for air defense artillery. How much Chaparral and Vulcan squads improved, on the average, in tactical performance relative to the first day of data collection, is shown in Table 1.

Controllers reduced ratings and behavior checklists to a summary score for each squad and then averaged these over squads and weeks. Since squads were chosen randomly from the battalion, they were not matched on baseline performance.

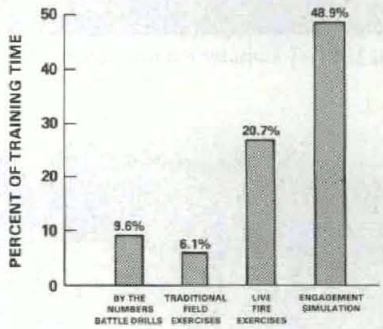
AGES squads show consistently more proficient execution of tactical behaviors than conventionally trained squads. Conventionally trained squads did not even perform as proficiently on subsequent days, as the first day they were in the field!

One might ask why conventionally trained squads show a decrease in performance, relative to the first day of training, in contrast to AGES squads which show improvement? One possibility is the frustration and boredom generated by "dry firing" at invulnerable aircraft with no possibility of positively confirming a "hit." This decrement became less on the third and fourth days, which suggests that perhaps some training effect occurred but never really overcame the initial negative experience.

AGES provided a more efficient training vehicle for the air defenders, and they realized it. When squad leaders and controllers were asked how they would divide their training time between four alternatives, they gave AGES the largest portion—on the average, twice as much as live fire, as shown in Table 2.

In the AGES USAREUR test, the collected data that described the development of tactical proficiency in air defense personnel indicated that AGES training produced greater positive changes in combat behaviors than a conventional training program. Over and above their improved tactical performance, exercise participants perceive AGES training favorably, and scientists were able to clearly demonstrate positive effects on attitudes and level of enthusiasm.

TABLE 2



LEADERS AND CONTROLLERS QUESTIONAIRE

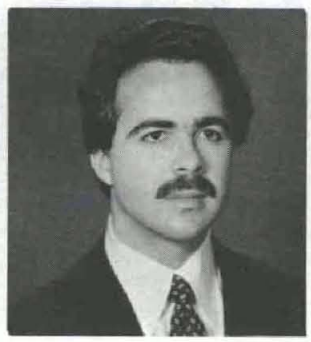
"IF YOU HAD LIMITED TIME FOR A TRAINING PROGRAM, HOW WOULD YOU DIVIDE YOUR TIME?"

Performance measurement instruments that were developed were capable of showing the growth of tactical proficiency in air defense squads undergoing field exercises. These instruments can eventually be used in portions of ARTEPs where development of squad tactical performance is emphasized.

Soldiers become better air defenders when they are exposed to AGES training. Engagement simulation for air defense has been shown to be a valid and effective training approach.

How and when will AGES be available to units? The current plan calls for a preliminary implementing of AGES at the Air Defense School at Fort Bliss by creating a repository of AGES equipment and expertise. The School would then have several sets of AGES equipment that could be used by a mobile training team to conduct training programs with units requesting AGES experience.

This approach is currently under study by the Directorate of Training Developments at Fort Bliss. Milestones for this implementation strategy are being established by the Air Defense School, the TRADOC System Manager for Engagement Simulation, and the Army Research Institute.



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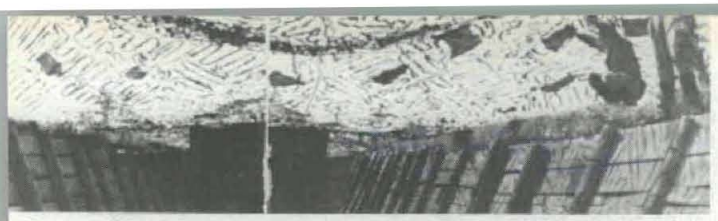
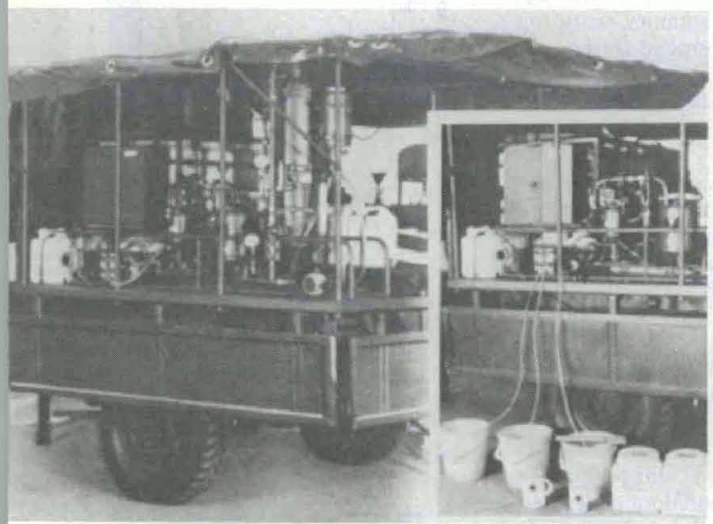
Foreign Combat Er

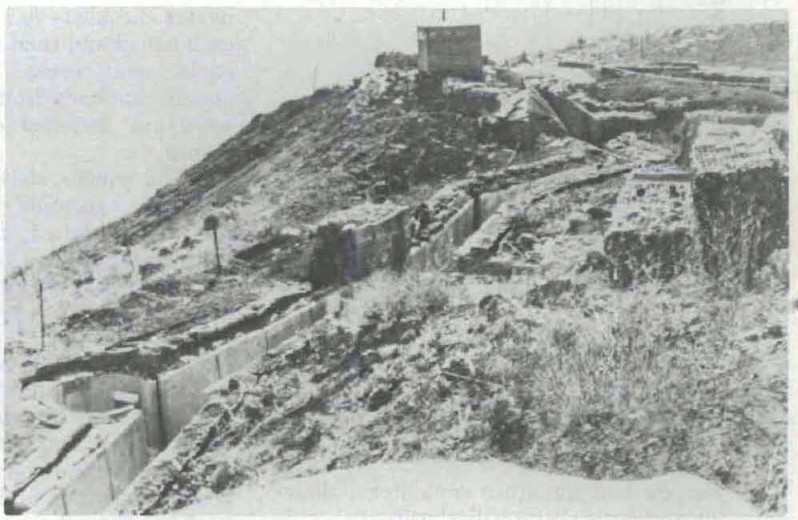
Fifth in a series of photospreads of the U.S. Army Foreign Science & Technology Center's review of foreign weapons and tactical vehicles. May-June displayed the Russian Infantryman's arsenal of weapons; March-April pictured 14 foreign infantry fight-



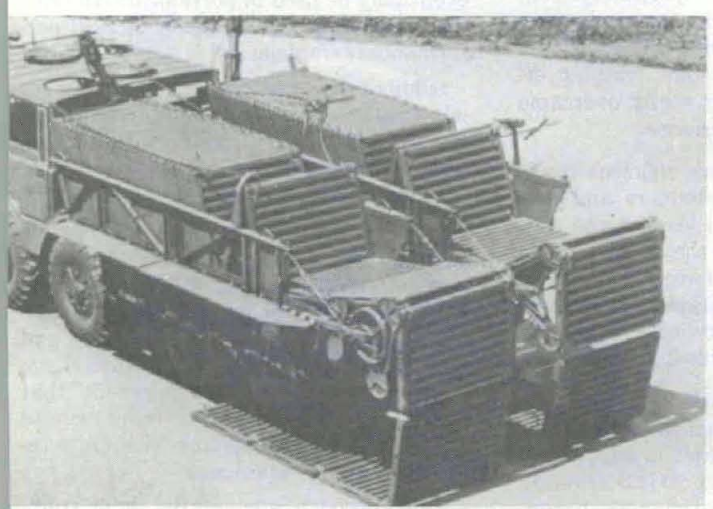
Soviet MKT–T summer camouflage net being erected over a vehicle revetment.



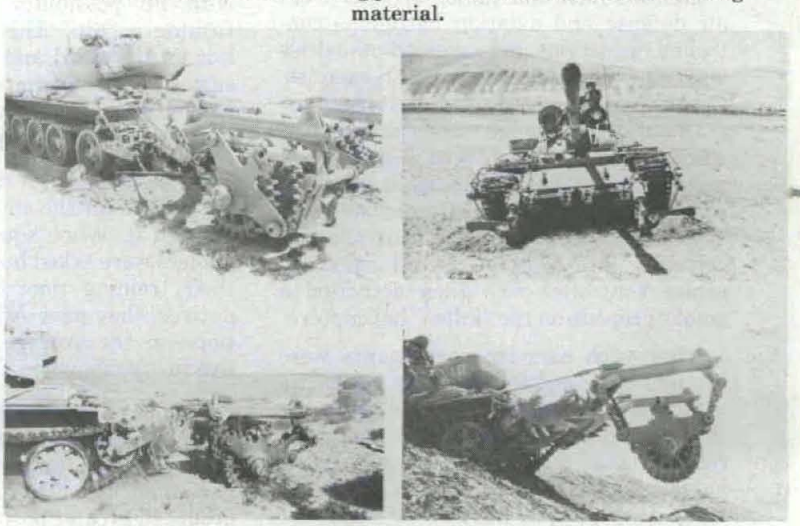
East German WFS–2 trailer-mounted water filtration station.



Israeli field fortifications using precast concrete slabs as reinforcing material.



Czechoslovakian truck-mounted roadway laying system.



Soviet KMT–5M mine plow and roller combination attached to a tank for minefield breaching.

Czechoslovakian AM–50 truck-mounted bridge.

Soviet GSP amphibious ferry carr

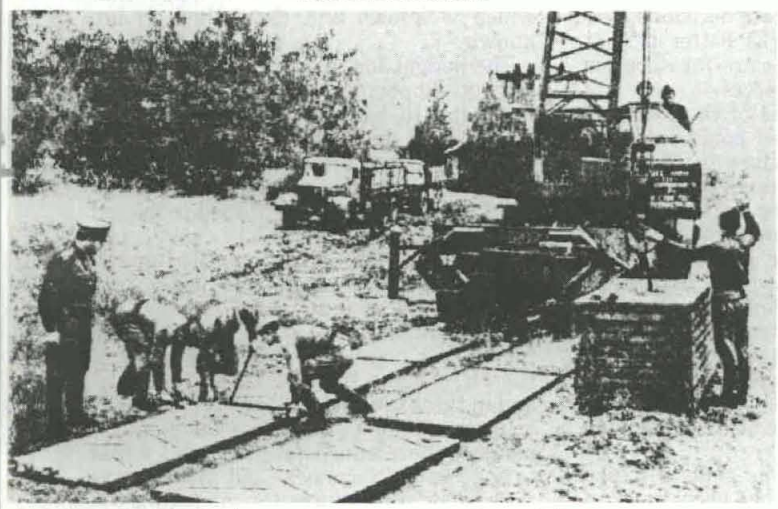
gineer Technology

ing vehicles; September-October, 1978, showed some recent advances in foreign transportation technology; March-April, 1978, features photos of the 1977 Red Square parade.

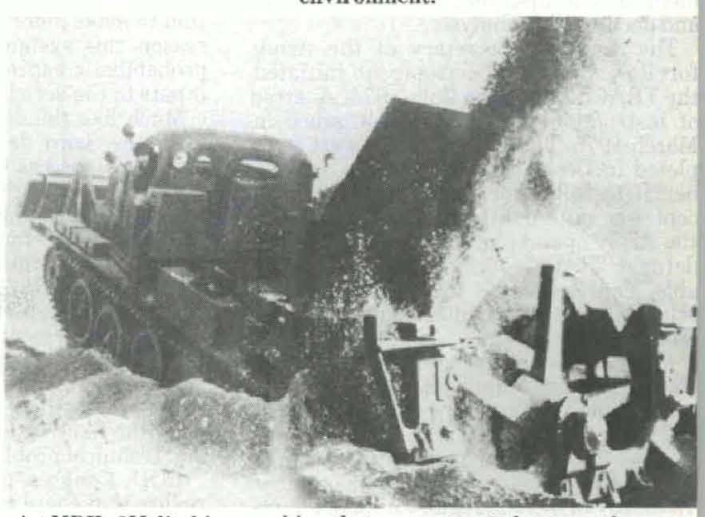
Soviet TM–57 antitank mine with tilt-rod fuse.

Polish combat engineer recon party in winter-white camouflage uniforms and helmet covers.

Soviet IMR engineer tractor performs multicombat construction task i environment.

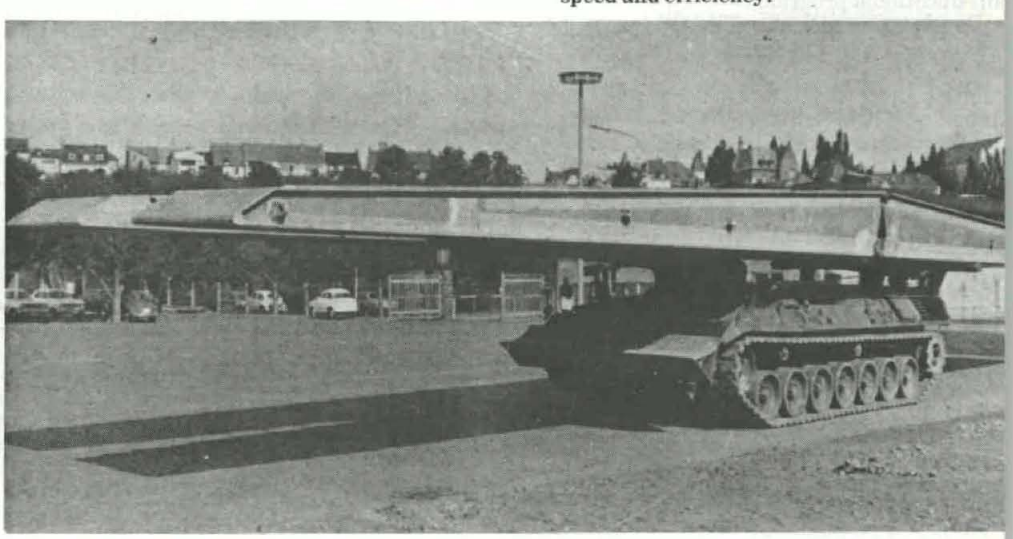


Soviet precast concrete roadway slabs.



Soviet MDK–2M ditching machine that can excavate large earth areas v speed and efficiency.

ing the East German BLG–60 bridge.



West German "Beaver" AVLB.

ARMY RDTE FUNDING, PLANNING, & MANGEMENT

"Total Risk Assessing Cost Estimate (TRACE)" Concept

By John M. Cockerham

The Total Risk Assessing Cost Estimate (TRACE) concept is an Army money management system that encompasses management science methods, procedures, controls, and continuing education. The concept is directed toward effective management of the Army's R&D dollars. Its objective is to reduce development time and costs, and increase productivity.

Cost effective management innovations have recently become fashionable, but very few creative ideas have been exploited and implemented. One of the greatest deterrents to solving management problems and implementing solutions is finding the focal point in the government that can think across agency boundaries, and ultimately, take action.

In the Army's case, the TRACE concept originated in the Office of the Secretary of the Army. However, the evolutionary development of the concept began with DOD Directive 5000.1, and an Army program called PROMAP 70. As a result, the Army, in 1972, promoted the development of the disciplines of risk analysis and decision risk analysis.

The Assistant Secretary of the Army for Research and Development initiated the TRACE concept in July 1974. A letter of instruction to the field was issued in March 1975. TRACE guidelines were completed in December 1976, and in December 1978 full implementation of the concept was initiated. During 1976 to 1978, the Army operated under a rather loosely defined TRACE concept, but gained valuable experience in the application of scientific methods and management controls.

From the industry side, several major contractors have applied the management science methods in their proposal and contractual efforts. They achieved favorable results. TRACE implementation for the Army will be completed in September 1979. It will include regulatory matter, revised guidelines, computer software and an educational program.

Development of the TRACE concept was directed primarily at the ways and means of coping with management uncertainties and risks. Too often, improbable, unplanned and unwanted events that "cannot occur" do occur! Results are always unpleasant and often fatal to projects that do not offer any strategies for dealing with the unexpected. Of course, the more complex the project the more likely such surprises will occur.

The first step for management was to accept the fact that major uncertainties and risks are associated with every development program. Next, was to stop worrying about the unknown and start planning for it.

Current management science techniques helped quantify cost, schedule and performance risks. These techniques addressed program costs and schedules of all planned activities and the probabilistic cost/schedule impacts resulting from technical and other program uncertainties. Once the uncertainties were quantified they could be managed more effectively to reduce or eliminate unfavorable cost and schedule impacts.

The question arises then, can probabilities be used effectively for decision making? There are certain types of decisions that must be based on probabilistic assertations. For example, approximately 10 years ago we all made decisions on our outdoor activities based on weather forecasts that either predicted "rain" or "no rain." Such predictions were made confidently and in simplistic terms everyone understood. The only problem was that the information was insufficient and could not be trusted for decision making.

In the past, weathermen were mistrusted throughout the United States. Finally, forecasters began to give weather information in terms of probabilities. This is now commonplace and the general public, with no training program or mathematical prerequisites, uses the information to make more accurate decisions. The reason this system works better is that probabilistic expressions are far superior inputs to the decision process.

Much like the dilemma of the weatherman, the Army developer could only predict total success or failure to DOD and Congress. For a prediction of total failure, project funding was very difficult, to say the least. Therefore, the Army has been predicting "no rain" for its development projects since 1776.

Driven by "success only" predictions, Army management controls and methods have matured around a rather inflexible success oriented philosophy. This philosophy promoted a tendency to ignore or deny the likely existence of cost, schedule and technical problems.

DOD, Congress and the general public realize that there really has been "rain" in the Army programs. Subsequently there was a loss of confidence in the Army's ability to provide good management and decision information.

Can the problem be solved? Changing anything in a large organization is difficult, and changing traditional thinking and management methods is truly a challenging task. The essential elements for such an undertaking are: Scientific Methods (technology); Sound Management Procedures; and Effective Education.

These elements have been incorporated into the Army TRACE concept and are being applied to all major research and development programs. Proven scientific methods are being used that consider all management activities and predict cost, schedule and the uncertainties of each.

Generally speaking, the technical uncertainties are quantified as probabilistic schedule impacts that can be further quantified to cost risks. Thus, management has cost and schedule information about all planned activities and probabilistic cost and schedule information about the problems that can occur. Monies can be budgeted and used to manage that which is known and that which is unknown.

The budget for the planned activities is largely supported by the Baseline Cost Estimate (BCE), whereas the budget for "unknowns" is determined by probabilistic means. A funding strategy is selected that gives the project manager a reasonable chance of not being forced to exceed his total budget allocation.

In Figure 1, the 60th percentile funding level is used. This means there is a 60 percent probability of no cost overrun at the $175M funding level. This level is called the TRACE point. The difference between the TRACE and the BCE is the Risk Cost and in this example is $35M.

In the example, $140M is budgeted to manage the planned program and $35M to cope with "Surprises" and problems as they occur. Procedures for managing the Risk Cost budget are in a businesslike

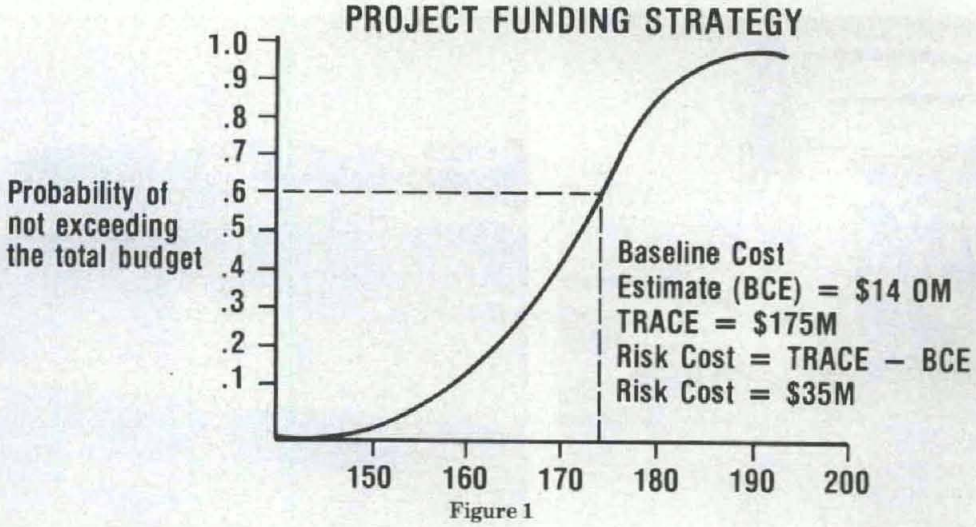


Figure 1

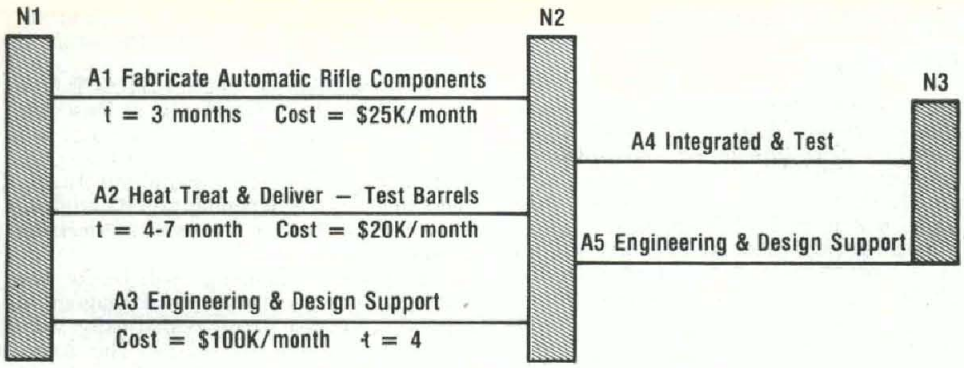


Figure 2

fashion similar to our banking system. The project manager determines and justifies the Risk Cost and ultimately has the responsibility for the proper use of the funds.

TRACE deferral money is held by the Department of the Army (DA) and is only released to the project manager for valid uses. A "Banker-Customer" relationship exists to the extent that the banker (DA) will help the customer (project manager) solve unforeseen problems and difficulties. However, the banker controls the money to insure its continuing proper use.

Some typical uses of TRACE deferral for the project manager are: rescheduling to work around technical problems; rescheduling to reduce program impacts from nominal budgetary limitations; design changes to correct deficiencies; Additional testing to verify design corrections; hardware to support design modification; schedule slippages; and project actions to reduce future costs.

Of particular interest, schedule slippages caused by late deliveries is probably the major contributor to cost uncertainty. This is due to the complex interactions between activities and deliveries. For example, consider the simple network of activities described in figure 2.

Activities A1, A2 and A3 must be completed before A4 and A5 can be initiated. Only the manpower costs are considered in this example. For A1, the cost is $25K/month times 3 months, or $75K. No uncertainty is expressed and there are no interactions since this is a labor pool type activity.

For A2, the cost ranges from $80K to $140K due to the schedule uncertainty. Thus, a $60K risk is associated with this activity. A3 is a support activity and, therefore, is affected by activities that have deliverables.

Engineering and design personnel cannot be laid-off simply because a deliverable is behind schedule. In this case, the schedule uncertainty of A2 impacts A3. Since A3 is dependent on the schedule of A2, the cost of A3 is $400K to $700K. Thus, a $300K risk is associated with A3.

This interaction type risk is far greater than the risk associated with the activity (A2) where the problem exists. This is a very common occurrence and, with projects involving hundreds of interactions, computer aided analysis is necessary to properly describe such cost risks. It is not enough for management to merely describe the risk. Money is needed to cope with the realization of problems and TRACE provides the means.

Another important use of TRACE deferral is in the area of project actions to reduce future costs. In the past, project managers have managed mostly in a reactionary sense, addressing problems as they occur. This is understandable. Since there was barely enough funding for the planned activities, it was virtually useless to think about and seize opportunities to spend monies that do not exist for reducing costs in subsequent years. Now that it is possible to spend money that will affect the future, management thinking will likely change and significant cost savings for the Army will result.

Although there are many uses for the TRACE deferral monies, there are two cases where the TRACE deferral cannot be used. TRACE deferral may not be used to replace funding decrements to the baseline program nor to fund any activities that relate to new requirements due to changes in the threat or any other reasons. These are reprograming type actions that are clearly outside the intended purpose of the TRACE deferral.

Responsibility for the success of TRACE rests with the Army's Deputy Chief of Staff for Research, Development, and Acquisition (DCSRDA), the Army Materiel Development and Readiness Command (DARCOM), and the project managers. The DCSRDA clearly has the decision responsibility to release TRACE deferral funds to the requesting project managers. Other responsibilities are to:

- Ensure the TRACE deferral request basically supports the release of funds.
- Ensure a timely decision on the funds and ensure that the funds are made available to the project office at the date requested.
- Make recommendations to the DCSRDA concerning action to be taken for projects that have violated the purpose and use of the risk capital funds.
- Establish and maintain TRACE policies.

DARCOM interfaces with DCSRDA primarily as an agent of the project manager. DARCOM responsibilities are to: Maintain a record of all requests and the distribution of funds; Ensure the operational process is followed; Ensure the TRACE deferral funds are being generally used as intended; Provide assistance to project managers in TRACE deferral requests and policy matters; and Implement DA policy and instructions.

The project managers' primary responsibilities are to maintain current cost estimates for the baseline program risks, and use the TRACE deferral monies as intended. Since the TRACE concept offers flexibility, there may be violations by project managers. There are, however, checks and balances at the DARCOM and DA levels to minimize these problems. Every effort will be made to keep the TRACE program flexible and dynamic with minimal regulatory constraints.

The TRACE concept is for the benefit of the Army's project managers and was designed to: Provide more effective use of management science techniques where potential problems and uncertainties are addressed openly; Better balance a project manager's authority and responsibilities; Provide the funds to solve unpredictable technical problems in the future; Increase flexibility; Minimize controls with using checks and balances; Increase visibility and long range planning; Increase emphasis on management; and Decrease emphasis on salesmanship.

Advantages at the Congressional levels will be better discourse with the Army and higher confidence in allocating Army funds. At the DA and DARCOM levels, there should be improved communication with Army project managers and a more positive influence on project problems. This is possible since problems and risks are handled openly and funding is available.

TRACE is a relatively simple concept to understand operationally. However, the long range implications to management motivations, total funding impacts, and cost savings are rather complex and not easily comprehended without detailed study.

There are a number of often asked questions such as: Why is Trace deferral needed? When everything is successful, risk money is not needed. However, nothing is totally successful. Management, therefore, must deal with unforeseen problems by over-budgeting, maintaining a management reserve, or by using a TRACE deferral type system.

Intentionally over-budgeting greatly inflates the cost and masks the true cost of planned activities. A management reserve, though often practiced, is a poor substitute for scientific management. Here, reserve money is allocated in proportion to the total expenditures in each year. There is no thought or analysis of the magnitude of uncertainties or risk or when they will likely occur.

TRACE deferral monies in the TRACE concept are determined, allocated by fiscal year, and justified by analysis. The idea is to have money where and when it is needed and to avoid the distruption of programs by unexpected cost overruns.

An obvious question is: Why not give all the TRACE deferral to the project managers from the onset? This is analagous to a businessman asking his banker for the keys to the vault and to just trust him to use the money properly. Since he has always used the money properly in the past, why not trust him to do so in the future?

(Continued on page 26)

"Total Risk Assessing Cost Estimate (TRACE)" Concept

(Continued from page 25)

Thus, remove the slight management burden of having to ask for the money. This concept would have the support of all project managers, but it is considered unworkable because of the temptation to spend the money prematurely on new requirements, and "nice-to-have" things.

Also, this concept would provide the undesirable motivation to project managers to spend the monies prior to the fiscal year end and to spend monies to ensure success during their management tenure. The likelihood is too great that when the funds are really needed, they will not be available.

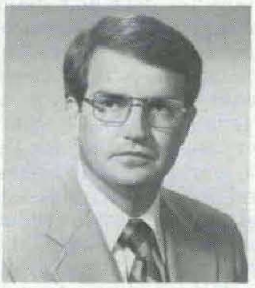
Another question heard is: Will TRACE deferral funding reduce funds for new developments and the smaller projects? There has been some apprehension about the application of TRACE since it is assumed that when funding levels are increased for any reason there will be fewer dollars for the smaller projects and new development starts. In the real world of practicalities, this may not be true.

If a project is funded at $200M with an additional $25M for TRACE deferral, the total funding (TRACE) is $225M. It is a certainty that unplanned and unknown problems will occur. The project manager has $25M to cope with such occurrences as defined in the TRACE concept.

If the project manager is successful, all of the problems can be solved with the $25M. Since the money is available and the problems are real, the cost could not be any less than the amount spent under the TRACE concept. However, if the money is not available, the problems would still have to be solved, but through reprograming actions. This is a lengthy process and the disruption to the program often costs far more than the original problem.

As to whether or not the TRACE concept will work for the Army, at least two years of experience with the system will be necessary for a fair evaluation. Conceptually, the system is sound but its success or failure is dependent on its application by the Army managers and decision makers.

The greatest challenge will be for the Army to change traditional management thinking to deal more realistically with program budgets and plans. The Army must also adopt the business-like logic of spending money to realize future returns through cost savings or the reduction of the disruptive impact of cost overruns.



JOHN M. COCKERHAM is president of John M. Cockerham and Associates, Inc., with headquarters in Huntsville, AL. He is currently under contract to the U.S. Army for the implementation of the TRACE concept to include the computer software, the management information system, and a command-wide training program. His academic credentials include a bachelor's degree in mechanical engineering from Mississippi State University, and a master's degree in industrial engineering/operations research from Texas A&M University.

Sacramento Gets First 'Distributed Processor' Automatic Test Equipment

The first of a new line of automatic test equipment, termed the Army Depot Automatic Diagnostic System (ADADS), has been installed at the Sacramento Army Depot, CA, according to a recent announcement by its developer—the U.S. Army Armament R&D Command.

ADADS is expected to eventually perform fault diagnosis and quality assurance testing during depot overhaul of a wide variety of items. The system at Sacramento is programed to test the modules and circuit boards of laser rangefinders on M60A1 and M60A3 tanks.

Automatic testing is not a new concept in production and maintenance plants. What makes ADADS unique is that it is the first "distributed processor" automatic test equipment system. This means up to 15 satellite test stations, each possessing a minicomputer conducting automatic testing and collecting data for management control, can be controlled by a central executive minicomputer where each satellite test program is stored. This procedure assures that the automatic inspecting of depot materiel will at all times be under strict management control and tested according to controlled specifications. Yet each satellite system, under the operator's direction, is capable of independently performing all required tests on all components down to the smallest electronic, optical, hydraulic or mechanical part.

Another feature of the new system is that failure-related data is acquired by each satellite minicomputer and then sent to the executive system via a communications link capable of transmitting large amounts of information.

Collection of failure-related data enables personnel to pinpoint problem areas and make design evaluations and improvements in the equipment being tested. ADADS also collects and updates stockage information from the satellite computers for comprehensive inventory control.

Finally, ADADS' executive minicomputer is capable of developing new applications programs for the satellite systems while the entire system is performing normal testing functions.

One system is scheduled for delivery to Anniston Army Depot, AL, in the fall and another to Mainz Maintenance Plant in Germany. They will be used to test the hydraulic and electronic components of the Add-on Stabilization (AOS) system on M60A1 and M60A3 tanks. The AOS enables the gun turret to remain stable while the tank moves.

Officials from U.S. Army Armament R&D Command's Fire Control and Small Caliber Weapon Systems Laboratory, where the system was developed, report that in the future ADADS will be used to test additional laser rangefinders, night sights, computers and tank engines and crossdrive transmissions, and, eventually, to test rebuilt XM1 tanks at Anniston and Mainz.

Allies to Study Patriot Acquisition Feasibility

The United States and six other countries have signed a memorandum of understanding calling for North Atlantic Treaty Organization (NATO) allies to study the most practical and economical ways to acquire and produce the Army's new Patriot air defense missile system. Signing with the U.S. were Belgium, Denmark, France, Germany, Greece, and the Netherlands.

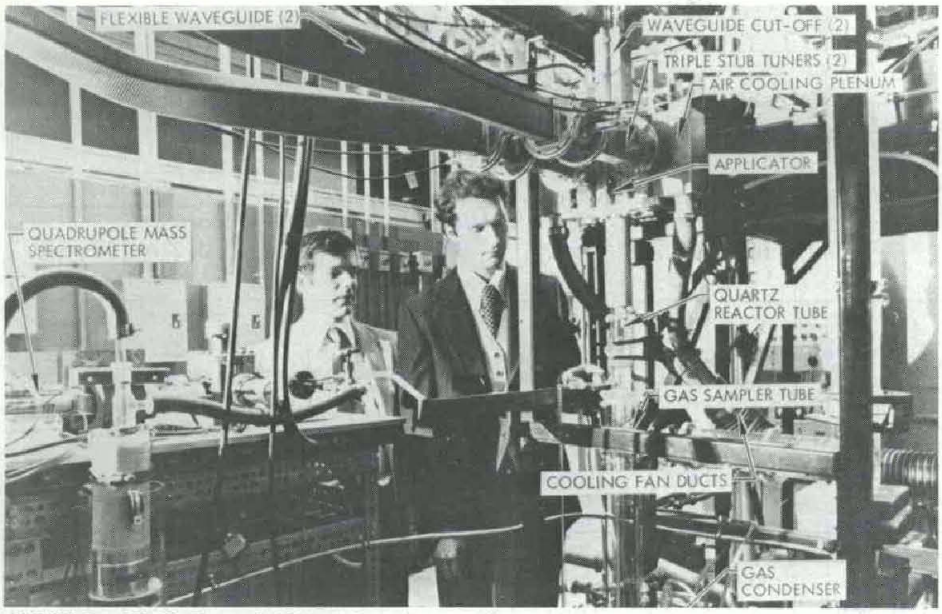
NATO has established a multinational working group to conduct the study—a steering committee composed of high level representatives of each nation and a full time management group of 21, which is located in Munich, Germany. Members will review the total acquisition process before making decisions on buying or coproducing Patriot as a replacement in NATO for both the Nike Hercules and Hawk systems.

The 2-year multinational study, terminating in October 1980, will consider a broad range of acquisition methods, including foreign military sales, coproduction, and licensed production in Europe.

The NATO management group visited the U.S. in March for a tour and briefings of Patriot hardware and production facilities. They went to Huntsville, AL, for technical and management briefings, to White Sands Missile Range, NM, to see ground equipment and missile tests, and they traveled to Massachusetts to look at the production sites.

The current study is a follow-on to Project Successor, a German-U.S. study concluded a year ago, evaluating Patriot's suitability for a European air defense role. The U.S. Army Missile Research and Development Command conducted this study for the Department of Defense.

New Technique May Ease Toxic Substance Disposal Problems



1LT Michael B. DeZearn (right) and an Army colleague, George C. Outterson, look over applicator and reactor detail of the microwave plasma system at the Lockheed, Palo Alto, CA, Research Laboratory.

How to dispose of excess quantities of unused or unwanted toxic substances has long been a problem which has been addressed in a number of ways. However, a new approach, recently described in a scientific paper, may offer better hope for the future.

The new approach, explained in a paper entitled "The Detoxification of Materials by Microwave Plasma," has been termed "a scientific advance" in the destruction of hazardous materials. It was reported on by 1LT Michael B. DeZearn, a chemical engineer at the Army Armament R&D Command's Chemical Systems Laboratory.

1LT DeZearn's paper, which was presented at the 177th National Meeting of the American Chemical Society, was prepared in conjunction with personnel in the municipal environmental research laboratory of the Environmental Protection Agency (EPA).

Researchers say that the microwave plasma process consists of an incinerator with a stepped-up power factor ten times greater than the normal home microwave oven. It made its first appreciable progress at the Lockheed Palo Alto (CA) Research Laboratory, supported by both the EPA and the Army.

The technique acts by trapping microwaves in a small metal box, referred to as an applicator. These trapped microwaves cause the material flowing through the applicator to split apart and glow like fluorescent or neon lights causing the gases to light up. As the material splits, it recombines below the glowing zone and as oxygen is injected into the system the material intended for destruction "burns."

Some of the materials destroyed by the process during tests have included malathion, kepone and transformer oil as well as rodent poisoning, herbicides and toxic nerve agent simulants.

1LT DeZearn entered the Army in 1976 and attended the officer basic course at the Army Ordnance and Chemical Center and School. He holds a BS degree in chemical engineering from the Rose-Hulman Institute of Technology, Terre Haute, IN.

Assigned to the Chemical System Lab's Munitions Division since January 1977, his research efforts have been devoted largely to the development of chemical dye manufacturing processes and the destruction of hazardous materials.

MERADCOM Awards $2.3 Million For New Mine Detector System

A $2.3 million contract has been awarded to Cubic Corp. for engineering development of the Vehicle Mounted Road Mine Detector System, according to a recent announcement by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA.

The system represents a major technological breakthrough because it is the only system that can reliably detect both metallic and plastic antitank/antivehicular land mines with a very low false alarm rate.

Using sophisticated microwave and microprocessor techniques, the system locates buried mines through a special search head that can be mounted on any standard Army vehicle. An alarm is sounded and a visual display pinpoints the exact location when a buried mine is detected.

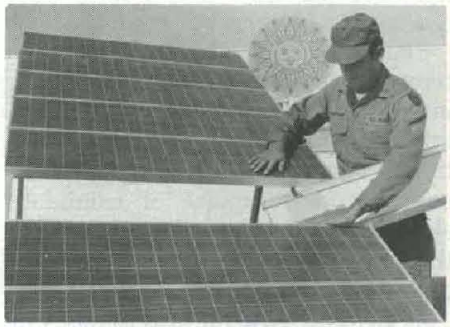
The system can clear a path up to eleven feet wide at eight miles an hour over unpaved roads or flat, sparsely vegetated terrain. Eight units will be produced for testing under this initial contract, with the first system set to arrive in January 1980.

New Solar Panels Slated for Use in Middle East

A new type of solar panel developed for the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA, will soon be used by United Nations peacekeeping forces in the Middle East. The new panels, which have rectangular rather than circular power cells, will be placed on top of Mount Iwebid in Egypt where they will power a radio relay station operated by the Sinai Support Mission. Their new design, which is similar to solar panels used in satellites, produces 60 percent more power than conventional panels which have round solar cells.

MERADCOM has contracted with ARCO Solar for 21 300-watt solar panels. Six will be shipped to the Sinai to power the radio relay station and the remaining 15 units will go to the Army's Dugway Proving Ground where they will be used to operate a remote weather station.

Purchase of these solar panels is part of MERADCOM's responsibility to act as the Department of Defense (DOD) agency for applications of photovoltaic equipment. MERADCOM was given the DOD charter under a federal program to promote the use of solar energy.



300-WATT SOLAR PANEL is made up of eight sections. The rectangular design of the photovoltaic cells allows the panel to produce 60 percent more energy than earlier systems that used round solar cells.

Electric Vehicle Test Program

By Edward J. Dowgiallo Jr.

Are electric vehicles advantageous for military applications? This is the question the Army is seeking to answer. Among the potential advantages are lower operating costs, improved logistics due to independence from petroleum fuels, and reduced air pollution. Electricity used for charging may come from nuclear, coal or other energy sources.

The Army now has a large inventory of special purpose electric vehicles which are in service on a routine basis. These include materials handling forklift trucks and golf carts. A survey of a typical Army base has estimated 50 percent of the ¾-ton engineering utility trucks, and 57 percent of the ½-ton pick-up vehicles could be replaced with electrics.

However, the Army needs early access to actual performance of state-of-the-art vehicles to determine if they could be used on military installations. These needs and the degree to which they are satisfied could then be verified by selected fleet testing in the user environment.

The U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA, began active interest in controller design for electric vehicles about 1959. About ten years ago a high energy density battery program was started to develop an advanced battery for fork lift trucks.

To evaluate these batteries realistically, it was necessary to acquire the discharge load profile in actual field useage. An instrumentation package was developed to acquire these profiles. A high power simulator was programed by these profiles to test molten salt batteries and hybrid fuel cell/battery systems.

Since the U.S. Postal Service was interested also in such applications, an interagency agreement was entered into with that Service. This was initiated about three years ago to evaluate the performance of candidate electric vehicles and batteries using the instrumentation package and battery test facility at MERADCOM. This gave the Army access to many of the electric vehicles being evaluated by the USPS and furthered Army expertise in this area.

A second agreement was entered into with the Energy R&D Administration (ERDA), now part of the Department of Energy (DOE). It is a joint, 3-5 year program for evaluation of electric and hybrid vehicles and components.

This agreement, authorized by and in response to Public Law 94-413 (17 Sept. 1976), states in part ". . . The Secretary of Defense, and heads of other federal agencies shall (1) carry out a study of the practicability of using electric and hybrid vehicles in the performance of some or all of the functions of their agencies; and (2) arrange for the introduction of electric and hybrid vehicles into their fleets as soon as possible."

The U.S. Army has a requirement for improved power sources for electric vehicles, particularly material handling equipment such as fork lift

TABLE I
FY77 Electric Vehicles Tested by MERADCOM, Fort Belvoir, VA

PERFORMANCE AND WEIGHT CHARACTERISTICS							
Vehicle (Body)	Curb Weight (lb.)	Pay-load (lb.)	Battery Type (System Voltage)	Battery Weight (lb.)	Acceleration Time to 30 mph (sec.)	Range* Start-Stop (J227A Schedule)	Range* Speed
Eva Metro Sedan (Renault 12)	3360	480	ESB EV106 (96v)	1040	20	(C) 21 mi	(34 mph) 27 mi (47 MPH) 23 mi
Jet 500 Mini Van (Subaru)	2680	570	ESB EV106 (108v)	1170	17	(B) 64 mi	(35 mph) 62 mi
Daihatsu Mini Van (EH-S40)	2035	665	Yuasa 100 AH/20A (96v)	564	21	(B) 24 mi	(35 mph) 28 mi
Citi Van (Sebring Vanguard)	1455	494	Globe Union 75A/106 min (48v)	464	22	(B) 28 mi	(31 mph) 27 mi

* Less than ±1% grades

TABLE 2
FY78 Electric Vehicles Tested at MERADCOM, Fort Belvoir, VA

Performance and Weight Characteristics

Vehicle (Body)	Curb Weight (lb.)	Pay-load (lb.)	Battery Type (System Voltage)	Acceleration Time to 30 mph (sec.)	Range* Start-Stop* (J227A Schedule)	Range* (Speed)**
Eva Pacer Wagon (AMC)	4280	600	Trojan T-135 (120v)	13	(C) 32 mi	(50 mph) 28 mi
Jet 600 Mini Van (Subaru)	2780	650	SGL 2H-6C Deep Cycle (102v)	12	(B) 39 mi	(44 mph) 35 mi
Jet 1000 Van (Chrysler)	4475	1000	Globe Union 220AH (144v)	14	(B) 33 mi	(44 mph) 20 mi

* Grades of less than ±1%
** +5% and −3.6% grades for 33% of range

trucks. In consonnance with this, MERADCOM's Electrochemical Division has designed and built a hybrid fuel cell-battery power source for a fork lift truck, and the system has been in operation for over four years.

The Army has been active in molten salt battery development and engineering. In its search for a power source to satisfy future Army needs, MERADCOM has funded, for over eight years, a molten salt battery program. Delivery of a prototype molten salt battery is planned within 18 months, and after acceptance it will be installed in a fork lift truck for evaluation.

In February 1977, a meeting was held by ERDA, Office of Electric and Hybrid Vehicle Systems with representatives from DOT, JPL, NASA Lewis and MERADCOM. This resulted in a test procedure for evaluating electric vehicles to establish a base line specification from which to make the first buy of electric vehicles under Public Law 94-413.

MERADCOM started tests of four electric vehicles in May 1977. These tests were completed in September 1977. Detailed reports on the results are available. A brief summary of the test results is shown in Table 1.

MERADCOM is also involved in evaluating components of electric vehicles for DOE. The Electrochemical Division's main interest is in batteries. However, it also has performed an evaluation of an on-board charger and drive train for electromagnetic interference effects and audible noise.

MERADCOM has developed procedures for screening batteries in testing of electric vehicles which have become the world standard. The purpose of the electric vehicle test program is not to test batteries in the field, but rather to test the vehicle/battery/charger as a system as supplied by the manufacturer.

The battery and charger should be operating according to specifications to avoid costly delays in field tests. In FY78, three electric vehicles were evaluated on the MERADCOM ANNEX test track. Results are summarized in Table 2. Improvements in acceleration times between FY77 and FY78 are particularly notable.

Extending the range and performance of electric fork lift trucks with a hybrid power source would make it possible to replace not only current electric truck batteries but make significant inroads on gasoline powered trucks.

TABLE 3
Examples of Conventional Military Vehicles Potentially Replaceable by Electrics

Vehicle Type	Number of Vehicles in Class	Potentially Replaceable by Electrics*	Average Daily Mileage	Vehicle Application and Comments
½-Ton Pick-Up	390	197	44 (71 km)	Onbase Maintenance and Repairs, Some Personnel Transportation and Messenger Service.
¾-Ton Utility Truck	155	75	22 (35 km)	Onbase Maintenance and Repairs.
29-Passenger Bus	17	11	49 (79 km)	Onbase Bus Service.
1-Ton Metrovan	40	40	22 (35 km)	Used for Mail Distribution, Aircraft Maintenance, and Delivery of Flight Crews on Base.
3-Wheel, Low-Speed Truck	41	41	13 (21 km)	Onbase Messenger and Light Repair Service.

* Criteria: Maximum Daily use would be 40 miles (64 km) and top speed requirement would be 25 miles per hour (40 km/h).

Twenty-eight battery-powered cargo carriers of a 2-passenger, 4-wheel type with a flat cargo bed have been purchased. They will be used for a facilities engineering work force at the Military District of Washington. Low maximum speeds of 10-12 mph and lack of power to negotiate hills could be overcome with a hybrid power source, with increased range.

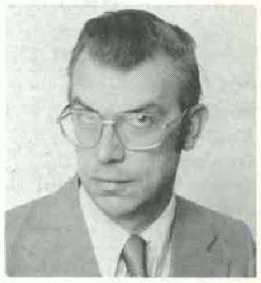
Several military truck manufacturers have indicated that they would respond to a documented Army requirement for electrics. An assessment of present and future military use of electric vehicles is needed. A preliminary study was published in 1976.

The potential for replacing gasoline powered vehicles with electrics was determined for three military bases: McClellan Air Force Base, Fort Ord Army Base and the Long Beach Naval Shipyard. Results are summarized in Table 3. The study was based on lead-acid electrics. Hybrid electrics' enhanced performance should assure rapid replacement of such conventional vehicles.

Therefore, an Army assessment of electric vehicle applications should be conducted. Inclusion of hybrid fuel cell-battery power sources in the assessment is expected to provide the margin required for successful resolution of present lead-acid battery deficiencies. This may accelerate development of electric vehicles as a practical alternative to conventional gasoline vehicles.

An Army electric vehicle program is being finalized with TARADCOM in which at least five vehicles will be evaluated at the Red River Army Depot in Texas. The Electrochemical Division will serve as an adviser and will be responsible for the batteries or other hybrid power sources.

EDWARD J. DOWGIALLO JR. is an electrical engineer in the Electrochemical Division at the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA. He has published papers on such topics as thermoelectric generators, fuel cell and battery equivalent circuits, and molten salt.



Career Prospects for the First Manager of an Army Project

By COL William J. Fiorentino

The following article, which has been edited slightly to conform to magazine format, was originally prepared in fulfillment of academic requirements for the Writing Program at the Air War College.

There used to be a fairly lively debate as to whether officers were rewarded or hurt by virtue of having been project managers. That issue appears to have been settled according to recent promotion lists which demonstrated that PMs were receiving at least their proportionate share of promotions.

However, based upon several years of close observation of the Army PM system, it appears that while the overall success rate of PMs was good it might not be uniformly distributed. This concern finally crystallized in the following hypothesis: The officer who is the first manager of a project does not have career prospects as good as subsequent managers of a project.

If the PM selection process results in uniformly good officers for first and subsequent PM assignments then it is important for the Army to know if the hypothesis is correct. There could be something in the nature of the first PM's job which makes success more elusive, something that might be changed if identified.

Inquiries at the Army and Air War Colleges, the Defense Systems Management College and the Defense Documentation Center indicate that no work has been done on this subject. Discussions with knowledgeable personnel did not turn up any research on this subject and tend to support the conclusion that there has been no prior work on this subject.

There are certain deficiencies in the data upon which this paper is based. They must be eliminated before all of the conclusions will withstand vigorous examination. These deficiencies will be discussed later.

The PM Selection Process. Army project managers are selected by a centralized board which meets annually for that purpose. The Board considers eligible colonels and promotable lieutenant colonels for assignment into designated PM vacancies.

Eligibility requirements include membership in the Project Manager Development Program, at least three years of remaining service, and a desire to be a PM. An officer cannot have declined any previously offered command or PM position.

Those who are not members of the PM Development Program may be nominated for consideration by their Personnel Career Division or may request consideration by the Board if they believe they are qualified. The PM selection board consists of a lieutenant general and six other general officers or promotable colonels, who have a mix of PM, logistics and R&D backgrounds.

In addition to the principal selectee, the Board will also select three alternates for each vacancy. If an unexpected vacancy should occur, it will be filled by convening a special meeting of the Board.

Thus, the current process for selection of PMs is one which has an extremely high probability of providing PMs of uniform quality. The Army-wide PM selection process has been in effect since the fall of 1974. Prior to that time, selection was done on a decentralized basis.

Testing the Hypothesis. There is one document available which made this research possible. The document is a project listing of all former and current PMs with annotations to show such things as present rank, next assignment, and active or retired status.

The document is updated periodically by the Office of Project Management, U.S. Army Materiel Development and Readiness Command (DARCOM). It was that office which graciously provided a copy to support this work.

Given the availability of the document, the process used to test the hypothesis is conceptually very simple. One needs only to compare the career progression of those officers who were the first managers of a project with that of the second, third, etc., managers of a project.

The DARCOM listing shows that there were a total of 134 Army projects of which 63 are still active. There were 380 officers who managed these projects. Sixteen projects are new enough so that they are still managed by their first PM. Most projects have had more than one PM, and, one is now managed by its 10th PM.

It is on these points that the simple conceptual approach becomes beset with difficulties of the real world. Data become ambiguous and care must be taken so the statistics are truly representative. For example, there are 22 officers who have managed more than one project.

One officer was PM of four different projects and, upon retirement, continued to manage the fourth project in a civilian status. At least one PM returned to the same project as PM after a promotion and an absence of two years. This last example shows that timing is also important.

The colonel PM who is on the job for six months or so and comes out on the BG list is probably not being rewarded for his PM service.

One of the principal indicators used in this study is retirements. Inference is made that retirement tends to be a contra-success indicator. Yet the data are not adjusted to distinguish between voluntary and mandatory retirement.

Nor do the data take into account retirement for physical, personal or professional reasons, which may be non-PM related. In fact, retirement may be a strong success indicator if it is caused by a company making a PM a financial offer that he cannot refuse. These effects have not been accounted for in the data pre-

TABLE 1
Next Assignment of Former PMs

Next Assignment	Number	Percent of Total
PCS	137	43%
Retire	91	29
Another PM Job	32	10
Command	30	9
Senior Service School	13	4
Deceased	2	1
No Data	12	4
Totals	317	100%

TABLE 2
Next Assignments of Former PMs As a Function of PM Number

	PM Number										
Next Assignment	1	2	3	4	5	6	7	8	9	10	*Totals*
PCS	47	38	22	10	11	6	1	2	0	0	137
Retire	44	19	13	8	5	1	1	0	0	0	91
Another PM	9	7	5	8	2	0	1	0	0	0	32
Command	6	7	8	4	1	1	1	1	1	0	30
Senior Service School	5	6	0	1	1	0	0	0	0	0	13
Deceased	2	0	0	0	0	0	0	0	0	0	2
No Data	5	4	2	1	0	0	0	0	0	0	12
Subtotals	118	81	50	32	20	8	4	3	1	0	317
Incumbents	16	14	14	3	2	10	1	0	2	1	63
Totals	134	95	64	35	22	18	5	3	3	1	380

TABLE 3
Percentages as a Function of Next Assignment
PM Number

Next Assignment	1	2	3	4	5	6	7	8	9	10	Totals*
PCS	34	28	16	7	8	4	1	2	0	0	100%
Retire	48	21	14	9	5	1	1	0	0	0	100
Another PM	28	22	16	25	6	0	3	0	0	0	100
Command	20	23	27	13	3	3	3	3	3	0	100
Senior Service School	38	46	0	8	8	0	0	0	0	0	100
Deceased	100	0	0	0	0	0	0	0	0	0	100
No Data	42	33	17	8	0	0	0	0	0	0	100

* May not add due to rounding.

sented.

Next Assignment Indicators. To date there have been 380 PMs. Of this number, 63 are now serving and have been disregarded in this analysis. This leaves the respectable number of 317 former PMs whose career success could be studied after they were PMs.

Table 1 shows the next assignment of these former PMs. The table also shows how many of the 317 went to that type assignment, and the percentage which that number represents. Thus, 43% of the former PMs were reassigned to some position other than one of those listed in the rest of the table.

Almost one-third (29%) went into retirement as their "next assignment." Approximately one-fourth went to a senior service school (4%), command (9%), or to another PM assignment (10%). Two officers died while serving as PMs and there were no data available on 12 others.

If the data in Table 1 are expanded to show the next assignment of former PMs as a function of which PM they were, we have the breakout shown in Table 2. This indicates that of the 91 former PMs who retired as their "next assignment," 44 were the first PM of a system while 19 were second PMs.

Similarly, it can be seen that of 32 PMs who went directly into another PM assignment 9 were first PMs, 7 second PMs, and 5 third PMs, etc. Since the number of first through 10th PMs is not the same, a direct comparison of the figures in Table 2 is not meaningful.

Tables 3 and 4 show these figures converted into percentages and permit direct comparisons at least for the first three PMs. Sample sizes then become small enough so that the percentages may distort more than illuminate.

Table 3 percentages are read across to give comparisons. Thus, of all retirees, 48% were first PMs. Likewise, 20% of those who went to command positions next were first PMs. It should be noted that only 2 PMs died while PMs. Both were first PMs.

Table 4 percentages are read down to give comparisons. Thus, we can see that 37% of first PMs retired, 8% went to another PM assignment, 5% went to commands, etc.

It is the Table 4 display of percentages which is perhaps most meaningful. Assume that: the PCS, deceased, and no data categories are "neutral"; the another PM assignment, command and senior service school categories are "success" indicators; and, the retire category is a "non-success" indicator.

The very clear trend is that first PMs retire more often than second or third PMs. They go to another PM assignment, command or senior service school less frequently than second or third PMs.

Promotion Indicators. Without question, the most visible success indicator in the Army is promotion. However, promotions are based upon a "whole career" perspective rather than just one assignment. Therefore, it is difficult, if not impossible, to make a direct connection between service as a PM and promotion.

Promotion statistics were examined for trends. Fifty-seven of 317 former PMs were promoted at least once after being designated as a PM. These 57 individuals received 80 promotions for an average of 1.4 promotions each.

TABLE 4
Percentages as a Function of PM Number
PM Number

Next Assignment	1	2	3	4	5	6	7	8	9	10
PCS	40	47	44	32	55	75	25	67	0	0
Retire	37	23	26	25	25	13	25	0	0	0
Another PM	8	9	10	25	10	0	25	0	0	0
Command	5	9	16	13	5	13	25	33	100	0
Senior Service School	4	7	0	3	5	0	0	0	0	0
Deceased	2	0	0	0	0	0	0	0	0	0
No Data	4	5	4	3	0	0	0	0	0	0
Totals*	100%	100%	100%	100%	100%	100%	100%	100%	100%	—

* May not add due to rounding.

Distribution of these promotions is shown in Table 5. Here we see that the first PMs had as many individuals promoted as the second PM group. However, because there were more former PMs in the first group than the second, only 14% of the first PMs were promoted compared to 21% of the second PMs and 20% of the third PMs.

This same trend is also seen in the next two lines, the number of promotions and the number of promotions per individual. The first PM group got 1.4 promotions per man while the second and third received 1.5 and 1.6 respectively.

Perhaps the most dramatic effect is shown in the next three lines of Table 5. They reveal the nature and distribution of the promotions. The notation "Field Grade to Field Grade" means that the PM began as a major or lieutenant colonel and was promoted no higher than colonel.

The notation "Field Grade to General" indicates that a field grade PM was eventually promoted to some general officer rank. "General to General" means that the PM was a general officer when assigned to the project and received a subsequent promotion.

The Table indicates that of the 17 first PMs promoted, 11 (65%) were promoted to or within general officer ranks. For the second and third PMs, the comparative figures are 14 of 17 (82%) and 7 of 10 (70%).

Conclusions. From the data presented, it must be concluded that *the first manager of a project does not enjoy the same de-*

TABLE 5
Promotion Indicators
PM Number

Indicator	1	2	3	4	5	6	7	8	9	10	Totals
Individuals Promoted	17	17	10	5	5	0	1	2	0	0	57
% Promoted	14%	21%	20%	16%	25%	0	25%	67%	0	0	—
Number of Promotions	23	25	16	6	7	0	1	2	0	0	80
Promotions per Individual	1.4	1.5	1.6	1.2	1.4	0	1.0	1.0	0	0	1.4
Promotions: Field Grade to Field Grade	6	3	3	1	0	0	0	0	0	0	13
Field Grade to General	8	13	7	4	4	0	0	1	0	0	37
General to General	3	1	0	0	1	0	1	1	0	0	7

gree of success as subsequent managers of a project. Specifics which support his conclusions are:

- For his next assignment, the first PM retires at a rate about half again as high as the second or third PM (Table 4).
- The first PM gets another PM assignment, command or senior service school as his next assignment at a lesser rate than the second or third PM (Table 4).
- The first PM gets promoted at a rate one-third less than the second or third PM (Table 5).
- For those first PMs who do get promoted, more stop at colonel and fewer get to general officer ranks than the second or third PM (Table 5).

Based upon these statements, and the assumption that the PMs were of uniform quality, then one wonders why the first PM is not as successful as the subsequent PM.

This leads to a new hypothesis: There is something unique about the first PM's environment which causes him to be less successful than subsequent PMs. Data to examine this hypothesis are not readily available. However, there are some indicators which tend to support it.

Clearly, the early days of a project are some of its most tumultuous. On the whole it will have a higher and broader level of interest at that time than at any other. Also, there are profound issues but no smooth operating PM Office. In fact, the first PM may well be dividing his time between thinking about profound issues, and carving out office space, and project staff, the latter being something that the follow-on PM generally does not have to consider. When he does, he has an operating office to help.

A Warning and the Future. Data conclusions presented are dependent upon information concerning individuals. These data are increasingly more difficult to obtain because of such things as the Privacy Act. For example, Volume I of the *U.S. Army Register* was withdrawn from public access by the Army for almost two years while the "legality of releasing some of the information in the Register" was reviewed.

The document is now available but it is For Official Use Only. Thus, it must be understood that basic raw data such as retirements and promotions were not verified against official records and contain some unknown degree of inaccuracy. There are several ways in which this analysis could be refined when accurate data are available. One way is to reexamine the indicators after having used some technique to separate the more significant projects.

Another approach would be to divide the projects by time frame. PMs studied served from June 1962 to the present—a 17 year period. Trends may well have changed in such a length of time. For instance, senior service school is now a prerequisite for selection to PM. Thus, we cannot expect to find current PMs going to senior service school as their next assignment.

The time frame of the promotion indicator should be examined. This might help to explain whether an officer got to be a PM because his record indicated he would probably be promoted or if he got promoted because serving as a PM improved his record.

There is at least one other phenomenon which would be interesting to examine. At least five projects have had five former PMs each, none of whom have been promoted. In contrast, there are four projects which have had at least six former PMs where 39% of the former PMs have been promoted. This supports the concept that some projects, by their nature, tend to encourage or inhibit success.

COL WILLIAM J. FIORENTINO is Pershing project manager, U.S. Army Missile Command, Redstone Arsenal, AL. A recent graduate of the Air War College, he served from 1976-78 as inspector general, U.S. Army Missile Materiel Readiness Command. His academic credentials include a BS degree in physics from Fordham University, and an MS degree in engineering from the University of Alabama.

APG Receives Fighting Vehicle Prototypes for Tests

Prototypes of the new XM2 Infantry Fighting Vehicle and the XM3 Cavalry Fighting Vehicle arrived at Aberdeen Proving Ground, MD, on 13 June for 10 months of comprehensive testing.

APG will receive two XM2s and an XM3 from the eight prototypes produced by the FMC Corp., of San Jose, CA. The company will keep one prototype for developmental testing and ship the remaining four to Fort Carson, CO, for crew training and operational tests.

The XM2 and XM3 are identical in outward appearance, weighing in excess of 20 tons, and are largely identical on the inside, except for differences in crew capacity and weapons and ammunition capabilities and storage capacities.

The XM2 carries a squad of 9; a driver, commander, gunner and six infantry squad members. It also carries seven TOW or Dragon antitank missiles, plus 900 rounds of 25mm, 4,400 rounds of 7.62mm and 6,160 rounds of 5.56mm ammunition.

The XM3 is arranged for a 5-member scout crew, and will transport 12 TOW missiles, plus 1,500 rounds of 25mm, 7,700 rounds of 7.62mm, and 1,460 rounds of 5.56mm ammunition. Both vehicles will replace the Army's M113 series of Armored Personnel Carriers.

The vehicles feature a 2-man turret with a stabilized 25mm cannon that fires both armor-piercing and high-explosive shells, and a 2-missile TOW launcher designed to knock out enemy tanks at ranges more than 3,000 meters.

Additionally, each vehicle features a 7.62mm coaxically-mounted machinegun that can be fired accurately on the move, as can its 25mm cannon. The XM2 has an additional feature of six ballistically-protected firing ports that enable crew members to fire 5.56mm automatic weapons at targets to the sides and rear.

Each vehicle has a 500-horsepower turbo-charged Cummins diesel engine and improved transmission and suspension system, providing high mobility and a top speed of over 40 miles-per-hour.

Both models are expected to be in production by May 1981, and are estimated to cost $472,000 each.

XM2 Infantry Fighting Vehicle

Problem Solving—A Good Track Record

Five years ago this past June, HQ DARCOM established an office for the special purpose of expediting the resolution of problems at the small program level—problems that sometimes flounder without adequate visibility, attention or decision. The track record to date indicates that this office has proven to be a most valuable asset.

The Special Assistant for Minor Programs, under the Deputy CG for Materiel Development, originated from a recommendation of the 1973 Army Materiel Acquisition Review Committee (AMARC). That group concluded that a point of contact for industry was needed at the headquarters level, to assure that problems faced in minor acquisition programs do not become lost in the bureaucracy.

Major programs usually go to large sophisticated contractors with knowledgeable managers and are given constant attention by Army officials. Small programs are not so highly structured and in the eyes of industry generally do not always receive adequate technical or managerial attention from the Army. The result is contractor frustration in relationships with the Army and lost efficiency to the Army when a problem goes unresolved.

More importantly from the Army viewpoint is the possible loss of an emerging technology in the frustrated small program. Since real technological advances usually come from the innovative efforts of a few engineers and scientists at the laboratory or bench level, the Army should facilitate programs that encourage that activity.

To handle this task, HQ DARCOM appointed Mr. John Stolarick, a career Civil Service employe with an extensive background in production and management of R&D, particularly in the quality assurance field.

Stolarick quickly found that there was a market for his office. The problems emerged "not so much as technical, but in the need to help industry in coping with the massive bureaucracy and the administrative complexities of the system." This philosophy as to where the bulk of the "small program" trouble areas lay would be confirmed in conversations between industry and Army officials.

As of March 1979, there were 315 cases or problems presented, involving 153 contractors. Of the 315 cases, large businesses were responsible for 45 percent and small businesses for 55 percent. This breakout confirmed initial expectations that small program problems would not be limited to small companies. Of the 153 contractors involved, 37 percent were large businesses.

The most difficult part of his job, says Stolarick, is in staying within the bounds of the system and the limitations of his own office as he seeks a solution. A very delicate balance must be maintained, he explains, in the relationship between contractor and the Army's contracting officer—an official who has statutory status, whereas his own role is essentially an extra-statutory, advisory one.

The job requires that all problems posed be heard, first off. The source of the problem then is identified, and once that is determined, a direction to go for solution is provided. For example, a company may feel its patent rights have suffered infringement by a second company who received a production contract for an item utilizing the first company's patented idea.

There are legal precedents and policy, says Stolarick, that permit this kind of procurement. The solution then, assuming data rights have not been violated, is to acquaint the complaining company with the procedures that govern such circumstances.

To categorize the types of problems brought to his office is difficult. They range from questions as to points of contact and procedural information, to problems with unsolicited proposals, to procurement practices, to need for advance planning information, to how to do business with the Army, to many others.

Examples of just a few included a request by one large U.S. firm for the procedure to obtain ammunition for an independent development project. Another large contractor had a program stalled due to resolution of design-to-cost provisions.

A small business also requested help with a claim involving a mistake in bidding. Another had legal problems on the use of contractor's data in procurement of a certain device. Many small businesses inquired as to how to get on the government's bidders' lists.

The term "minor programs" however, can be extremely misleading. While the criteria for determining what is minor is that it has not been officially designated as a "major program," and thus subject to far more attentive high level and congressional interest, a minor program can have a high overall dollar value when taken in its entirety. For instance, a small item of issue to an individual soldier may be relatively inexpensive in itself, but when issued or consumed in large quantity, becomes a considerable expenditure.

Another aspect of the term minor that is misleading, is that a minor problem can become a critical one and in time a major one if allowed to go unattended or unresolved.

The ultimate goal of Stolarick's job is the elimination of acquisition problems on minor programs, and theoretically the concurrent elimination of his own job. However, in a command as vast and diverse as DARCOM, with a constantly changing work program, there continues to be a need for this type of help. Anyone who feels strongly that the Army's interests are not being served because their program is in some way unnecessarily stymied or frustrated should contact Mr. Stolarick's office. The DARCOM telephone number is (202) 274-9559.

AMMRC Installs Hot Isostatic Pressing Unit

Installation of a hot isostatic pressing (HIP) unit—incorporating the latest state-of-the-art features to carry out a broad range of material processing requirements—has been announced by the U.S. Army Materials and Mechanics Research Center, Watertown, MA.

Dr. Saul Isserow, an employe in AMMRC's Prototype Development Division, reports that the HIP unit is a valuable example of AMMRC's expanding capability for applying modern techniques of powder metallurgy and other processes. AMMRC, says Isserow, expects to use HIP extensively to upgrade and introduce new materials.

Hot isostatic pressing, according to Isserow, was first developed to effect solid-solid bonding to achieve sound metallurgical bonds meeting rigorous nuclear requirements. Such bonding is currently being used for numerous Army applications.

The HIP process can also be used to heal castings and liquid-phase-sintered components by closing and sealing residual porosity. Savings in machining and material costs are expected.

AMMRC's HIP unit was assembled and installed by a private firm, and can be operated to 2500°F (1370°C) at 15,000 psi. The unit is thus capable of processing materials such as beryllium, nickel and titanium.

Contract Calls for Infrared Jammer

A contract for almost $11,700,000 has been awarded by the U.S. Army Electronics Research and Development Command (ERADCOM) to Sanders Associates, Inc., Merrimack, NH, for production of the AN/ALQ-144 jammer. The contract calls for production of 450 units to be delivered in 18 months.

The AN/ALQ-144 is a small, lightweight, omnidirectional infrared (IR) jammer designed to protect small and medium size Army helicopters from ground launched and air-to-air IR missile threats. It has four configurations, each consisting of a transmitter and control unit weighing less than 30 pounds.

Development of the jammer has been under the direction of ERADCOM's Electronic Warfare Laboratory, located at Fort Monmouth.

Capsules...

DARCOM Will Consolidate Missile Commands

The U.S. Army Materiel Development and Readiness Command (DARCOM) has established a new command at Redstone Arsenal, AL. Known as the U.S. Army Missile Command (MICOM), it was formed by consolidating the assets of the U.S. Army Missile Materiel Readiness Command (MIRCOM) and U.S. Army Missile Research and Development Command (MIRADCOM), both now collocated at Redstone.

The change was effective 1 July 1979, but implementation will be phased over 18 months to hold personnel turbulence to a minimum. Total employment will remain at current personnel levels. The MICOM commander will report to the commander, DARCOM in Alexandria, VA, and the new command will serve as a single manager for research, development, and materiel readiness of Army missile systems.

Realignment of the commands will reportedly reduce indirect overhead costs, permit better use of missile engineering talent and improve the ratio of employes to supervisors. It will also help facilitate transition from developmental to operational missile systems.

Merger of the two commands results from a continuing DARCOM review of its installations and agencies to use available resources in the best possible manner and to ensure that Army manpower is used in an efficient, cost-effective way.

ERADCOM Provides $77.4 Million for Radars

The U.S. Army Electronics R&D Command has announced award of a $77.4 million contract for an additional 22 artillery-locating radars (AN/TPQ-37), following an earlier order for production of 10 of the radars.

Hughes Aircraft Co., Fullerton, CA, recipient of the contract, recently delivered the first of the original 10 AN/TPQ-37s to the Army for acceptance testing. The new contract calls for delivery, beginning in October 1980, of one radar per month for 22 months.

The AN/TPQ-37 is the Army's first automatic radar that can detect and pinpoint the origin of hostile artillery and rocket launchers at their normal firing ranges. This is achieved by scanning the horizon and tracking a series of data points.

Responsibility for development of the AN/TPQ-37 and its counterpart, the AN/TPQ-36, a mortar locating radar, is assigned to Firefinder Project Manager COL Thomas Cameron, Fort Monmouth, NJ.

$24.7 Million Contract Orders GLLD Production

The U.S. Army Missile Command, Redstone Arsenal, AL, has announced award of a $24.7 million contract for engineering services and production of the Ground Laser Locator Designator.

Under the fixed price incentive fee contract, Hughes Aircraft Co. will establish production facilities and produce a first year quantity of GLLDs at their plant in Culver City, CA. The system weighs about 52 pounds and has been type classified "Standard" for issue to Army troops.

Tested extensively at Redstone, White Sands Missile Range, NM, and Fort Carson, CO, the GLLD has reportedly demonstrated its compatibility with Hellfire, Copperhead, Maverick, laser guided bombs, and airborne tracking devices. GLLD is also expected to be compatible with all U.S. and NATO laser guided systems.

In addition to guiding missiles, bombs and artillery shells fitted with a laser seeker, GLLD also acquires and identifies targets, determines range night or day, and gives azimuth and elevation for conventional artillery.

COL Benjamin Pellegrini, project manager for Ground Laser Designators, has tri-Service responsiblity for development and production of all ground laser equipment. Two other laser programs, now under development or in production, include the Laser Target Designator, and the Modular Universal Laser Equipment.

Army Awards $7.7 Million for Quick Look II

A $7.7 million contract, awarded recently by the U.S. Army Electronics Research and Development Command, Adelphi, MD, to UTL Corp., Dallas, TX, calls for production of Quick Look II, an information collection system. Ten airborne components and two ground receiving subsystems will be delivered over a 30-month period.

The Quick Look II system is the first to supply the battlefield commander with information on the location and identification of certain types of emitters on a real time basis. The first systems will be deployed early in 1980 and will be fully supported by the military logistical system.

Contract Calls for Subsystem Advanced Model

The U.S. Army Electronics Research and Development Command (ERADCOM) has awarded a 2-year, $13 million contract for the advanced development model of a signals intelligence/electronic warfare subsystem. This subsystem, to be used for the tasking and reporting of tactical signals intelligence and electronic warfare information, is part of the Army's development effort of an All Source Analysis System.

The contract calls for the development of hardware and software by RCA Corp. of Burlington, MA, the prime contractor, and HRB Singer Corp. of State College, PA, the subcontractor.

Hardware for the advanced model consists of five S-280 shelters containing central processing units, displays, entry devices, and peripheral equipment such as fixed and moving head discs, and communications equipment.

Software will be developed for both the model and the Technical Control and Analysis Center (Division) system. The division system is a quick-reaction capability system. It is needed to provide an interim automated signals intelligence/electronic warfare capability for U.S. Army divisions in Europe until a full division ASAS can be fielded. When funds are made available, a contract option to provide five Technical Control and Analysis systems will be exercised.

Both efforts will be managed by the Office of the Project Manager, Control and Analysis Centers, located at Vint Hill Farms Station, Warrenton, VA. Technical support is provided by the Signals Warfare Laboratory.

CSL Announces New Systems Development Division

COL John D. Spence, commander-director of the U.S. Army Armament R&D Command's (ARRADCOM) Chemical Systems Laboratory (CSL), has announced establishment of a new Systems Development Division.

The new division, formally approved in late February by MG Bennett L. Lewis, ARRADCOM commander, combines the Systems Assessment Office and the Planning and Technology Office. Both offices will be discontinued.

Thomas A. Treglia

Mr. Thomas A. Treglia, a veteran Chemical Corps engineer and technical administrator, will head the new division. The division is designed to provide the most responsive organizational alignment to assist the CSL commander-director in the direction, control, execution and assessment of the CSL's chemical weapons and chemical biological defense R&D programs.

Treglia began his combined military-civilian federal career at Edgewood Arsenal in 1950 when he was recalled to active military duty. He was initially assigned as project officer for field laboratory development in the Army Chemical and Radiological Labs.

After completing his military tour of duty, he was named assistant chief of the Labs Materials Development Branch. He progressed through a series of assignments and later headed up the Labs Packaging and Materials Research and then the Engineering Analysis Branch.

Treglia was appointed associate technical director for Engineering for Edgewood Arsenal in 1974 and remained in that position at CSL until the Army Armament Command's reorganization in 1977. He was chief of the CSL systems assessment office prior to the establishment of the Systems Development Division.

In 1973, Treglia was awarded the Meritorious Civilian Service Medal, the Army's second highest award presented to civilian employes for outstanding service.

Brown Approves Initial Production of 110 XM1s

Initial production of 110 XM1 Main Battle Tanks has been approved by Secretary of Defense Harold Brown. Incorporating revolutionary armor protection, enhanced firepower and improved mobility, the XM1 is scheduled to begin replacing the M60 series fleet in 1981.

Chrysler Corp. will produce the new main battle tank in the government-owned Army Tank Plant in Lima, OH, and the first XM1 is scheduled for delivery in February 1980. All 110 initial production vehicles will be used in extensive engineering and user oriented testing and training designed to confirm the system's technical and reliability performance.

Second year and follow-on production rates, leading to a total acquisition objective of 7,058 XM1 tanks, will depend upon attainment of specific performance goals.

Future production plans call for the Detroit Army Tank Plant to join the Lima facility once M60 production requirements are completed in 1982. Both plants will give the Army the capability to surge to a production rate of 150 tanks per month. Actual production rates will be determined by Congressional funding and Army requirements.

LACV-30 Receives Army Type Classification

The Army has type classified the LACV-30, an air cushion vehicle which can be used to transfer supplies from ships at sea to troops on shore. A company of 12 craft will be procured for Army use.

The LACV-30, adapted by the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA, for military use, can carry two ISO 20-foot containers weighing up to 30 tons. In Logistics-Over-The-Shore (LOTS) amphibian operations, the craft can negotiate surf regardless of tidal and bottom conditions and deliver cargo to the beach or inland to avoid beach congestion and possibility of enemy attack.

In addition to its ship-to-shore logistical mission, the LACV-30 could support secondary missions such as intermediate range logistics support, search, rescue, medical evacuation in coastal, harbor and inland waterways. The craft has also been used by the U.S. Coast Guard for icebreaking operations.

Plans call for MERADCOM to award a contract for the initial production of four craft in August with an option to purchase four more in 1980 and the remaining four craft in 1981.

Corps of Engineers Becomes Major Command

Designation of the U.S. Army Corps of Engineers as a major command (MACOM)—comprised of engineer divisions, districts, R&D laboratories, and other field agencies—was announced recently by the Department of the Army.

The new command will not include members and units of the Corps of Engineers' Branch of the Army, such as combat, facility, and construction engineers, and other units which are part of other MACOMs.

The DA announcement also indicated that the Office, Chief of Engineers will remain a DA staff agency under the current Chief of Engineers LTG John W. Morris. He will serve both as head of the OCE and as commander of the new MACOM.

Establishment of the new MACOM is expected to clarify the Corps functions within the Army. The move is also designed to increase the readiness of the Corps in the event of mobilization, and improve use of Corps services and resources.

There will be no increase in civilian or military personnel authorizations, and congressional and executive branch oversight of Corps programs will remain the same.

ALMC Announces 25th Anniversary Celebration

Twenty-five years after the establishment of its predecessor—the Army Supply Management Course—the Army Logistics Management Center, Fort Lee, VA, the largest educational activity of the U.S. Army Materiel Development and Readiness Command, is celebrating its 25th anniversary.

Present curricula consists of approximately 60 different courses, both in residence and non-residence. Courses cover the whole spectrum of logistics management, from R&D to property disposal and recycling. ALMC also offers courses in operations research/systems analysis, decision risk analysis and environmental management.

Students are not limited to DARCOM activities. About 10 percent of them are employes of the Defense Logistics Agency and its activities. Others are from the U.S. Army Training and Doctrine Command, the Forces Command, the Criminal Investigation Command, the Army Audit Agency, and others.

ALMC, in conjunction with the Florida Institute of Technology, offers two cooperative degree programs. They are a master's degree in either logistics management or contract and procurement management. In conjunction with Chapman College, ALMC also offers an undergraduate BA degree in economics and business administration with emphasis in logistics management.

Another ALMC educational mission is the Intern Training Center at Red River Army Depot, Texarkana, TX. The Center conducts supply management and maintenance career intern training and offers speciality training for DARCOM engineering interns.

Firm to Produce M60A3 Fire Control Systems

Production of 540 fire control systems for the M60A3 Tank is called for in a recent contract, totalling $54,925,020, awarded by the U.S. Army Armament Research and Development Command, Dover, NJ.

Hughes Aircraft Co. of Los Angeles, CA, is the recipient of the contract. Delivery of the systems of the U.S. Army Detroit Arsenal Tank Plant, Warren, MI, will begin late this year and continue through 1980.

WES Establishes Tracked-Vehicle Speed Record

A modern tracked-vehicle speed record was established recently by the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS. A standard M113 armored personnel carrier modified to use two Chrysler engines consistently achieved speeds over 74 miles per hour in three test runs.

Mr. Carl May of WES, the driver, achieved an average speed of 75.76 miles per hours over a 500-foot section of airport pavement. The tests are part of an Armored Combat Vehicle Technology program conducted jointly by WES, the U.S. Army Tank-Automotive R&D Command, Warren, MI; and the TRADOC, Fort Monroe, VA.

The program objective is to increase the survivability of ground vehicles in combat. Test results will be used to establish baseline data for high-powered combat vehicle performance. Other tests will be conducted to evaluate vehicle performance in different types of soil.

The M113 "hot rod" carries two 440 cubic-inch Chrysler V-8 engines and a special power train developed and installed by WES. It supplies over 700 horsepower for the 9-ton vehicle, or about 80 horsepower per ton.

Power of a standard M113 is about 17 horsepower per ton, and the Army's new XM1 battle tank has about 27 horsepower per ton. High octane airplane fuel drives the engines.

Primary emphasis of these tests is to study tracked-vehicle performance at high speeds. Subsequent tests will be necessary to evaluate other factors for overall vehicle design criteria. The tracked-vehicle speed record is believed to be 70 miles per hour, set by C. W. Wilson at Aberdeen Proving Ground, MD, in 1944.

WES Geotechnical Laboratory Chief Jim Sale congratulates Carl May for setting a new speed record for tracked vehicles of over 74 mph. Others who observed the tests include (from left) Newell Murphy, WES; Dr. Ron Bech, TARADCOM; Charles Green and Cliff Nuttall, WES.

London International Youth Science Fortnight winners (l. to r.) Bruce E. Anderson, Todd E. Hoffman, Eric D. Evans, Lisa A. Rone, Paul J. Hoehner and John V. Kubicek, flanked by (left) Dr. Robert H. Rines, president, Academy of Applied Science, and DARCOM Deputy Commander for Materiel Development LTG Robert J. Baer, and (right) U.S. Military Academy Dean of the Academic Board BG F. A. Smith Jr.

Conferences & Symposia . . .

ASA (RDA) Gives Keynote Address . . .

17th NJSHS Draws More Than 300 Participants

"High Technology and the Army's Role" was the title of the keynote presentation by Assistant Secretary of the Army (RDA) Dr. Percy A. Pierre, at the 17th National Junior Science and Humanities Symposium, at the U.S. Military Academy, West Point.

More than 300 students and teachers who participated in the symposium heard Dr. Pierre highlight some of the high potential areas of Army research and technology. Dr. Pierre specifically noted those areas in which the civilian community had benefited from military R&D. He also encouraged the young scientists to look to the government, and particularly the Army, when considering their career.

Forty-two students, selected at regional symposiums throughout the U.S. and at the Dependent Schools in Europe, presented papers on their original research. Six students were chosen to represent the U.S. at the forthcoming London International Youth Science Fortnight at the University of London.

Selectees, their schools, and the titles of their papers are: Bruce Edward Anderson, Oelwein High School, Oelwein, IA, "The Effect of Magnetism on Plant Growth and Productivity"; John Vinton Kubicek, Lincoln Northeast High School, Lincoln, NB, "Photodissociation of Hexamethylenetetramine as a Mechanism for the Production of Amino Acids and Polypeptides in a Prebiotic Environment"; Paul James Hoehner, Lutheran High School North, Mt. Clemens, MI, "Shock and Cardiac Arrest"; Eric David Evans, Stow High School, Stow, OH, "Dimensional Projection of Number Sequences and Their Applications"; Todd Everette Hoffman, Butte Falls Public Schools, Butte Falls, OR, "Aversive Conditioning in Raccoons"; and Lisa A. Rone, Starkville High School, Starkville, MS, "The In Vivo Effects of Endrin on ATPase Activity in Selected Tissues of Insecticide-Resistant and Susceptible Mosquitofish (Gambusia affinis)."

In addition to Dr. Pierre's presentation, Dr. Ernst Soudek of the University of Virginia School of Engineering spoke on "The Transformation of Western Civilization, or: Who's Really Afraid of Dr. Frankenstein." COL John A. Feagin, commander of the Keller U.S. Army Hospital at West Point, discussed "Pasteur, Lister and the Operating Room Environment."

The subject of "junk food" was addressed by Dr. Howard Appledorf of the University of Florida, Gainesville, in his presentation on "Nutrition for the Now Generation." Also, the highly innovative field of "Glass Fibers for Optical Communications" was discussed by Dr. Suzanne R. Nagel of Bell Laboratories.

University as well as military researchers also discussed various aspects of their work during eight seminar sessions. Subjects ranged from "The World Protein Shortage" by LTC Gerald Elkan, USAR and professor at North Carolina State University, to "Entropy and the Self-Regulation of Natural Geologic Systems" by Dr. Maynard Miller, State geologist for the State of Idaho. Mr. Richard N. Gottron, Harry Diamond Laboratories, introduced "Fluidics—Thinking With Air" to a group of the students.

U.S. Army Materiel Development and Readiness Command Deputy Commander for Materiel Development LTG Robert J. Baer presented certificates of achievement to the six London trip winners. He also awarded their high schools an Army Research Office plaque for "outstanding educational excellence."

The Junior Science and Humanities Symposium is an ongoing effort conducted by the U.S. Army Research Office, located at Research Triangle Park, NC. The JSHS program is designed to encourage young people to follow careers in mathematics, science, and engineering. More than 7,000 students participate annually in the Army effort.

ISEF Cherry Blossom Winner Gets 6 Awards

DARCOM Deputy Commander for Materiel Development LTG Robert J. Baer with (at left) London International Youth Science Fortnight winner Dale Distant and alternate Shirley Renuart, and Operation Cherry Blossom winner Elisabeth Bryenton and alternate Mark Miles.

Elisabeth A. Bryenton, a 17-year-old senior at Fairview H.S., Fairview Park, OH, set a new record of six for number of awards received for a single high school research project exhibited, during 30 years of International Science and Engineering Fair competition sponsored by Science Service.

Operation Cherry Blossom. Miss Bryenton was selected by the U.S. Army to receive an expense-paid trip to Tokyo, Japan, to attend the 23d Annual Japan Student Science Awards Program in January 1980. As one of 11 U.S. Army Superior Award winners, she also was awarded a Certificate of Achievement, a gold medallion and the choice of an expense-paid trip to, or summer employment at an Army research facility.

She also received $100 U.S. Savings Bonds and certificates of recognition from the General Motors Corp., the Patent and Trademark Office/U.S. Department of Commerce/Patent Office Society, and the U.S. Department of Agriculture; a certificate of merit and a one-year subscription to *Agricultural Research* from the U.S. Department of Agriculture; and a plaque, letter of congratulations from the Secretary of the Air Force, a $25 U.S. Savings Bond, and a one-week tour of research and development facilities from the U.S. Air Force.

Miss Bryenton's project "The Effect of Natural Nitrogen Fixation Through Algal Inoculants on Plant Growth and Development" demonstrated that treatment of various plants and grain crops with an algal inoculant was found to produce results at least equal to, and in many cases better than, those obtained with synthetic nitrogen compounds that require large amounts of petroleum.

Army alternate for the trip is Mark Miles, 17, Frederick Douglass H.S., Atlanta, GA, who was selected by the Army panel of

judges as a superior award winner for his exhibit "Plasma Propagation Through a Transverse Magnetic Field."

The Army has been participating in Operation Cherry Blossom since 1963 when it was initiated in cooperation with the Japanese newspaper *Yomiuri Shimbun*. The Association of the U.S. Army (AUSA) contributes $100 checks to winners of the Japan and the London trips.

London International Youth Science Fortnight. Army judges selected Dale Distant, 17, Benjamin N. Cardoza H.S., Bayside, NY, to receive an expense-paid trip to the London International Youth Science Fortnight. He will attend the event 24 July-8 August, along with six 17th National Junior Science and Humanities Symposium (JSHS) winners, for his exhibit "Effect of Starvation Upon Retention of the Maze Habit in *Dugesia dorotocephale*."

Shirley K. Renuart, 16, Cardinal Gibbons H.S., Fort Lauderdale, FL, was selected as alternate for exhibiting "Hydrologic Study of Oxygen Depletion by Effluents of Urban Waste."

LTG Robert J. Baer, deputy commander for Materiel Development, U.S. Army Materiel Development and Readiness Command (DARCOM), presented the awards to Army winners, with the assistance of COL Anthony P. Simkus, U.S. Army Research Office commander. Dr. Gordon Bushey, DARCOM, was chairman of the Army Panel of Judges. Mrs. Anne G. Taylor was Army project officer for the ISEF program.

Army Superior Awards also went to Lynda Suzanne Rhodes, 18, East Noble H.S., Kendallville, IN, for "A Study of PCBs—Phase IV—Effects on a Cellular Respiratory Enzyme"; Chris Gronet, 16, Oakland Mills H.S., Columbia, MD, for "The Storage of Solar Energy in Organic Photoisomers"; and

Mark W. Turner, 15, Niceville (FL) H.S., for "Determination of Rocket Nozzle Thrust Coefficients, Cf"; Richard Allen Garriott, 17, Clear Creek H.S., League City, TX, for "Wave Propagation With Computer Analysis II"; Robert John D'Amato, 17, Hempfield H.S., Landisville, PA, for "A Convenient Optical Method for Mass Diagnosis of Multiple Sclerosis"; and

Paul T. Graziano, 16, North Fort Myers (FL) H.S., for "The *in vivo* Study of the Chemotactic Response of White Blood Cells to Diffusion Chamber Implants"; and William P. Kulp, 17, Dallastown Area (PA) H.S., for "Effects of Exposure to a Magnetic Field on *Drosophila*."

Meritorious Awards of certificates of achievement and silver medallions went to Phil P. Guba, 18, Bloomington (IN) H.S.; Arani Bose, 17, Bronx (NY) H.S.; Forrest L. Piehl, 15, Keyser (WV) H.S.; David James Herring, 18, John Adams H.S., South Bend, IN; Kelly McAleese, 14, Black River H.S., Sullivan, OH;

Maria Teresa Conover, 15, Fletcher Jr. H.S., Jacksonville Beach, FL; Michael Howard Glassman, 17, Cherry Creek H.S., Englewood, CO; David John Dvorak, 17, Terre Haute (IN) North Vigo H.S.; Carlos Ortiz, 16, CROEM, Mayaguez, PR; Jeffrey Mitchell Bonds, 16, Warren Central H.S., Bowling Green, KY; and Kent Rhodes, 16, Marshalltown (IA) Senior H.S.

The 22 Army winners were selected from more than 450 finalists who exhibited science/engineering projects at the 30th International Science and Engineering Fair (ISEF), San Antonio, TX.

Design of Experiments Meet Slated for Natick

The 25th Conference on the Design of Experiments (DOE) in Army Research, Development and Testing will be held, 17-19 Oct., at the U.S. Army Natick (MA) Research and Development Command. The DOE conference was initiated by the eminent statistician Prof. S. S. Wilks, who served as conference chairman until his death.

The Army Research Office (ARO) in conjunction with the Army Mathematics Steering Committee (AMSC) has maintained the conference excellence enjoyed under the former leadership of Prof. Wilks. The 15th annual presentation of the Samuel S. Wilks Memorial Award and Medal will be made at this conference in conjunction with the American Statistical Association.

Dr. Douglas B. Tang of the Walter Reed Army Institute of Research, Washington, DC, is chairman of the Subcommittee on Statistics and Probability of the AMSC. Mr. Donald Kass of the Natick R&D Command will be chairman of local arrangements.

Several features in this year's agenda will point out the special significance of the 25th anniversary of this conference. The program will be dedicated to Dr. Francis G. Dressel, formerly Professor of Mathematics at Duke University.

For the past 25 years, Dr. Dressel coordinated conference programing and local arrangements, and has edited proceedings of this and other ARO sponsored conferences. The DOE Program Committee invites Dr. Dressel's friends to join in expressing appreciation for this loyal service.

The program will begin with a special invited address by Dr. Frank E. Grubbs, formerly of the U.S. Army Ballistic Research Laboratory, and a renown statistician. His talk is titled, "A Quarter Century of Army Design of Experiments Conferences."

Other invited speakers and their topics are: Mr. Al L. May, Pillsbury Research Labs, "Designed Experiments in Sensory Testing"; Mr. Ray E. Schafer, Hughes Aircraft Co., "Computer Aided Hypothesis Tests—The Birnbaum Test"; Mr. Warren Stewart, The Mathematics Research Center and the University of Wisconsin, "New Algorithms for Nonlinear Least Squares and Bayesian Parameter Estimation"; and Mr. Marvin Zelen, Harvard University, "Ethics and Strategy in Therapeutic Investigations."

A special 2-day tutorial, held in conjunction with the DOE conference, will also be held at the Natick R&D Command on 15-16 Oct. Prof. Stephen Fienberg of the University of Minnesota and a noted researcher in discrete data analysis will instruct the course entitled, "Contingency Table Analysis," based on his text *The Analysis of Cross-Classified Categorical Data.*

Mr. Donald Kass will send the host invitational letter early in September. Further information about this symposium and workshop can be obtained from Dr. Robert L. Launer, Mathematics Division, Army Research Office, P.O. Box 12211, Research Triangle Park, NC 27709.

7 Nations Attend Smoke Symposium III at HDL

More than 250 military, industrial and academic representatives from the U.S., United Kingdom, Canada, France, Denmark, Norway, and Israel participated, earlier this year, in Smoke Symposium III at the U.S. Army's Harry Diamond Laboratories, Adelphi, MD.

Convened by COL Henry R. Shelton, PM Smoke/Obscurants, the symposium was designed to disseminate current information related to technology and development achievements, effects of battlefield obscurants environments on weapons systems, modeling, instrumentation and methodology, and smoke/obscurant operational concepts.

Thirty papers were presented on such subjects as modeling the effects of smoke, dust, and battlefield debris upon electro-optical systems; determination of obscurant characteristics; measurement of electro-optical system performance in an obscurant environment; military smokes and smoke munitions; doctrine and training from combat in a smoke environment; and systems evaluation and analysis.

One session, limited to U.S. Government agency participation, discussed evaluation of electro-optical device performance in obscurant environments, hardware testing in Smoke Week II, conducted November 1978 at Eglin Air Force Base, tactical employment of smoke, and conceptual development of countermeasures.

Significant highlights and conclusions of the symposium were:

- Smoke Week II, wherein the PM Smoke made available to developers of electro-optical devices characterized smoke/dust environments for evaluation of counter measuring effects on such systems, was successful in generating participation and met the goal of providing meaningful data.
- Extensive effort in both laboratory experiments and field tests has provided an abundance of technical data which is available to the modeling and developer communities.
- Instrumentation and methodology, although greatly improved during the past three years, need to be further improved to characterize battlefield obscurants, and to evaluate electro-optical devices.
- Validation of models for predicting effects of smoke, dust, and battlefield debris upon performance of electro-optical devices has progressed; however, additional effort remains for comparing model predictions with empirical data.
- Smoke symposiums serve a useful purpose in disseminating and exchanging information relating to development of obscurant/electro-optical systems and their associated tactics and doctrine. These symposiums should be continued on an annual basis.

Proceedings of Smoke Symposium III, classified Confidential, were published and distributed in June.

Navy Will Host Nondestructive Test Conference

The 28th Defense Conference on Nondestructive Testing (NDT) will be hosted by the U.S. Navy at Pensacola Beach, FL, 27-29 Nov. 1979. The conference is scheduled during the first quarter of FY80 to allow all activities adequate lead time for planning and budgeting purposes.

Hosted annually on a rotational basis by the Air Force, Army, and Navy, the conference brings together military and civilian scientists, engineers, technicians, and managers who have the responsibility for development or application of NDT methods in R&D, engineering, maintenance and quality assurance work.

The prime purpose of the meeting is to provide a forum in which agencies of the DOD can disseminate information and develop potential solutions to problems in the field of NDT. Specific objectives are: To interchange information pertaining to NDT methods and applications; and, to present technical problems advance potential solutions.

The deadline for submission of summaries was 31 May 1979. Additional conference information may be obtained from Mr. Eli F. Nicosia, Naval Air Rework Facility Code 341, Naval Air Station, Pensacola, FL 32508, or commercial telephone 922-3551.

BRL Hosts Army Mathematicians Conference

Prof. Benjamin Noble and ASA (RDA) Dr. Percy A. Pierre.

New mathematics technology applications to current and envisioned U.S. Army materiel research and development problems were discussed during the 25th Conference of Army Mathematicians at the Johns Hopkins University, Baltimore, MD.

The U.S. Army Ballistic Research Laboratory was host to the Silver Jubilee meeting. The conference is one of three annual ones sponsored by the Army Mathematics Steering Committee. This year's theme was "Continuum Mechanics."

Army Ballistic Research Laboratory Director Dr. R. J. Eichelberger opened the conference with welcoming remarks. Conference chairman was Dr. Jagdish Chandra, Army Research Office. Dr. Stephen S. Wolff, BRL, was local arrangements chairman.

Keynote speaker Prof. R. S. Rivlin, Lehigh University, discussed "The Mechanics of Non-Newtonian Fluids." Another featured speaker, Prof. Werner Goldsmith of the University of California-Berkeley, reviewed "Mathematical Modeling of Some Aspects of Penetration of Plates."

Other invited speakers included Prof. Daniel D. Joseph, University of Minnesota, "Motions Which Perturb States of Rest of Viscoelastic Solids"; Prof. S. Nemat-Nasser, Northwestern University, "Finite Deformation Plasticity and Plastic Instability"; Prof. George Papanicolaou, New York University, "Effective Parameters and Fluctuation Phenomena in Continuum Mechanics"; Prof. Harry Tiersten, Rensselaer Polytechnic Institute, "Theory of Interpenetrating Solid Continua and Some Applications"; and Prof. Morton Gurtin, Carnegie-Mellon University, "Recent Results in Finite Elasticity."

A special feature of this year's Conference of Army Mathematicians was presentation of the Decoration for Distinguished Civilian Service to Prof. Benjamin Noble, director of the Mathematics Research Center at the Univ. of Wisconsin-Madison.

Assistant Secretary of the Army (RDA) Dr. Percy A. Pierre presented the award at the conference banquet. He praised Prof. Noble's "outstanding scientific contributions" to the field of mathematics, and stressed that Prof. Noble had made the MRC more responsive to the Army's needs.

Dr. Pierre also discussed the essential role that mathematics plays in the analysis and modeling of a wide variety of problems that arise in Army science, engineering, and operations. He noted that farsighted management decisions will be necessary to reconcile future Army needs with short-term pressures.

Career Programs . . .

75 Personnel Chosen for 1979 MARED Program

Selection of 75 civilian personnel for participation in the 1979 U.S. Army Materiel Development and Readiness Command Materiel Acquisition and Readiness Executive Development (MARED) Program, has been announced.

Initiated in 1976, the MARED Program is designed to provide career development opportunities for civilian employes whose employment records indicate high potential for future executive responsibilities.

Selection into the program is based upon a review of GS-13 through GS-15 applicants who are employed in the fields of science and engineering, procurement, quality and reliability assurance, supply management, materiel maintenance management, and transportation.

Qualifications of this year's 146 applicants were screened first at the field command level, and later by a DARCOM career program panel. Final selections were made by a high level MARED Board. All selectees must commit themselves to geographical mobility and five years of additional government service.

A 4½-day seminar was held, 24-28 June, in St. Louis, MO, to provide this year's selectees with individual counseling, an Individual Development Plan outlining short and long range training and duty assignments, and to present an overview of DARCOM's present and future management picture.

Listed by their agency/activity, the 1979 MARED Program selectees are:

HQ Army Materiel Development and Readiness Command. Marie B. Acton, logistics management specialist; Roy L. Arnold, industrial specialist; Frederick Bierman, procurement analyst; Robert J. Fahy, quality assurance specialist; David W. Foulk, quality assurance specialist; Walter J. Hodgins, logistics management specialist; William Holley, supervisory maintenance management specialist; Ralph E. Hoyle, logistics management specialist; Melvin E. McGee, quality assurance specialist; Frederick J. Michel, general engineer; Harold S. Tiernan, supply systems analyst; Bruce H. Waldschmidt, industrial specialist.

HQ Army Armament Research and Development Command. Lewis S. Fichter, operations research analyst; William Stank, contract specialist; Clinton J. Williams Jr., contract specialist. *HQ Army Armament Materiel Readiness Command.* Carl C. Dietz, general engineer; Byron O. White, mathematician. *HQ Army Test and Evaluation Command.* Robert M. Braun, electronics engineer; Donald R. Jeanblanc, aerospace engineer; Richard K. Sparks, electronics engineer. *HQ Army Mobility Equipment R&D Command.* Martin E. Falk, civil engineer; John V. Lavery, general engineer; Lynwood M. Rabon, general engineer.

Corpus Christi Army Depot. John R. Falkenham, procurement officer; Don L. Roland, industrial operations manager; Francis D. Sharp, supervisory supply systems analyst; Ward R. Whitehead, materiel maintenance manager. *Yuma Proving Ground.* Robert E. Elmore, electronics engineer; James N. Mitchell, general engineer. *HQ Troop Support and Aviation Materiel Readiness Command.* Charles W. Armbruster, supervisory inventory management specialist; Larry D. Johnston, general engineer; Maurice N. Shriber, supervisory inventory management specialist. *Rock Island Arsenal.* Gary L. Lomax, chemical engineer.

HQ Army Aviation R&D Command. Betty A. Parker, logistics management specialist; Gene A. Mongiordini, procurement officer; John K. Shannon, product assurance engineer; Shirley Smith, aerospace engineer. *HQ Army Natick R&D Command.* Robert S. Smith, physical science administrator; Robert J. Walsh, supervisory mechanical engineer. *PM TRADE.* Phillip E. Sprinkle, general engineer; Paul E. Wampner, general engineer. *HQ Army Tank Automotive Materiel Readiness Command.* Arthur M. Hopkins, logistics management specialist; Richard W. Siorek, senior program engineer.

HQ Army Missile Materiel Readiness Command. William F. Keith, inventory management specialist; Thomas E. Leech, industrial engineer. *HQ Army Electronics R&D Command.* Jay C. Billings, procurement analyst. *HQ Army Communications and Electronics Materiel Readiness Command.* James W. Brown, electronics engineer; Anthony J. Consentino, electronics engineer. *LAO, Fort Huachuca, AZ.* Hardie Lenquire, logistics management specialist. *LAO, Fort Riley, KS.* Phillip N. Brooks, logis-

tics management specialist. *LAO, Fort Carson, CO.* Harold W. Josephson, logistics management specialist. *LAO, Fort Shafter, HI.* James W. Rose, logistics management specialist. *LAO, Nellingen, Germany.* Harro Zuest, logistics management specialist.

HQ Army Security Assistance Center. Marie E. Hurley, supply systems analyst; James C. Thomas Sr., logistics management specialist. *HQ Army Missile R&D Command.* William R. Rencher, contract price analyst. *Office, PM Stinger (MIRADCOM).* John W. Howerton, aerospace engineer. *Office, PM Viper—AHAMS (MIRADCOM).* Sarah H. Kelly, procurement analyst. *Office, PM Hellfire (MIRADCOM).* James E. Shepard, supervisory general engineer. *Office, PM Patriot, Redstone Arsenal.* Ralph O. Limmer, electronics engineer.

PM, Kuwait/Jordan Missile Systems (MIRCOM). William A. Fondren, supervisory general engineer. *PM, DCS (Army) Communication Systems.* Thomas J. Michelli, electronics engineer. *New Cumberland Army Depot.* Michael A. Buchanan, general supply specialist. *Savanna Army Depot.* Thomas P. Lighthiser, supply management representative. *Tooele Army Depot.* Kara J. Jarman, supervisory computer specialist.

Dugway Proving Ground. Walter Gooley Jr., physical scientist. *White Sands Missile Range.* Woodie R. Jenkins, supervisory industrial engineer. *Aberdeen Proving Ground.* James C. Liu, general engineer. *Army Support Activity, Philadelphia.* James P. McDonald, supervisory inventory management specialist. *HQ Tank Automotive Materiel Readiness Command.* Gary Neuman, OPM research analyst. *PM, NAVCON, Fort Monmouth.* Donald P. Clark, supervisory logistics officer. *Avionics R&D Activity, Fort Monmouth.* Richard H. Gregory, electronics engineer. *Applied Technology Lab, Fort Eustis.* George T. Singley III, aerospace engineer. *Automated Logistics Management Systems Activity.* Arlene C. Nurre, procurement and production analyst. *Electronic Warfare Lab, Fort Monmouth.* Michael T. Kokinda, electronics engineer.

Shulman Begins Executive Training Program

William Shulman

Mr. William Shulman, who began his federal civil service career more than 22 years ago as a GS-3, recently began the first leg of the Army Armament R&D Command's Chemical Systems Laboratory (CSL) executive-technical development training program.

Shulman, lead engineer for the Non-Lethal Disposal Program in CSL's Munitions Division, is the 31st Edgewood Arsenal-CSL employe appointed to the 6-month Technical Executive Program established in 1970 by Dr. B. L. Harris, CSL's deputy director.

He received a BS degree in chemical engineering from the University of Maryland, College Park. He entered federal civil service in 1956 with the Department of Agriculture, and upon college graduation, was assigned to the Edgewood Arsenal Engineering Command as a chemical engineer. Shulman is a member of the American Institute of Chemical Engineers, the Alpha Chi Sigma, and was listed in the 75-76 *Who's Who in the East.*

A former Rabbinical student at the New Israel Rabbinical College, he is currently researching and writing a book comparing Biblical law with the current law of land warfare. He hopes to have it published within two years.

ALMC Presents Workshops on OMB Circular A-76

The U. S. Army Logistics Management Center (ALMC), Fort Lee, VA, has been requested to present approximately 22 one-week workshops, at numerous locations, on the new Office of Management and Budget (OMB) Circular A-76 and related Cost Comparison Handbook.

The workshops, which began on 4 June, will continue until 25 Oct. throughout the United States and one overseas location (Germany). To augment the ALMC faculty for these presentations, the Department of Defense has tasked the Air Force and the Navy to each provide two instructors.

The Commercial/Industrial Review Program Workshop is designed to provide attendees with enough basic policy and procedural knowledge to become successful cost study team members. Instruction is intended to be a "coaching" session using a fictionalized cost comparison as the teaching tool.

Nominees for the workshops will be chosen because of their involvement in the cost comparisons, and will be from those installations and commands where Fiscal Year 1980 cost comparisons have been planned.

These workshops are part of a DOD program to study possible conversion from in-house operation to commercial contract of various functions at military installations. This program is part of a continuing requirement of OMB for all federal agencies to periodically review in-house operations and make conversion to contract when it is less costly to the government.

Fiscal Year 1980 studies already announced involve 24,000 jobs in the DOD. FY79 cost comparisons now underway total 10,000 positions. About 22 percent involve military spaces. The DOD believes these studies could result in decisions to convert to contract and lower operating costs by about $33 million.

After firm bids and/or offers have been received from potential contractors and compared to audited in-house costs, a decision will be made. Each of these studies is expected to take approximately nine months to complete. If contracting is more cost effective, conversion would take place with 90-120 days.

CSL Picks D'Andrea for Executive Training

Joseph A. D'Andrea

Mr. Joseph A. D'Andrea, a project engineer, has been selected to participate in the Armament R&D Command's Chemical Systems Laboratory's (CSL) executive-technical development training program. Assigned to CSL's Environmental Technology Division, D'Andrea is the 32d employe selected for the tech-exec program which was established in 1970.

D'Andrea will receive three months of intensive executive and managerial training at CSL headquarters and then receive an equal period of training at HQ U.S. Army Materiel Development and Readiness Command, Alexandria, VA.

D'Andrea served in the Army Signal Corps from 1952-54, before attending the University of Delaware where in 1959 he received a bachelor of science degree in engineering. In 1970, he was assigned to the Army Small Arms Systems Agency at APG. Three years later, he transferred to Edgewood Arsenal, and subsequently to CSL.

Awards . . .

Jernigan Receives Meritorious Service Award

Mr. James J. Jernigan, an employe of the U.S. Army Missile Command, recently received the Department of the Army's Meritorious Civilian Service Award. The award, which is the Army's second highest for civilians, was presented by Dr. Walter B. LaBerge, Under Secretary of the Army, during the Secretary's visit to Redstone Arsenal, AL.

The citation, signed by Secretary of the Army Clifford Alexander, commended Jernigan for his outstanding performance as study director, Project Successor. His efforts, the citation states, were instrumental in achieving acceptance of the Patriot missile as the European air defense replacement for Nike Hercules.

Awards Ceremony Honors 80 Patent Holders

More than 80 patent holders were recognized in a recent U.S. Army Electronics Research and Development Command (ERADCOM) award ceremony. Three of the inventors were given special honors for having received eight or more patents.

MG Charles D. Daniel Jr., ERADCOM commander, commended the group of scientists for their "contributions and achievements which make important headway in fields of great interest to our government." He presented 104 patents. The honorees are employed in ERADCOM's Technical Support Activity, Electronics Technology and Devices Laboratory (ETDL), Combat Surveillance and Target Acquisition Laboratory, Night Vision and Elec-

tro-Optics Laboratory, and Electronics Warfare Laboratory.

Patents granted to the inventors covered a broad range of scientific fields, including color-signature of targets in photo-optics, energy conversion, high energy density power sources, microstrip antennas and antenna feeds, electron beam scanning antennas, crystal growth, electron beam semiconductor devices, and slow wave structure.

The three inventors who received special honors are all employed in the Electronics Technology and Devices Laboratory. Recognized for patents awarded during the past three years were John Carter, inventor of eight patentable devices and systems; Joseph McGowan, recipient of nine joint and individual letters patent; and John Vig, recipient of 10 patents.

ARI Receives Army Award for Excellence

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has received a Department of the Army Research and Development Award for Excellence. LTG Robert G. Yerks (above, left), deputy chief of staff for Personnel, Department of the Army, presented the award.

General Yerks rated ARI with an "A" for excellence for addressing so many different and difficult areas having the broadest definition of research. He cited ARI's valuable service to soldiers, decision-makers, and the national security interest.

In accepting the award, COL William L. Hauser, ARI commander (center), and Dr. Joseph Zeidner (right), ARI technical director and chief psychologist of the U.S. Army, expressed renewed commitment toward excellence. They pointed out that the task of conducting Army research in the behavioral and social sciences is immense—and often difficult for others to perceive and define.

Also present was Dr. Eugene E. Yore, deputy for Science and Technology, Office, Assistant Secretary of the Army for Research, Development, and Acquisition. He emphasized ARI's reputation for "enhancing high quality among Army labs." He cited ARI's timely response to human issues.

Natick Presents Annual R&D Incentive Awards

Achievements in research, engineering, and administrative leadership were recognized recently during an annual incentive awards ceremony at the U.S. Army's Natick (MA) Research and Development Command.

The Technical Director's Gold Pin for Research was presented to *Mr. Leo G. Holmes* of the Food Sciences Laboratory. He was cited for development of a new method for determining the amount of soy flour protein added to ground meats. Soy flour is often added for economic or nutritional purposes.

Mr. Edmund M. Powers, also from the Food Science Laboratory, received one of the two Technical Director's Silver Pins for Research. He was credited for research leading to development of a rapid assay for the enumeration and identification of fecal coliforms in foods.

A second Silver Pin for Research was shared by *Dr. Irvin A. Taub,* Food Engineering Laboratory, and *Dr. Charles A. Merrit Jr.* and *Dr. Pio Angelini,* both of the Food Sciences Laboratory. They were honored for investigation of the radiation chemistry of food and food components and for studies of formations and reactions of primary and secondary radicals and other species.

The Technical Director's Gold Pin for Engineering was presented to a team of five Natick professionals comprised of *Mr. Richard P. Richardson, Dr. D. Paul Leitch, Mr. Brian M. Hill, Mr. Paul Short,* all from the Operations Research/Systems Analysis Office, and *Mr. George Turk,* Food Engineering Laboratory.

They were praised for their analysis and engineering of a totally new concept of military food service for use on naval aircraft carriers. The concept has been initiated aboard the *USS Saratoga* and has reportedly resulted in increased personnel attendance, satisfaction, and morale. Improvements in space utilization, food quality and worker productivity have also been realized.

Recipients of the Technical Director's Silver Pin for Engineering were *Mr. Thomas F. Goodrick,* Aero-Mechanical Engineering Laboratory, and *Mr. Frank P. Calabrese* of the Clothing Equipment and Material Engineering Laboratory.

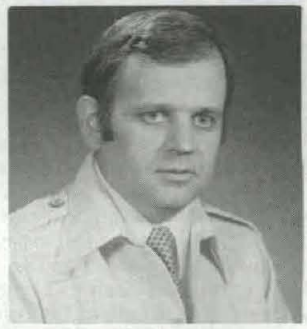
Goodrick was cited for developing a computer program which permits simulation studies of the flight dynamics of gliding parachute systems. Calabrese was credited for his work which led to the adoption of a new filament polyester and hollow cut staple polyester fiber insulating materials for the intermediate sleeping bag.

The Commander's Award for Military Personnel for Research, Development, Test and Evaluation Achievements was won by *CPT Kerry W. Wyant* of the Food Sciences Laboratory. He was recognized for his work as principal investigator on the project entitled "Prediction of Food Habits Changes in Air Force Personnel."

The Commander's Gold Pin for Leadership in Administration went to *Mr. Daniel F. Shimkus* of the Engineering Program Management Office. He was cited for outstanding management of Natick's Value Engineering Program.

Mr. Maurice P. Gionfriddo, an aerospace engineer in the Aero-Mechanical Engineering Laboratory, received the Silver Pin for Leadership in Administration. He was credited for major contributions to the development and fielding of airdrop equipment and techniques.

Army Physicist Gets Patent for Amplifier Device



Louis J. Jasper Jr.

Mr. Louis J. Jasper Jr., a physicist at the U.S. Army Communications and Electronics Materiel Readiness Command, has been granted a patent for development of a magnetic-bubble traveling wave amplifier which is expected to have wide application in military equipment.

Although traveling wave amplifier tubes are of great importance in high frequency applications, and magnetic-bubble techniques are used extensively in computer storage devices, this reportedly marks the first time such techniques have been used in traveling wave amplifiers.

The result of this technological union, Jasper explains, is a solid state traveling wave amplifier that lends itself to miniaturization and to operation in the millimeter wave region.

Unlike conventional traveling wave tube amplifiers, which use an electron beam and evacuated envelope, the magnetic-bubble traveling wave amplifier avoids these complications and hence, can be built simply, economically and with great reliability.

Because of an urgent need for low cost, compact and reliable traveling wave amplifiers in military equipment, the newly patented device is projected for extensive use in military communications, radar and jamming systems.

Jasper, who holds master's degrees in physics and mathematics, previously received an Army Research and Development Achievement Award and an Army Science Conference award for his work in the field of microwave devices and subsystems. He holds five patents and has written numerous published papers.

ERADCOM Employes Patent Circuit Chip Tests

Mr. Owen P. Layden, an electronics engineer, and Mr. Francis J. Murdoch, a physicist, both civilian employes of the Army Electronics R&D Command at Fort Monmouth, NJ, have been granted a patent on a device for shock-testing small electronic circuit chips. The device tests strength of adhesives used in microcircuit packages to establish reliability in high-G environments.

When electronic circuitry is placed behind enemy lines for surveillance purposes, the microcircuit chips and substrate bonds are subjected to high-G forces that can cause failure. Previously known pull testers were difficult to utilize with such small components under high-shock conditions.

The patented device secures the component to an adhesive layer at the end of a rotary arm and uses the centrifugal force of the rotating arm to test the adhesive. Additional masses can be added to the component to multiply the pulling effect on the bond and obtain the desired G-forces which will be experienced.

Layden, who has been employed at Fort Monmouth the past 26 years, holds a BS degree in electrical engineering from the University of Notre Dame, and his master's in electrical engineering from Rutgers University. He has written or presented more than 20 technical papers. He is team leader of the Hybrid Microcircuits and Assembly Team in the ERADCOM Electronics Technology and Devices Laboratory.

Murdoch, who has been employed at Fort Monmouth 12 years, is also assigned to the Hybrid Microcircuits and Assembly Team. He holds a BS degree from North Carolina State University, and his master's in physics from Polytechnic Institute of Brooklyn.

CERCOM Electronics Technician Gets 4th Patent

Mr. John L. Kerr, an electronics technician at the U.S. Army Communications and Electronics Materiel Readiness Command, Fort Monmouth, NJ, has been granted his fourth patent for an antenna using elements on printed circuit boards.

A basic "microstrip" antenna uses a printed circuit board which is copper clad on both sides with part of the copper etched away on one side to leave a patch used as a radiating element at a resonant ultra-high frequency.

Kerr and a co-inventor, Mr. Michael J. Timochko, discovered that a hole could be etched in the center of the patch, and that this reduced its size. It was also possible to leave a small patch in the center of the hole on the same or a separate board to radiate at a second much higher frequency.

Chemist Gets Patent for Electrode Development

John Perry Jr.

Mr. John Perry Jr., a chemist at the U.S. Army Communications and Electronics Materiel Readiness Command, Fort Monmouth, NJ, has been granted a patent for a new method of making a fuel cell electrode. It represents an improvement in electrode development, by reducing the cost of catalyst in fuel cells.

The invention concerns a method of producing fuel cell anode electrodes for use in methanol-air and ethylene glycolair fuel cell batteries. These fuel cells have been investigated for use in military equipment.

The high cost and quantity of noble metals, such as platinum and palladium required for anode electrode fabrication, has been one of the factors limiting the acceptance of these fuel cells. Perry's invention provides for fabrication of an anode electrode with low noble metal catalyst loadings of platinum, doped anodically with lead dioxide. Total loading is reduced by 81 percent.

The performance of cells with the new anode electrodes reportedly gives about the same performance as the cells with anodes containing high quantities of noble metal catalyst. Perry has authored 19 technical publications relating to his fuel cell work, and has been awarded three previous patents in this area.

Employed at Fort Monmouth since 1951, he has been assigned to the Electronic Technology and Devices Laboratory since 1956.

Personnel Actions . . .

Johnson Follows Burnell as Engineers' Deputy

MG James A. Johnson

The Department of the Army has announced that MG James A. Johnson has succeeded MG Bates C. Burnell as the U.S. Army Corps of Engineers' deputy chief of Engineers. MG Johnson had served since May 1977 as division engineer for the Corps' North Atlantic Division.

A 1947 graduate of the U.S. Military Academy, MG Johnson holds a master's degree in engineering from Stanford University, and is a graduate of the Army Command and General Staff College and the Industrial College of the Armed Forces.

MG Johnson has commanded the Army Engineer Center and Fort Belvoir, VA, and has served as commandant of the Army Engineer School. Other tours have included director of Military Engineering and Topography, Office of the Chief of Engineers, Washington, DC, district engineer, Philadelphia District; and deputy district engineer, San Francisco.

MG Johnson's staff assignments have also included director, Industrial Preparedness and Munitions Production, Office of the Secretary of Defense; staff officer, Office, Assistant Chief of Staff for Force Development; and assistant secretary to the general staff, Staff Action Control, Office of the Chief of Staff.

Among MG Johnson's military awards are the Distinguished Service Medal, Silver Star, two awards of the Legion of Merit, two Bronze Star Medals, Air Medal, Joint Service Commendation Medal, Army Commendation Medal, and combined Infantry Badge and Parachute Badge.

Hardin Chosen as DARCOM Materiel Readiness DC

MG Harold F. Hardin Jr.

Nomination of MG Harold F. Hardin Jr. for 3-star rank and assignment as deputy commander for Materiel Readiness, HQ U.S. Army Materiel Development and Readiness Command, was announced by Secretary of Defense Harold Brown.

MG Hardin, who has served since March 1977 as commander of the U.S. Army Tank-Automotive Materiel Readiness Command, Warren, MI, replaces LTG J. D'Ambrosio, following his retirement from active military service.

Graduated with a BS degree in history from Loyola University of Los Angeles and an MBA degree in industrial management from Babson Institute, MG Hardin has completed requirements of the Command and Staff Course (Naval War College), Army War College, and the Ordnance School (Advanced Course).

Listed among his previous assignments are director of Requirements and Procurement, HQ Army Materiel Command; director of Procurement and Production, Army Armament Command; and deputy director of Requirements and Procurement, Army Materiel Command.

Paige Assumes Duties as CORADCOM Commander

BG (P) Emmett Paige Jr., commander of the U.S. Army Communications Systems Agency, Fort Monmouth, NJ, since 1976, has assumed new duties as commander of the U.S. Army Communications Research and Development Command, also at Fort Monmouth.

A veteran of more than 26 years of active military service, BG Paige served during 1974-76 at Fort Huachuca, AZ, first as dep-

uty chief of staff of the U.S. Army Communications Command, and later as commander of the 11th Signal Group.

His other key assignments have included chief, Voice Network Global Management Branch, Operations Directorate, Defense Communications Agency, and commander, 361st Signal Battalion, 1st Signal Brigade, U.S. Army Strategic Communications Command, Vietnam.

BG Paige has a BA degree in business administration from the University of Maryland and a master's degree in public administration from Pennsylvania State University. He is a graduate of the Command and General Staff College, and Army Signal School courses.

Listed among his military honors are the Legion of Merit with two Oak Leaf Clusters, Bronze Star Medal, Joint Service Commendation Medal, Army Commendation Medal, and the Meritorious Service Medal.

BG Emmett Paige Jr.

Lasher Commands Communications Systems Agency

Commander, U.S. Army Communications Systems Agency, Fort Monmouth, NJ, is the new title of BG Donald R. Lasher, following an assignment since 1978 as project manager, Army Tactical Data Systems/deputy commander, Communications R&D Command.

BG Donald R. Lasher

A graduate of the U.S. Military Academy, BG Lasher holds an MS degree in industrial engineering (data processing) from Stanford University. He has also completed requirements of the Command and General Staff College, Army War College, and the Army Signal School basic and advanced courses.

During 1976-77, BG Lasher served tours of duty as PM, Multi-Service Communications Systems, U.S. Army Electronics Command, and as PM, ARTADS. He served also in 1976 as director (PM designee), Position Location Reporting System/Tactical Integrated Distribution System, PM, ARTADS.

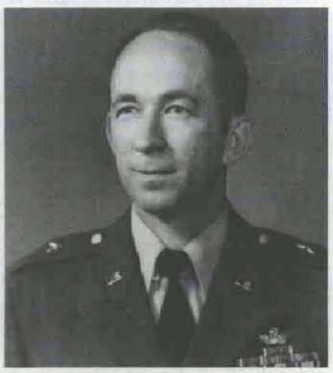
From 1973-76, he was assigned first as chief, Intelligence, Electronic Warfare and Control Systems Division, U.S. Army Training and Doctrine Command, and later as commander, director, Data Processing Laboratory, Army Electronics Command.

BG Lasher has more than 25 years of active military service and he is a recipient of the Legion of Merit with two Oak Leaf Clusters (OLC), the Air Medal, Army Commendation Medal with OLC, and the General Staff Identification Badge.

McNair Chosen as Aviation Center Deputy

BG Carl H. McNair Jr. has been named deputy commander of the U.S. Army Aviation Center and Fort Rucker, AL, following duty since July 1978 as deputy director of Requirements and Army Aviation Officer, Office, Deputy Chief of Staff for Operations and Plans.

BG McNair received a BS degree in military science from the U.S. Military Academy, a BAE and an MS degree in aerospace engineering from Georgia Institute of Technology, and an MS in public administration from Shippensburg State College.



BG Carl H. McNair Jr.

His military schooling includes the U.S. Army War College, the Armed Forces Staff College, the U.S. Army Aviation School, and the Infantry School basic and advanced courses.

During 1977-78, BG McNair served as executive to the Army deputy chief of staff for Research, Development, and Acquisition. From 1974-77, he was assigned first as commander, Troop Brigade, U.S. Army Aviation Center, Fort Rucker, and later as deputy for Aviation to the Assistant Secretary of the Army (R&D), Office, Secretary of the Army.

His tours of duty have also included deputy director, Command, Control, and Communications Directorate, MASSTER, Fort Hood, TX, and chief, Career Branch, Office of Military Instruction, Department of Tactics, U.S. Military Academy.

BG McNair is a recipient of the Legion of Merit with two Oak Leaf Clusters (OLC), Distinguished Flying Cross with three OLC, Bronze Star Medal with "V" device and OLC, Air Medals, Army Commendation Medal with OLC, and Parachutist Badge.

Hardin Takes Over as ERADCOM Associate TD

Mr. Clyde D. Hardin, a federal government employe for more than 33 years, is the new associate technical director of the U.S. Army Electronics R&D Command (ERADCOM). He served formerly as director of ERADCOM's Electronic Warfare Laboratory, Fort Monmouth, NJ.

Clyde D. Hardin

A U.S. Navy veteran of World War II, Hardin has served extensively in the R&D field, including assignments as director, Defense Research, Development, Test and Engineering Group, Korea; special assistant for Southeast Asia Matters to the assistant secretary of the Army (R&D), and consultant to the science adviser, U.S. Military Assistance Command, Vietnam.

He has also been the Army representative to the American Defense Preparedness Association, a member of two Quadripartite Groups, the senior Army representative to the DOD Provost Council, Defense Communications Planning Group, and the Army Scientific Advisory Panel.

A recipient of an Army R&D Achievement Award, Hardin is a graduate of Wake Forest University, and has done graduate work in physics at the University of Maryland. Additionally, he is a Fellow of the Institute of Electronic and Electrical Engineers.

Kronkaitis Chosen as Rock Island Commander

COL John Kronkaitis, director of the U.S. Army Armament Materiel Readiness Command's Materiel Management Directorate since 1978 has assumed new duties as commander of Rock Island Arsenal, IL. He succeeds COL John C. Scholz.

COL John Kronkaitis

Born in Lithuania, COL Kronkaitis earned his bachelor's degree in industrial administration from the University of Connecticut. He also has a master's degree in business administration from Syracuse University, and has attended the Command and General Staff College and the Army War College.

His 20 years of Army service includes a tour in the Pentagon, and two tours in Germany and Vietnam. He is a recipient of the Bronze Star Medal with two Oak Leaf Clusters and the Air Medal.

Kenyon Assumes Duties as Requirements Deputy

BG Richard D. Kenyon

BG Richard D. Kenyon, project manager, Black Hawk, since 1976, has assumed new duties as deputy director of Requirements and Army Aviation Officer, Office, Deputy Chief of Staff for Operations, HQ, Department of the Army, Washington, DC.

Graduated from the U.S. Military Academy, BG Kenyon has an MS degree in aeronautical engineering from Princeton University, and he completed the advanced management program at Cornell University. His military schooling included the Command and General Staff College, and the Industrial College of the Armed Forces.

From December 1974 until October 1976 BG Kenyon served at the U.S. Army Aviation Systems Command, St. Louis, MO, first as project manager of the Heavy Lift Helicopter, and later as director of Weapon Systems Management. He also served briefly in 1974 as executive officer to the Assistant Secretary of the Army (Installations and Logistics).

Listed among his other key assignments are staff officer, Research Technology Division, Army Research Directorate, later Combat Support Aircraft Branch, Air Mobility Division, Office, Chief of Army R&D; and commander, 145th Combat Aviation Battalion, 1st Aviation Brigade, U.S. Army Pacific-Vietnam.

BG Kenyon is a recipient of the Legion of Merit, Bronze Star Medal, Meritorious Service Medal, Air Medals, Joint Service Commendation Medal, Army Commendation Medal, and the Parachutist Badge.

Army Announces Key Changes in OASA (RDA)

The position of executive to the Assistant Secretary of the Army (RDA) recently underwent a personnel change. *COL Donald E. Shaw,* who served in the position for two years, retired from the Army effective 30 June.

COL Shaw was a graduate of the U.S. Military Academy (1953), the U.S. Army Command and General Staff College, and the National War College. He had served in a number of staff and command capacities in his Artillery Branch, in the Office of the Joint Chiefs of Staffs and the Army Staff.

At a ceremony honoring COL Shaw, Dr. Percy Pierre, ASA (RDA), presented him with the Distinguished Service Medal.

Shaw has been replaced by *COL Eugene Fox,* a graduate of the U.S. Military Academy (1956), the U.S. Army Command and General Staff College and the National War College.

COL Fox has served as project manager, Missile Minder/Air Defense Tactical Data Systems; Group commander, 10th Air Defense Artillery Group (IH), as well as division chief and staff officer in the Office, Chief of R&D and Office of the Chief of Staff.

COL Samuel L. Myers Jr., a career armor officer, R&D specialist, and member of the project manager program, has been assigned to the Office of the Assistant Secretary of the Army (RD&A), as deputy for Combat Materiel. Myers assumed his new duties 25 June upon completion of course requirements at the Industrial College of the Armed Forces.

COL Myers served prior to the ICAF assignment, as Department of the Army Systems Coordinator—M60 Tanks and as chief of the Armor Team in the Office of the Deputy Chief of Staff for Research, Development, and Acquisition, HQDA.

His academic credentials include a 1958 BS degree in engineering from the U.S. Military Academy, and a 1966 master's degree in mechanical engineering from the University of Michigan.

Conover Directs Waterways Experiment Station

COL Nelson P. Conover, former chief of staff of the U.S. Army Training Center Engineer and Fort Leonard Wood, MO, has succeeded COL John L. Cannon as director of the Waterways Experiment Station, Vicksburg, MS.

A veteran of 26 years of military service, COL Conover has served as Walla Walla (WA) District engineer; in staff positions with the Office, Chief of Engineers and Safeguard Systems Office; and chairman, Engineer Committee, Infantry School.

Other key assignments have included company commander and operations officer, 12th Engineer Battalion, 8th Infantry Division, West Germany; and two Vietnam tours, with the 1st Brigade, 101st Airborne Division, as commander, 588th Engineer Battalion (Combat) and as chief of Operations 20th Engineer Brigade.

Graduated from Auburn University with a bachelor's degree in civil engineering, COL Conover holds a master's degree in nuclear engineering from Massachusetts Institute of Technology, and has completed requirements of the Command and General Staff College and the Army War College.

Additionally, he is a registered professional engineer in the District of Columbia, and a recipient of the Legion of Merit, three Bronze Star Medals, three Meritorious Service Medals, Air Medal, and the Army Commendation Medal.

Apperson Assumes New Duties as DCG (R), MICOM

BG Jack A. Apperson

BG Jack A. Apperson, a career Army ordnance officer and former commander of Red River Army Depot, Texarkana, TX, has been deputy commanding general for Readiness, U.S. Army Missile Command, Redstone Arsenal, AL.

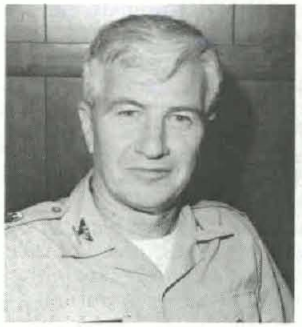
BG Apperson is a 1957 graduate of the U.S. Military Academy. He holds an MS degree in physics from the University of Alabama, and has completed requirements of the Army Command and General Staff College, the Army War College, the Ordnance School (advanced course), and the Armor School.

During 1976-77, BG Apperson served as executive officer to the Assistant Secretary of the Army (Installations and Logistics), following a tour of duty as chief, War Reserve and Operational Project Management Office, Supply and Maintenance Directorate, Office, Deputy Chief of Staff for Logistics.

Listed among his other career assignments are member, U.S. Army Materiel Command Study Group, Office, Chief of Staff of the Army; staff officer, Supply and Maintenance Directorate, Office, Deputy Chief of Staff for Logistics; and commander, 701st Maintenance Battalion, 1st Inf. Div. (Mechanized), Fort Riley, KS.

BG Apperson is a recipient of the Legion of Merit, the Bronze Star Medal with Oak Leaf Cluster (OLC), Meritorious Service Medal with two OLC, Air Medals, Army Commendation Medal with two OLC, and the Parachutist Badge.

Phillips Heads Chemical Directorate at OCCS



COL Walton A. Phillips

Director of the Chemical Directorate, U.S. Army Ordnance and Chemical Center and School, Aberdeen (MD) Proving Ground, is the new title of COL Walton A. Phillips, following an assignment since 1977 as chief of the Chemical Systems Laboratory's Physical Protection Division.

A veteran Chemical Corps officer with more than 25 years of military service, COL Phillips holds BS and MS degrees from Auburn University, and is a graduate of the Army Command and General Staff College.

Prior to joining the Chemical Systems Lab, he served at Department of the Army Headquarters as chief of the Chemical R&D Team, in the Office of the Deputy Chief of Staff for Research, Development, and Acquisition.

He has served also as chemical officer with the 7th Division in Korea; as chemical adviser to the Chinese Army in Taiwan, and as deputy senior adviser to the 1st area Logistical Command, Vietnam. His military honors include the Bronze Star, Meritorious Service Medal with OLC and the Army Commendation Medal with OLC.

In Brief . . .

Army Deputy Chief of Staff for Research, Development, and Acquisition LTG Donald R. Keith was a featured speaker, earlier this year, at the American Defense Preparedness Association's Annual Symposium on Industrial Base Planning. A summary of his presentation on "industrial preparedness" follows:

LTG Keith stated at the beginning of his speech that he did not have a great deal of good news to report. He said there is not a lot that can be done to significantly upgrade U.S. industrial preparedness. He added that it will be a major achievement of arms, leadership, courage and technology if "we" are able to blunt and contain a massive, little-or-no-warning attack by the Warsaw pact in Europe.

Our priorities, noted the General, are *near-term readiness*, *mid-term modernization*, and *sustainability*. "All of these," he remarked, "are not fully fundable, but they are reflected in the force packaging technique which is a realistic method of resource allocation."

Force packaging, according to LTG Keith, has the concomitant advantage of preventing the natural tendency to buy glamour items and neglect the less glamourous linchpins that are required to win wars.

The General defended his recent remarks and those of ASA (RDA) Dr. Percy Pierre which indicated that currently fielded U.S. equipment is qualitatively inferior in virtually every category to that of the Soviets. Examples of Soviet superiority are their soon to be fielded T-80 tank, the BMP infantry fighting vehicle, their air defense equipment, and their Hind-D helicopter.

"These Soviet advantages," he said, "are going to keep us on very thin ice for the next three or four years." This is because it will take the U.S. that long to make real progress on its second priority objective: mid-term modernization.

Between now and 1983, noted the General, the U.S. Army will be fielding a new tank, an infantry fighting vehicle, two new helicopters, four new air defense systems, laser homing artillery projectiles, C^3 gear, multiple rocket launchers, and much more. Every item, he continued, will be first rate and will regain much of the deterrent capability eroded during the past decade.

LTG Keith noted that this modernization program will also improve the posture of our industrial base. He cautioned, however, that U.S. industry's potential for massive wartime expansion is nowhere near what it should be.

One of the biggest problems, indicated the General, is that many important and influential people have looked at the Army's total procurement requirement—compared it with anticipated program funds for the next five years—and concluded that the Army has a "Bow Wave" problem that can be solved by killing some of the programs that are just beginning procurement.

LTG Keith stressed that although the prospects for accomplishing the Army's first two priorities are good, the outlook for long-term sustainability and overall industrial preparedness is not as bright. However, several things are being done to solve this problem.

One of the first things the Army is doing, stated the General, is conducting intensive studies to get a handle on the costs of an adequate preparedness base. The Army's gun tube facility at Watervliet is also receiving a "badly needed" modernization.

Relative to ammunition, LTG Keith noted that the new Mississippi ammunition plant will enlarge the Army's 155mm production capacity. Extensive modernization has also been made at the Volunteer, Joliet, Radford, and Badger plants, and improvements have been made in the melt pour and assembly capabilities at Lone Star, Milan and Louisiana for major caliber munitions.

Investments have also been made in the private sector to improve their capability, said the General. These investments have included modernization of the 105mm projectile capability at National Presto and 105mm cartridge case capability at Norris Industries. More than a $1 billion has been invested in the ammunition production base since 1970 to enchance the U.S. industrial readiness.

LTG Keith concluded his remarks by appealing to his industry audience to assist the Army in providing managerial or engineering solutions so that greater surge capacity can be built into existing or planned facilities. Industry, he said, could also help develop new definitions and techniques to aid the Army in building production base support for the Army of the 1980s.

Earlier this year Deputy Under Secretary of Defense for Research and Advanced Technology Dr. Ruth M. Davis delivered a Statement to Congress on "Defense Mobility Fuels." A synopsis of her remarks—presented before the Subcommittee on Economic Stability of the Committee on Banking, Finance and Urban Affairs—follows:

Dr. Davis opened her presentation by emphasizing that an essential ingredient for U.S. national defense is guaranteed access to energy supplies. She expressed concern that energy resources are becoming more scarce and less subject to U.S. control.

U.S. military capabilities, she noted, are strongly dependent on the mobility of U.S. weapons and support systems. Because of this, she said, we are becoming increasingly concerned about our heavy reliance upon liquid hydrocarbon fuels.

Dr. Davis pointed out that during FY 1978, DOD energy usage totaled 247 million barrels of oil equivalent or about two percent of the nation's total energy usage. Defense related industries consumed an additional 2-3 percent of the national total.

She stressed that these consumption rates represent recent peacetime patterns. However, under typical wartime conditions, DOD's energy usage would increase about threefold. Nearly 75 percent of DOD's energy requirement is for petroleum products. This compares to 46 percent for the U.S. as a whole.

About 90 percent of DOD's total petroleum consumption, or 413,000 barrels per day, is for mobility fuels for use in aircraft, shipboard and land-based mobile systems. Dr. Davis stressed that that although DOD's pro rata share of the nation's total energy usage is comparatively small, the DOD is still the largest energy consumer in the U.S., accounting for 81 percent of total energy used by the Federal Government.

DOD continues to design and build weapon systems under the implicit assumption that they can be fueled with petroleum-like products. The Deputy Under Secretary cautioned that unless present designs as well as currently operating weapon systems are modified extensively, liquid hydrocarbons will continue to be the primary mobility fuel for DOD well into the 21st Century.

Continued dependence on liquid hydrocarbon fuels, particularly foreign oil, poses a most serious threat to our ability to guarantee adequate energy supplies to meet essential military requirements, particularly for mobility fuels, said Dr. Davis.

Dr. Davis stated that in 1978, a DOD Task Force issued some major recommendations regarding fuel strategy. These recommendations, approved by the Secretary of Defense, include:

Establish a comprehensive Defense Mobility Fuels Action Plan with emphasis on development of synthetic fuels; formulate technical and operational plans to ease transition from conventional to synthetic fuels use in the post 1985 time frame; accelerate the DOD engine/fuel technology program; develop the industrial base to permit DOD to implement use of synthetic fuels; initiate actions to ensure complete vertical and horizontal coordination within DOD and with other federal agencies; and emphasize cooperative efforts between DOD and the DOE to assist in meeting DOD's mobility fuel requirements through commercial development of a domestic synthetic fuels industry.

Successful conversion from conventional to synthetic fuels, or combinations thereof, said Dr. Davis, will require full establishment of the capability to use synthetic fuels in mobile military systems. The DOD, she added, must assume primary responsibility for developing this capability.

Relative to the increased use of coal to relieve our dependence on foreign oil, Dr. Davis noted that U.S. technology for producing middle distillate liquid fuels from coal is lagging that of other alternatives. Cost factors will probably limit coal to gasoline, boiler heating oil, and petrochemical feedstock uses.

Oil shale, said Dr. Davis, must be considered the most attractive near term source of fossile fuel energy alternatives for defense mobility use. Several oil extraction technologies have been developed and tested in equipment ranging from one-tenth to one-fourth commercial scale. Said Dr. Davis: "We see no major technical barriers to the development of a commercial shale oil refining industry."

The Deputy Under Secretary concluded her presentation by calling for a review of the energy priority allocation legislation, such as the Defense Production Act. This legislation, she stressed, must ensure the flexibility needed to respond to uncertainties in the national and international energy situation.

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WES Serves Nation Through Engineering RDA Facilities

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ABOUT THE COVER:

Front cover shows military vehicles negotiating a 25-percent slope surfaced with landing mat, during tactical bridge access/egress tests at the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. The back cover shows a scale model of the Seabrook Lock at Lake Pontchartrain, LA, used in a hurricane flood protection project, and typical of WES research to develop environmentally sound, economical solutions to water related problems.

FEATURES

DEPARTMENTS

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