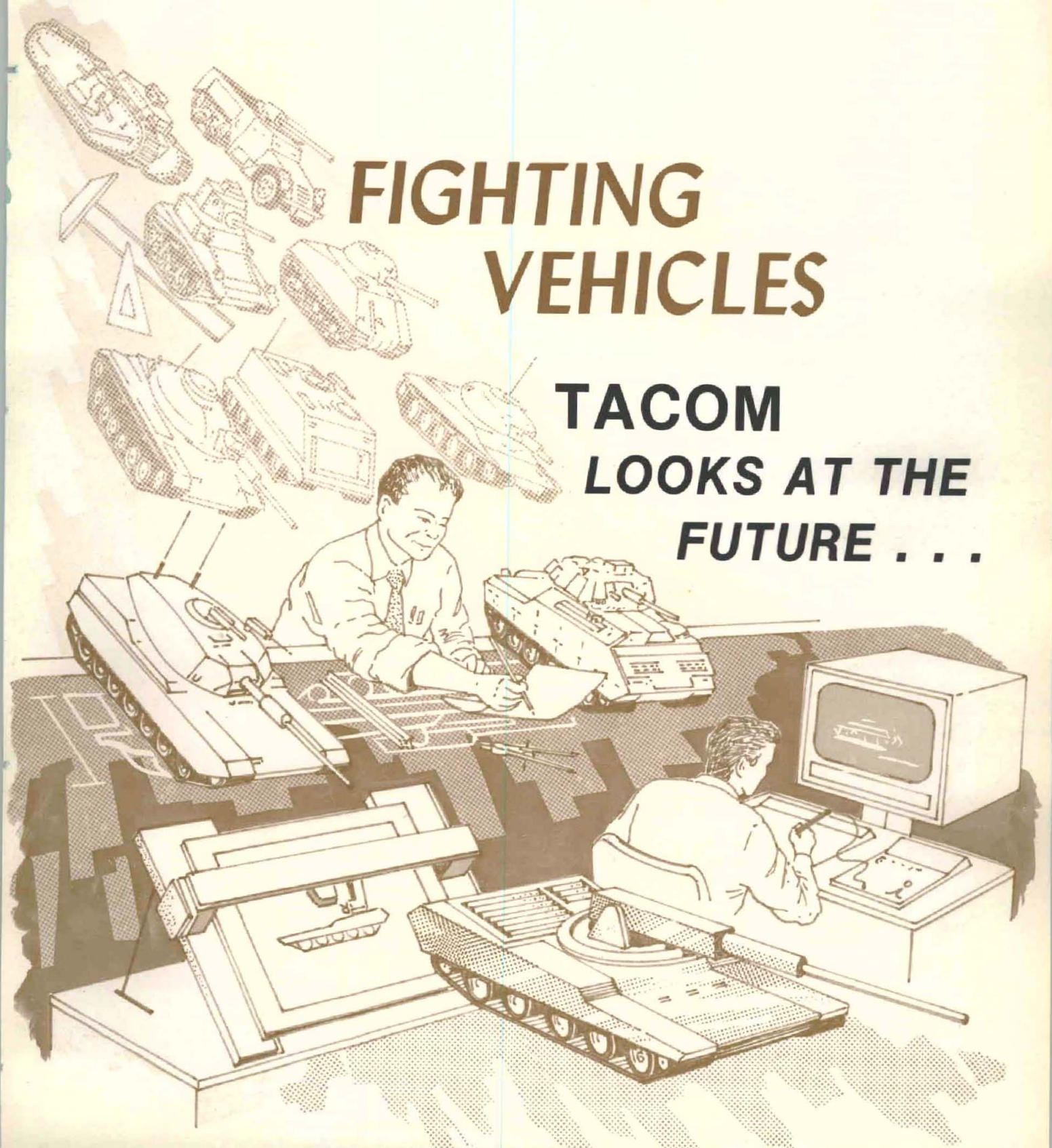
ARMY
R,D&A
- RESEARCH
- DEVELOPMENT
- ACQUISITION

MAY - JUNE 1981



FIGHTING VEHICLES

TACOM LOOKS AT THE FUTURE . . .

R,D&A ARMY

Vol. 22 No. 3 **May-June 1981**

OFFICIAL MAGAZINE OF THE RDA COMMUNITY, established 1959

ABOUT THE COVER:

U.S. Army progression in fighting vehicles of WWI and WWII, through production of the M1 Abrams Tank and development of the M2 and M3 Fighting Vehicles, is being looked at by TACOM through advanced computerized design and engineering techniques, in development of the future close-combat vehicle family.

FEATURES

DEPARTMENTS

DISTRIBUTION is based on requirements submitted on DA Form 12-5. Army agency requirements must be mailed to the U.S. Army AG Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220.

Distribution on an individual basis is restricted to active and reserve officers who hold a specialty indicator of R&D (51), Procurement (97), Atomic Energy (52) and Project Management (6-T).

CHANGE OF ADDRESS. Individual addresses are provided by Officer Military Personnel Center, Alexandria, VA, and the USARPC, St. Louis, MO. Where active officer addresses are incorrect, individuals should contact their respective officer personnel office to ensure forwarding of correct address. Reservists should contact USARPC, ATTN: AGUZ-OEPMD, St. Louis, MO 63132.

OTHER GOVERNMENT AGENCIES requirements should be submitted directly to U.S. Army Materiel Development and Readiness Command, ATTN: DRCDE-M, 5001 Eisenhower Ave., Alexandria, VA 22333.

ALL NON-U.S. GOVERNMENT agencies, firms and organizations must obtain this publication through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Single copies: domestic-$2.00, foreign-$2.50. Subscription rates (6 issues annually): domestic, APO and FPO addresses-$7.50, foreign mailing-$9.40.

Published bimonthly by the Development and Engineering Directorate (DRCDE), HQ U.S. Army Materiel Development and Readiness Command, Alexandria, VA, in coordination with the DARCOM Public Affairs Office, the Office of the Chief of Engineers, the Office of the Surgeon General's Medical R&D Command, and the Office of the Deputy Chief of Staff for Research, Development, and Acquisiton, HQ Department of the Army, to serve all elements of the U.S. Army Research, Development and Acquisition community.

Grateful acknowledgement is made for the valuable assistance of Public Affairs Offices within the Army Materiel Development and Readiness Command, Office of the Surgeon General, Office of the Chief of Engineers, Army Health Services Command, Army Training and Doctrine Command, Army Forces Command, and related activities. Use of funds for printing of this publication has been approved by Department of Army, 23 Feb. 1979, in accordance with provisions of AR 310-1.

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

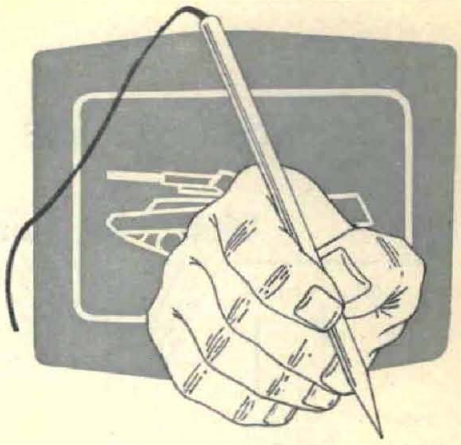
Picture Credits: Unless otherwise indicated, all photographs are from U.S. Army sources.

Submission of Material: All articles submitted for publication must be channeled through the technical liaison or Public Affairs Officer at installation or command level.

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

Fighting Vehicles:
The Next Generation

By Clifford D. Bradley



Now that the M1 Tank is in production and the M2 and M3 are nearing production, the Tank-Automotive Concepts Laboratory (TACL) at the Tank-Automotive Command (TACOM) has launched a program that will lead to the follow-on vehicles to the current M1 Tank, the M2 Infantry Fighting Vehicle, and the M3 Cavalry Fighting Vehicle.

Groundwork for the next generation of fighting vehicles began at TACOM in late 1979 and continued through the early months of 1980, with several discussions being held with the Army user community. In-house future tank concepts that explained new and innovative technological alternatives provided the basis for the discussions.

In a similar manner, discussions were held between TACL and other elements of the development community at TACOM and ARRADCOM to explore the expected new combat vehicle technologies relating to guns and ammunition, armor, fire control, engines, transmissions, and tracks and suspensions, that may be available for the future concepts.

An additional objective of these meetings with other members of the technical community was to surface possible areas where critical technology may be lagging or not started due to other priorities.

Key technological exchange discussions were initiated and conducted under the umbrella of the TACOM Tank Science and Technology Program, recently redesignated the Close Combat Science and Technology Program. Under this joint DARCOM/TRADOC-sponsored program, representatives from involved agencies participate on action teams (firepower, mobility, sensing, survivability, communications, and support) that identify, discuss, evaluate, and focus technological opportunities and requirements.

On 21 May 1980, the TACOM Concepts Laboratory hosted a presolicitation conference to discuss future close-combat vehicles with some 220 representatives from industry and government. The objective of the conference was to bring the best "brains" of industry together for the specific purpose of inviting them to look at the challenge of the follow-on vehicles to the M1, the M2, and the M3 - in other words, the future close-combat vehicle family.

During the all-day conference at TACOM, industry representatives from over 90 companies were given briefings on future combat vehicle technologies by representatives from TACOM and ARRADCOM. Briefings were also presented on future operational concepts for the mid-1990's by representatives from both the Infantry Center and the Armor Center.

The conferees were told the successful industry bidders would be provided with an operational concept entitled "The Land Battle of the 90s" developed by TRADOC, and with a detailed projection of the threat for the 1990's by the intelligence community.

Additional briefings on future armor,

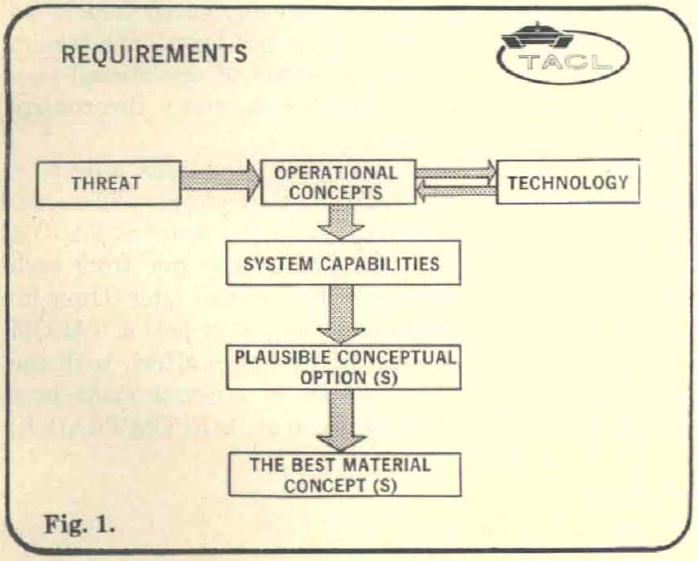


Fig. 1.

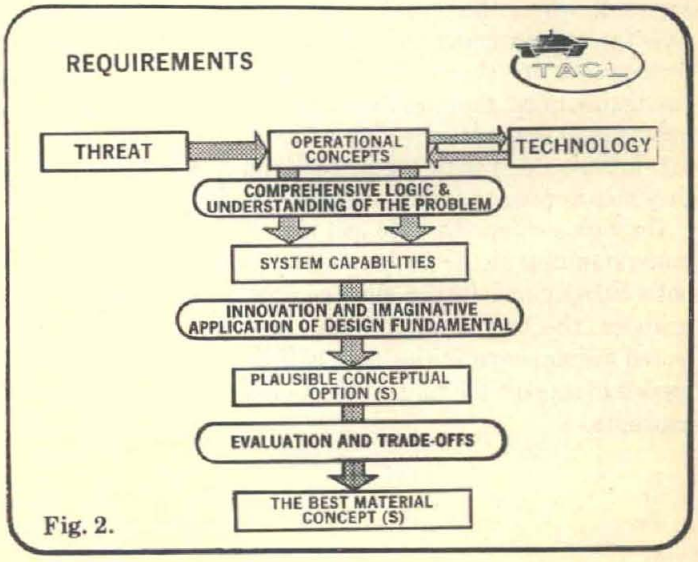


Fig. 2.

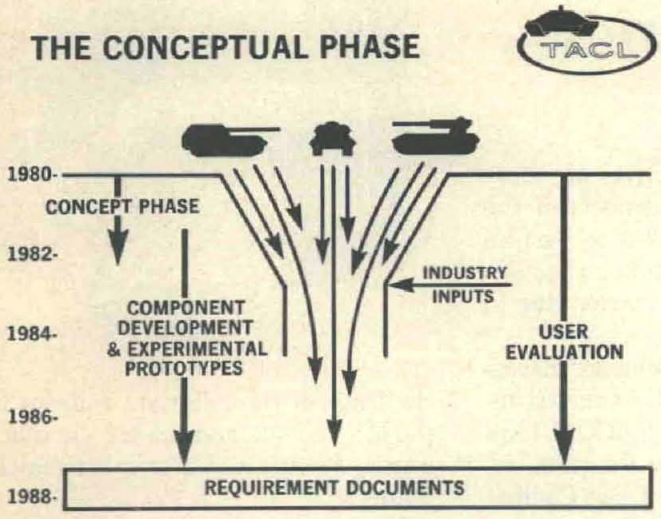


Fig. 3.

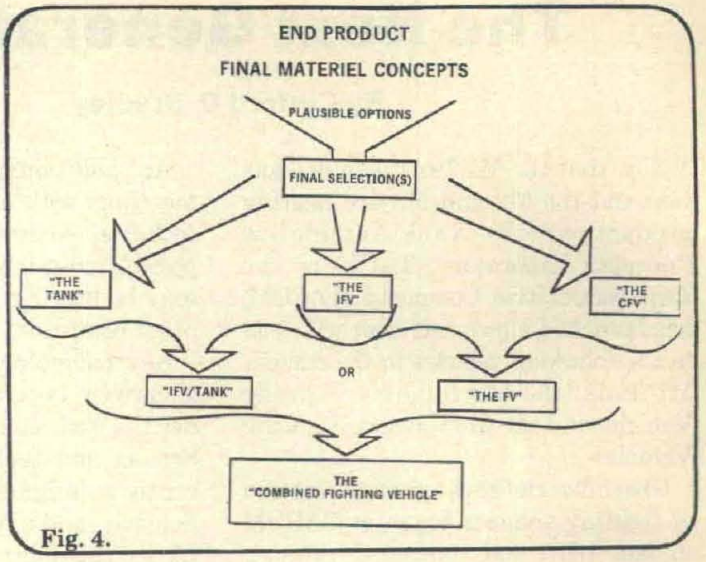


Fig. 4.

the threat, and operational concepts were planned on an "as-needed" basis to the successful bidders. They will also be free to tap whatever source they see fit as related to the technologies pertinent to the study.

The study teams will take the threat, operational concepts, and future technologies as shown in Figure 1 and successively develop system capabilities, plausible conceptual options, and lastly the best selection for the final choice.

How the contractor study teams will move successively through this process can be best understood by examining Figure 2, where the "gates" they must pass through in going from one phase to the next are shown. For example, the teams must thoroughly study the operational concept, the threat documentation, along with the projections they help develop of future technologies.

Through a comprehensive and logical understanding of the problems facing both current and future close-combat vehicles, the teams will develop projected system capabilities that will be needed to support the future operational concepts.

Once system capabilities are developed, through innovative and imaginative thinking, coupled with a broad knowledge of total system design and integration, there must be a compendium of plausible conceptual options incorporating system capabilities developed previously.

For the last, and possibly the most important part of the study, the industry teams must, through a series of evaluative trade-offs, select the best concept or concepts to fill the future role of the follow-on M1, M2 and M3.

The end product is a detailed design of the selected concepts, with supporting rationale, technical analyses, system characteristics, and projected performance data. The choices and latitude given the contractor teams are broad. It was deliberately made broad in order to encourage the widest possible degree of innovation and imagination in the interpretation of the threat and operational concept provided.

As shown in Figure 3, the choice may be a one-for-one replacement of the current vehicles, or a single vehicle that will accomplish all three roles, or some other combination of vehicles. It is their option, as long as their rationale supports their choice. There are no preconceived correct answers at this point.

Seven proposals were received from industry and were evaluated by a joint DARCOM/TRADOC team. Based on the evaluation and other pertinent consideration, four contractor teams were selected. On 21 January 1981, four contracts were awarded to the successful bidders.

Each of the winning teams consisted of at least an experienced vehicle designer or system integrator, a system analyst in terms of operational concepts and threats, and a fire control member.

At the end of 12 months, a draft of the study and the concepts will be presented to the review board at TACOM with the final report due from each contractor two months later. Three in-process reviews will be held at TACOM during the 12-month effort, with the presentations of progress made to a selected group of DARCOM/TRADOC

representatives that will make up the review board.

During the period that the industry teams are addressing the future close-combat vehicle challenge, TACOM's Exploratory Development Division, with other supporting elements within the Command and ARRADCOM, will be following a similar path. They will also be coming up with in-house concepts based on essentially the same guidance that was provided to the contractor teams.

The in-house work will have a two-fold payoff. First, it will provide an additional source of conceptual alternatives to be factored into the "stable" of concepts. Secondly, and perhaps more importantly, it will help to develop a backlog of knowledge and expertise related to the challenge, and will help to develop a "yard stick" for quality when the time comes to evaluate the contractors' teams efforts. Simply put, it will make in-house TACOM engineers better "buyers" or evaluators of the concepts provided by industry.

The next phase of the Future Close-Combat Vehicle Program will start to unfold in the spring of 1982 when the contractors' concepts and in-house candidates are delivered. This is best understood by referring to Figure 4 where all the candidates eventually end up at the bottom of the "hopper" or funnel.

During the spring and summer of 1982, the concepts will be evaluated and rated by a team of DARCOM and TRADOC experts employing the latest methodologies and techniques available. From the most promising concepts selected will come those picked to become test bed concepts to help resolve critical issues in components, subsystems, and total system concepts. These test beds will be built and evaluated throughout the period 1983 - 1988.

Results of these test-bed evaluations and other supporting technologies will then form the technical basis for the specifications for the next family of future close-combat vehicles. It is believed the Future Close-Combat Vehicle Program, with the initial emphasis placed on generating a broad base of technical alternatives followed by hardware test beds, will provide the highest level of confidence in the technical decisions that will be made.

CLIFFORD D. BRADLEY is currently serving as chief of the Exploratory Development Division, Tank-Automotive Concepts Laboratory, Tank-Automotive Command, Warren, MI. He joined the Tank-Automotive Command in June 1951 after receiving his BS degree in mechanical engineering from Wayne State University. Mr. Bradley has been associated with advanced military vehicle concepts for his entire career and has participated to some degree in all major vehicular development programs initiated at TACOM.

High-Energy Test Facility May Be First in U.S.

Ground was broken recently at White Sands Missile Range, NM, for what is believed will be the first tri-service, high-energy laser testing facility in the United States.

The facility, which will take two or three years to construct, will comprise an area of 90,000 feet, cost $24,693,000, and will provide jobs for about 150 local workers.

Dr. J. Richard Airey, director of the DOD-Directed Energy Programs, addressed participants at the ground breaking ceremonies. He noted that the new facility did not signify that the DOD was going to actively pursue high-energy weapons, but rather it demonstrates an interest in laser potential.

Airey explained that the Soviets have a very active laser program, spending four to five times as much as the U.S. "Laser development at White Sands Missile Range is not only important to White Sands Missile Range, but to the entire defense posture of the U.S.," he said. He added that laser applications will be important to the Army, Navy and Air Force as an offensive force and also for defense.

"It (high energy laser) has many, many applications and associated programs," Airey said. "White Sands Missile Range's (laser) testing will bring all these components together."

During the ground breaking ceremony, Navy CPT Alfred Skolnick, commander at the Naval Sea Systems Command, said the U.S. Navy and White Sands Missile Range, working together, will be playing an instrumental role in the essential demonstration of the value of high-energy lasers for many military applications.

". . . What this step represents is the lengthy drama of maintaining for our nation a defensive capability that keeps pace with the inexorable and advancing threat," Skolnick said. "This is the measure which must drive us relentlessly."

Skolnick closed his short talk by adding, "We stand here today a small band of visionaries, artisans and even some skeptics; a proper microcosm of our country. But, note this well, we stand upon the threshold of new dimensions in military defense and are members of a brotherhood that connects one to the other down the years as links in a chain . . . "

Vincent Boudreau, chief of HEL at WSMR, said the Department of Defense began studying the national range as a high-energy laser testing site as early as 1975. Bidding on the construction project began in the summer of 1977.

Corrosion and Corrosion Control

By Milton Levy

Corrosion is an insidious form of material deterioration. It is both economically and militarily expensive because it shortens the lifespan of materiel and is too often the source of catastrophic failure.

Control of corrosion then, is of vital importance to the Army, because of the need for the easy maintainability, reliability, functionability, and combat readiness of military equipment, especially after prolonged periods of use, storage, or idleness. Unfortunately, corrosion-induced damage continues to impede the efficient design, production, storage, and application of materiel.

Also of growing concern is the additional burden imposed upon our limited energy and raw material resources and natural environment by the complex problems of corrosion and corrosion control.

The mechanisms of corrosion and corrosion prevention are still not well understood, because corrosion is such a complex phenomenon. There are many types, some broadly described as uniform, pitting, galvanic, stress, fatigue, fretting, microbial, hydrogen embrittlement, sulfidation, and high-temperature oxidation. Performance criteria for military materials embrace chemical, biological, mechanical, and physical properties.

Monetary loss to the American economy, due to corrosion, has been estimated to be upwards of 70 billion dollars per year, equivalent to more than 4 percent of our gross national product. Some of the costs of deterioration are avoidable and can be dramatically reduced through judicious application of currently existing deterioration and corrosion control technology, but mitigating the remaining costs requires advances in technology.

As the lead laboratory for materials technology, the Army Materials and Mechanics Research Center was tasked by HQ DARCOM to develop a DARCOM corrosion-control program. In cooperation with the Product Assurance Directorate, HQ DARCOM, a Materiel Deterioration Prevention and Control (MADPAC) Program was established.

DARCOM Regulation 702-24, dated 16 October 1979, prescribes policy, procedures, and responsibilities for the program, which is aimed specifically at the reduction of deterioration of Army materiel. The MADPAC Program is centrally managed by the director of Product Assurance, HQ DARCOM, with the assistance of AMMRC. Advice concerning the program is proffered by the Central Steering Committee composed of members from the subordinate commands, selected offices from HQ DARCOM, AMMRC, and AMSAA.

Objectives of the program include: insure maximum use of state-of-the-art technology in the prevention of deterioration; provide for deterioration prevention reviews encompassing the areas of design, material selection, manufacturing processes, technical documentation, product assurance, field and depot maintainability operations, feedback data and training requirements; and insure that all applicable contracts for Army systems and associated equipment contain requirements for a deterioration prevention program.

Highlights of the program include the conduct of a triennial inspection of DARCOM facilities, the establishment of a Materiel Deterioration Information Center, the dissemination of lessons learned, the coordination of training programs, the updating of military specifications, standards, and handbooks, and the promotion of technology effort.

Continued advances in weapon systems technology involve new concepts, materials, and environments, which require updated knowledge and data to insure freedom from corrosion damage. Moreover, failure of materiel during manufacture, storage, and field application exposes the need for constant surveillance of procedures. RDT&E investigations are planned to provide designers and users of military materiel with both short and long-term solutions to the multifaceted problem of corrosion.

Both basic research and applied research investigations of corrosion are underway. The Army Materials and Mechanics Research Center formulates technical plans and programs that identify and define pacing problem areas which must be resolved to achieve improved weapon systems development.

AMMRC participates in all stages of Army materiel acquisition. Included in current efforts are programs in research and development, engineering, testing research, standardization, and manufacturing technology. Structural materials considered include metals, cereamics, organics, and composites.

To obtain maximum technology transfer, AMMRC recommends and implements projects in industrial technology programs, in materials processing, testing, standardization, fabrication, and scale-up. AMMRC responsibilities encompass technical management of participatory materials technology programs including basic and applied research in corrosion at AMMRC and other DARCOM laboratories and installations.

Army major subordinate commands are responsible for the development and production of materiel required by our troops. Consequently, major subordinate command personnel are constantly on the alert for problems that threaten to impede the order-

TABLE 1
Examples of Corrosion-Related Problems in Missiles

System	Component	Problem
Bullpup A	Propulsion Unit	Metallurgical Exam After 3-Year Storage
Chaparral	Fuel Cells	Evaluation of Polyurethane Coatings
Chaparral	Springs	Stress Corrosion Cracking
Dragon	Propellant	Epoxy Paint Compatibility
Dragon	Gas Generator Case	Failure Analysis
Dragon	Guidance Wire	Coating Evaluation
Dragon	Aluminum Wire	Anodized Coating and Chemical Film Evaluation
Hawk	Motor Case	Stress Corrosion
Hawk	Adhesive Bond	Degradation Evaluation
Hercules	Motor Case	Stress Corrosion
Lance	Battery/Conn. Pin	Surface Finish Problem
Lance	Ogive	Protective Paint Durability
Lance	Elastomeric Seals	Age and Deterioration of Piston Seals
Pershing	Missile #307	Age and Deterioration
Pershing	Missile	Arctic/Tropic Environment Analysis
Pershing	Motor Case	Develop Surface Finish
Safeguard	General	Develop Organic Coating Specification
Nike-X	Connector Pins	Evaluation of Gold Plate System
Shillelagh	Initiator Devices	Corrosion Problems
Spartan	Motor Case	Production-Failure Analysis
Spartan	Missile	Develop Environmental Criteria
Tow	Guidance Wire	Protective Coating Evaluation
Tow	Eyeguards	Evaluate Elastomeric Coatings (Perspiration Resistance)

ly and efficient supply and utilization of military equipment. For example, the U.S. Army Missile Command closely monitors problems, both minor and gross, encountered in Army missile systems. Table 1 lists a partial series of corrosion-related problems investigated by their engineers and scientists.

As indicated in Table 1, many missile systems and a variety of components, both large and small, are represented. A cursory review of the problem column reflects the need for corrosion protection during the entire life cycle of a product commencing with the design and selection of compatible materials, through producibility and storability. The latter characteristic was investigated in the Bullpup missile, shown as the first item in Table 1, after a 3-year storage period. In the second item, polyurethane coatings were investigated as a means for preventing unwanted chemical reactions in fuel cells for the Chaparral system. Stress corrosion cracking was identified as the failure mechanism causing damage to springs in the third item. Other similar examples of components susceptible to corrosion damage are also described in Table 1.

Further examples illustrating the wide range of corrosion problems are shown in Table 2. The U.S. Army Armament R & D Command has investigated corrosion effects in small rockets, bomblets, fuses, connectors, bus cables, and rifle forgings. In addition, studies have been made of the corrosion susceptibility of large installations such as the Kwajalein Facility and North Dakota site for the Ballistic Missile Systems Command (BMSC).

The frequency and severity of reported corrosion of mortar and artillery projectiles caused by inadequate surface preparation appears to have increased in recent years, as shown in Table 2. The cost for reworking ammunition (stripping and repainting) is $11-15 each for 155mm projectiles and $4-6 each for 105mm projectiles. The original cost for cleaning and painting is a small fraction of these figures. In recent years, the cost of reprocessing 105mm, 155mm, and 8-inch projectiles has exceeded 10 million dollars.

Another problem of significant impact involves rusting of tactical vehicles including the 1/4-ton, 2-1/2 ton, and 5-ton vehicles at the Fort Shafter and Schofield barracks, HI. Even new vehicles shipped to Hawaii are subject to early rusting because of the severe environment: high humidity (70-80 percent), salt contamination, and high atmospheric pollution.

Rusting was also found to be a serious problem with the M151 Series 1/4-ton truck at several Army CONUS installations (Forts Belvoir, Meade, and Hood). Approximately 25 percent of the trucks had sufficient rust to question the structural integrity of the unit/body area.

AMSAA found that the severity of rust appears to be more related to location environment than to age. For example, vehicles at Fort Belvoir, VA, and Fort Meade, MD, showed generally more severe rust than at Fort Hood, TX. It has been estimated that corrosion of the Army tactical truck fleet costs between 3.2 and 4.8 million dollars per year.

Acutely aware of the problem, the Tank Automotive Command (TACOM) is taking steps to protect the current fleet of military vehicles by insuring that all newly produced tactical vehicles, as well as all overhauled vehicles, are rust-proofed. Also, development programs have been initiated in a long-range effort to develop technology that would allow production of rust-free vehicles.

Other Army operations are likewise adversely affected by corrosion-induced damage to equipment and structures. A broad view of some additional problems are shown in Table 3, a spiderchart of some failure analyses conducted at the Army Materials and Mechanics Research Center in cooperation with other Army elements such as AVRADCOM, ERADCOM, MERADCOM, NARADCOM, ARRCOM, and the Corps of Engineers. DCASA personnel have also been advised on contractor storage problems.

As indicated in the chart, many different metals are involved, including aluminum, magnesium, steels, superalloys, and refractory metals. Corrosion was a minor or major contributing factor in the failure of the wide variety of components shown. It may be noted that most of the problems deal with components of warfare equipment such as aircraft, ground vehicles, and missiles.

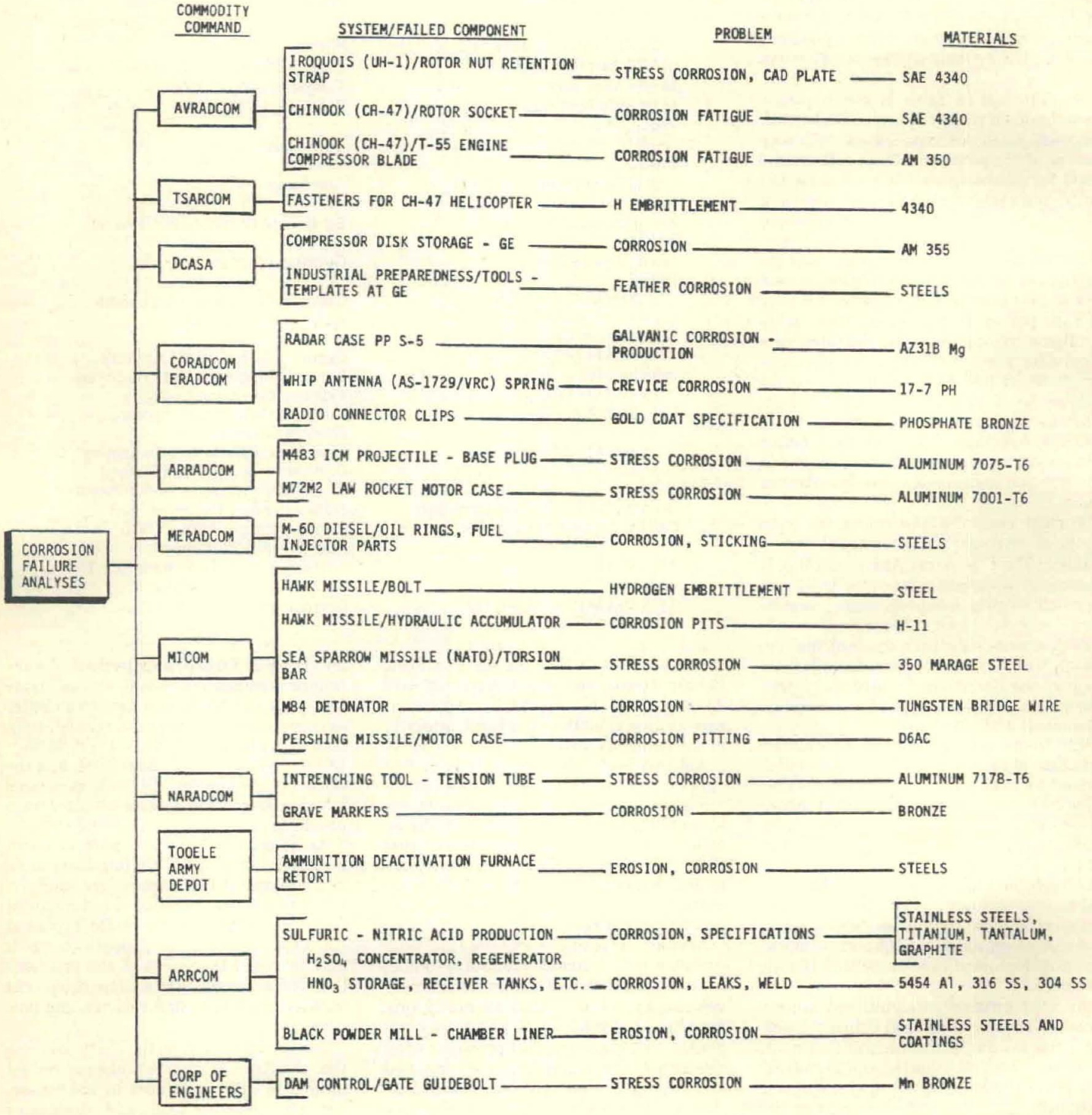
Cursory inspection of the chart indicates that the Army corrosion problems are not limited to equipment used by the troops, but also includes tools and equipment needed for producing hardware and munitions.

Problems encountered in the production of nitroguanidine and TNT resulted in the initiation of the study of "Corrosion of

TABLE 2
Examples of Corrosion-Related Problems in Armaments

System/Components	Problem
M55 Aluminum Rocket	Pitting
M139 Aluminum Bomblet	Leaks - Storage Predictions
M564 Mechanical Time Fuses	Tungsten Alloy Corrosion
M16 Rifle Forgings WECOM	Exfoliation 7075-T6
Steel Conduit Connectors BMSC	Corrosion
Digital Rack Power Bus Cable BMSC	Corrosion
Kwajalein Facility BMSC	Equipment Deterioration Review
North Dakota Site BMSC	Corrosion Survey
105-MM M375 Steel Cartridge Cases - Flinchbaugh Corp. & Chamberlain Corp.	Galvanic Corrosion in Threaded Area During Storage
155-MM M483AI Projectiles Kansas AAP	Galvanic Corrosion at Undercut During Storage - Rework Required
155-MM M116E2 Projectiles Pine Bluff Arsenal	Incipient Corrosion Due to Inadequate Surface Preparation - Rework Required
155-MM M107 Projectiles Louisiana AAP	Iridescence on Surface Indicating Corrosion, Due to Poor Surface Preparation - Rework Recommended
90-MM M191B1 Steel Cartridge Cases - Tooele Army Depot	60% Exhibited Traces of Rust During Storage, Attributed to Poor Surface Preparation
105-MM M392 Projectiles Jefferson PG	Corrosion on O. D. Surface Due to Poor Surface Preparation
155-MM M107 Projectiles Jefferson PG	Corrosion Noted on Surface

TABLE 3
Corrosion-Induced Damage Failure Analyses Conducted by AMMRC



Equipment and Materials of Construction Used in the Processing of Munitions". This work was originally requested by the PM, Munitions Production Base Modernization and Expansion Program. AMMRC responsibilities include providing consultations on materials selection for equipment used in processing sulfuric and nitric acids for producing nitroguanidine and TNT.

In addition, metallurgical analyses of failed components such as acid storage tanks, receiver tanks, heat exchangers, liners, condensers, and pumps were made.

Product failure analyses and product development studies affirm the need for supplemental support of Army mission areas through the advancement of corrosion technology. Mission areas of major importance to the Army include, aircraft, missiles, armaments, armored vehicles, command control and communications, intelligence, logistics/personnel support, craft, surface mobility, barrier/anti-barrier, chemical warfare, biological defense, and laser hardening.

Further improvement of many functions and properties of materiel can only be achieved through advances in the understanding of fundamental phenomena. Hence, the Army has a vital interest in basic research. Paucity of experimental data or theoretical methods often inhibit progress in applied research or exploratory development investigations.

The prime sponsor of studies of basic mechanisms of corrosion is the Army Research Office (ARO). Generally, these fundamental studies are conducted by noted researchers at academic institutions in this country. Institutions investigating corrosion fundamentals include: Arizona State University, New York University, Rensselaer Polytechnic Institute, North Carolina State University, American University, Georgia Institute of Technology, Massachusetts Institute of Technology, University of Minnesota, and Portland State University.

Direct chemical attack of structural and coating metals by hostile substances remains a formidable problem. Basic research investigations sponsored by the Army Research Office, Research Triangle Park, NC, are being made to clarify the mechanisms underlying the initiation of cracking under fretting corrosion fatigue in steels. Fretting and its ramifications have had serious consequences in engine and rotating Army aircraft structural components.

Investigations are underway to study fundamental mechanisms of erosion of materials in hot flowing media and to study mechanisms of protection of materials in environments encountered in gun tubes, gas turbines, and propulsion components in missiles.

The role of sulfur in the corrosion of superalloys is also being elucidated through investigations of the mechanism of migration of sulfur through single crystal and polycrystalline oxides including NiO, CoO, Al_2O_3, Cr_2O_3, and Fe_2O_3. An improved understanding of this phenomonon will result in better materials for the hot section of aircraft engines.

An activity of practical interest concerns the chemical interaction of fiber reinforcements with aluminum alloy matrixes. This new class of lightweight, high-strength, materials exhibit high potential for many aircraft and bridging applications.

Principles governing the corrosion behavior of aluminum-graphite and aluminum-alumina fiber composites exposed to aqueous and atomospheric service are being investigated. The ability of ion implantation to form self-healing coatings for inhibition of localized corrosion is being investigated for applications in armaments.

Another phenomena of practical interest that requires greater understanding involves the complex behavior of stress corrosion cracking. Several studies are underway to upgrade fundamental knowledge through investigations of mechanisms of stress-corrosion cracking of aluminum alloys.

Basic and applied research investigations are conducted in-house within AMMRC and the several Army laboratories at ARRADCOM, MICOM, and MERADCOM, because of expertise and experience with particular Army materiel systems.

Within the general corrosion area, in-house studies are continuing, utilizing both long-time surveillance and short-time electrochemical methods, to minimize corrosion of equipment and materials of construction employed in the processing of ammunition.

Oxidation-sulfidation corrosion modes are of deep concern to designers of aircraft engines. Protective coatings for the upgraded performance of gas turbine alloys are being developed in-house.

Erosion-corrosion is a failure mechanism that can appear in Army materiel such as cannon tubes, gas turbine engines, rocket nozzles, and ammunition processing equipment. Solid particles entrained in a high-velocity, viscous reactive media are among the conditions contributing to combined mechanical and chemical attack.

In-house studies are underway to identify the extent of chemical reaction between propellant gases and gun steels under gun-chamber conditions of temperature and pressure. Efforts are also being made to determine the erosion constituents as well as the factors affecting the surface cracking phenomenon. Concomitantly, the parameters governing the erosive effects of high-temperature, high-pressure, and high-gas velocity on gun steels are being investigated.

Stress-Corrosion Cracking (SCC) failure attracts attention because of its catastrophic nature. In addition to the several ARO studies described earlier, efforts are being made to upgrade the SCC resistance during the development of new Al-Zn-Mg-Li wrought and Al-Zn-Mg-Cu powder metallurgy materials through composition and thermomechanical treatments. SCC effects of humidity and up to 150°F temperatures on commercial grades of aluminum alloys are also being determined.

High-strength steels are also of continuing importance to the Army. Unfortunately, these steels are highly susceptible to stress corrosion. Effects of humidity, temperature, impurities, surface treatments, and hydrogen-diffusion characteristics are being investigated. Realistic missile storage parameters are being established. Also, efforts are continuing to devise an accelerated test method for evaluating SCC characteristics of armor steels.

Stress-corrosion cracking characteristics are also an important consideration in the improvement of uranium alloys for armor-piercing ammunition penetrators. Effects of hydrogen, humidity, strain rate, thermal treatments, and residual stress are being studied. Protecting the surface of susceptible alloys with a compatible coating is another approach employed to alleviate the problem of corrosion-induced failure.

In-house investigations are underway to develop materials and processing techniques for protecting a variety of materials including aluminum, cast magnesium, columbium, titanium, uranium alloys, superalloys, gun steels, magnesium-aluminum oxide, and aluminum-graphite composites against the harmful effects of a wide range of environments. Metallic, intermetallic, and nonmetallic coating systems are being developed. Lead and hexavalent chromate replacement in organic and semi-organic primer paints are being studied because of toxicity and pollution effects.

Army applications for these coating systems include mobility equipment, vehicle armor, aircraft structures, gas turbine engines, munition processing equipment, and high-velocity armor penetrators. Evaluation of experimental and commercial coatings in natural environments is also continuing. The Clean Air Act requires the develop-

ment of an entirely new range of low-solvent-content organic coatings or paints to replace the presently required and used coatings.

Efforts underway have concentrated on waterborne coatings and polymers. Low-solvent-content coatings are being developed to replace the high-volume specifications, which presently include camouflage coatings, anti-corrosive primers, chemical agent resistant coatings, and pre-treatments. The water-soluble alkyds appear the most promising for basic primer and camouflage use.

Waterborne polyurethane, catalyzed resins, and modified polyurethane resins appear to be most suitable for applications involving severe environmental exposure, including chemical agents. Utilization of waterborne epoxy and epoxy esters, high-solids alkyds, polyurethane, and epoxies are also being explored.

In summary, a wide variety of RDT & E investigations are continuing to determine and clarify the basic mechanisms of corrosive attack and protection, and to develop economical, new, and improved solutions for defeating the destructive effects of corrosion in Army materiel.

MILTON LEVY is corrosion research group leader, Metals Research Division, U.S. Army Materials and Mechanics Research Center, Watertown, MA. He has been the recipient of the Army Research and Development Achievement Award and the AMMRC Director's Award in Science. Mr. Levy has authored more than 30 papers, in the open literature, covering the areas of aqueous corrosion, stress corrosion, corrosion fatique, high-temperature oxidation and sulfidation, and protective coatings. He received a BS in chemistry from Boston University and did graduate work at Boston University and the University of Maryland.

CNAD Approves 4 NATO Small Arms RSI Recommendations

A major plateau in realizing NATO small arms rationalization, standardization and interoperability (RSI) has reportedly been reached with the decision by the Conference of National Armaments Directors (CNAD), the highest civilian level within NATO, to officially adopt all four recommendations proposed by the NATO Coordinating Panel (CP) for the Testing and Evaluation of Small Arms Weapons and Ammunition.

The CP recommendations were: adoption of 5.56mm as the second standard NATO caliber (7.62mm became a NATO standard caliber in the 1950's); approval of Belgian SS109 ammunition as a basis for standardization; direction to a NATO subpanel to prepare a standardization agreement (STANAG 4172) for an ammunition for use in both individual and light-support weapons; (the SS109 was used as a basis around which the STANAG 4172 was written) and agreement that a recommendation not be made for NATO standardization of an individual or light-support weapon.

These determinations were arrived at after three years of extensive testing, during which the majority of NATO members jointly participated in both civilian and military trials conducted primarily in Germany. The tests were designed to collect extensive data so that an unbiased and objective decision could be made based upon performance of the light infantry weapons and ammunition contenders. The ammunition is expected to be deployed in NATO weapon systems during the post 1980 period.

Although technical assistance was provided by many major Army agencies, such as the U.S. Army Operational Test and Evaluation Agency, the Army Materiel Systems Analysis Activity and various U.S. Army Armament R & D Command Laboratories, the overall responsibility for this effort was that of ARRADCOM's Fire Control and Small Caliber Weapon Systems Laboratory (FC&SCWSL). The FC&SCWSL provided the essential management direction, financial planning, technical evaluation and coordination necessary to administer such a broad, complex and internationally sensitive program.

Selection of the SS109 ammunition is not expected to have any detrimental impact on current U.S. weapons using U.S. 5.56mm ammunition, such as the M16Al rifle, the Squad Automatic Weapon or the Firing Port Weapon. To acquire optimum performance of the SS109 round with the U.S. M16Al rifle, it would be necessary to alter the barrel rifling, that is change it from one twist per 12 inches of travel to one twist per 7 inches. This is necessary to flight-stablize the heavier SS109 projectile, providing the imposed effectiveness of that round and range. There are now no plans to make this alteration.

The SS109 can be fired from the 1:12 barrel with a certain degredation in performance. Tests to date indicate that accuracy and penetration suffer at ranges over 600 meters.

Interview with WRAIR Director/Commandant COL Philip K. Russell

COL Philip K. Russell, director and commandant of the Walter Reed Army Institute of Research, since September 1979, was interviewed recently by a staff member of the Army Research, Development and Acquisition Magazine. *A former mission area manager at the Army Medical R & D Command and a former WRAIR deputy director, COL Russell provided some very frank responses to a broad range of questions.*

COL Philip K. Russell

★ ★ ★

Q. During every war the Army has always learned something about improving the treatment of combat injuries, both physical and psychological. What were some of the "lessons learned" from the Vietnam experience?

A. One general answer is that we learned, or perhaps relearned, that medical problems associated with military operations must be addressed by specialized training and skills if the medical department is going to deal with them effectively. We had to deal with major retraining of surgeons and infectious disease personnel. This occurs largely because casualties from military operations require specific approaches that are not widely known in civilian medicine. For example, the civilian surgeon's experience in trauma surgery is normally limited to automobile and industrial accidents. This is entirely different from wounds on a dirty battlefield. In addition, military surgery requires knowledge and an appreciation of how to deal with high-velocity missile wounds. These types of wounds just don't exist in the civilian community, so there must be a specialized approach to the treatment of these types of wounds if there is going to be a successful outcome.

Surgical experience gained in Vietnam resulted in some major advances in reconstructive vascular surgery. This contributed to a substantial reduction in limb amputation rates as compared with the Korean War and World War II. Therefore, I think the combination of dealing with combat casualties and the improvements in vascular surgery and the general improvements in managing shock and wounds were moderately impressive.

Another area where we improved our combat care is in the management of psychiatric casualties. The forward and early treatment of neurophychiatric casualties is extremely important. The application of early treatment was very successful in Vietnam. Vietnam allowed us to optimize psychiatric treatment. However, there is some serious concern that future operations may pose major and different problems because combat scenarios for the future project a much higher intensity and longer duration of sustained combat. We expect this to produce more severe and greater numbers of neuropsychiatric casualities.

I think the most important lessons learned from Vietnam are that the duration and intensity of conflict is an important issue and that the best way to deal with psychiatric problems is to try to prevent them. We also learned a great deal about the management of drug-resistant Malaria and several other infectious diseases.

Q. Costs of medical care have increased substantially in recent times and promise to go even higher. Do you envision any new approaches to patient care which might moderate these costs?

A. Medical care of the hospitalized patient is extremely technologically complex and depends heavily on skilled manpower. Therefore, by its very nature, hospital care is very expensive. Also, if you accept the concept, as I do, that the U.S. Serviceman deserves the best state-of-the-art medical care we can deliver, then the prospects for major cost reductions, at the hospital level, are not very great. However, I am not saying that there is no approach to reducing medical costs. In fact, the approach is very simply — we should put the major research investment into preventive medicine.

Fundamentally, the way to decrease medical costs in the military is to prevent people from going into the hospital. I would like to stress that 80 percent or more of our research program is aimed specifically at improving the art and science of preventive medicine. Prophylactic technology is probably the most cost-effective research investment. For example, the Polio vaccine, in the civilian community, has resulted in billions of dollars in savings. In the Army, savings have also been substantial as a result of vaccines developed by WRAIR to prevent acute respiratory diseases and hospitalizations due to Meningitis. Costs of developing these vaccines were recovered very shortly after they were introduced. I think these examples point out that the best way to cut medical costs is to prevent hospitalizations from occuring. There is real promise for reducing medical costs by new preventive techniques in several areas including psychiatry and infectious diseases.

Q. WRAIR has been recognized for demonstrating the feasibility of stockpiling "donor" freeze-dried veins for vessel replacement in humans. What is the state-of-the-art of this program?

A. Prosthetic replacement for veins and arteries has been developed rather highly, but has a serious disadvantage in the potentially infected wound. Unfortunately, the artificial artery would not be compatible with the typical combat casualty. Currently, other work is being done with umbilical arteries and veins. I think this is a promising field of research and it will further improve our capability for restoring limbs that were damaged by battle wounds.

Q. How would you assess the quality of personnel in the current Army medical R & D field?

A. The real answer to this question is that quality remains as high as it ever was. We are still internationally recognized for our research in a variety of fields. Additionally, "world class" scientists are employed in almost all of the areas in which the Army Medical R & D Command is engaged. The high quality of our research personnel is evidenced by our performance in competition with other Army laboratories and our representation on national and international scientific advisory committees.

Our primary problem is the quantity of personnel. Restrictions on military and civilian manpower during the past decade have seriously hurt our effective strength. Our current ability to recruit junior scientists is quite good. However, we are going to suffer at some point because of the period when we did not have a high influx of scientific manpower and our total strength was restricted.

". . . the way to decrease medical costs in the military is to prevent people from going into the hospital. I would like to stress that 80 percent or more of our research program is aimed specifically at improving the art and science of preventive medicine."

Q. WRAIR's impressive achievements during its 87 year existence are numerous. What are some of the major efforts that WRAIR is currently engaged in?

A. The single largest program is the drug and vaccine development program. We are continuing to develop vaccines for immunization against diseases of major military importance. These include recruit camp diseases such as meningitis. I think I can confidently predict that we have a chance of functionally eradicating meningococcal meningitis from our recruit camps with the introduction of our next generation of meningococcal vaccines, which include additional serotypes. We have already made a major impact with the first two vaccines (types A & C).

Relative to our research for deployed troops, such as the Rapid Deployment Force, we are working on dengue vaccines and shigellosis (dysentery) vaccines. I believe the development of these two vaccines is very important because of their potential for protecting deployed troops in areas where risk of indigenous diseases is very high.

Another one of our major efforts, drug development, has historically been geared toward the development of antiparasitic drugs. We are particularly proud of our development of the drug mefloquine. This drug is currently being purchased by the Army for potential use in areas where malaria parasites are resistant to existing drugs. We are doing similar work with drugs for leishmaniasis. This program, again, is aimed at an organism that is resistant to current drugs, and is a real threat to deployed troops in areas of current military interest such as the Middle East.

Another major aspect of the WRAIR effort is to develop a basic research program for defense against chemical warfare agents. We are doing basic research aimed at developing protective drugs against nerve agents and cyanide. This is an increasingly important aspect of our research program and it involves pharmacologists, toxicologists and basic research scientists. The overall Army program is comprehensive and goal directed; the WRAIR portion of the program is a basic research effort.

Another area that is significant is the problem of blast overpressure from large caliber weapons, and the general problem of blast injuries. For example, we have sought a definition of the level of risk for gun crews exposed to blast overpressures from large-caliber weapons. This, of course, is related to the safety aspect of weapons development.

I believe that one of the most important programs we have been engaged in recently is the one involving our Division of Neuropsychiatry here and at our European field unit. This particular program is directed toward the prevention of "breakdowns" in combat. We recognize that any conflict in Europe would produce intense and prolonged fighting and concomitant and severe psychiatric stress. In order for troops to withstand the stress of prolonged combat, they must function in a cohesive unit where there is a lot of bonding and mutual reinforcement. We feel that the factors that produce unit cohesiveness and stability are very important in preventing neuropsychiatric casualities.

Q. If a major medical breakthrough were to be made during the next decade, in what area do you think it would most likely occur?

A. There are some areas where we can predict some big steps forward as a result of recent technological advances. However, I think that really major discoveries tend to be unexpected. We can predict though, that fundamental scientific advances during the past four or five years will have a profound effect on our research programs.

In the infectious disease area, where we have a major research investment, two developments offer very powerful technological tools for prophylactic medicine. These are the development of monoclonial antibodies and the development of genetic engineering and recombinant DNA technology. The combination of these two technologies offer some real promise, particularly in the development of vaccines. For example, we are already using genetic engineering technology to develop a shigellosis (dysentery) vaccine. I think that if we achieve expected success with this vaccine, it will be a major step forward for military medicine. I also think that these new technologies hold promise for developing an antimalaria vaccine and several viral vaccines. I believe we are going to see some very impressive gains in this area during the next 5 to 10 years.

I also believe that the drug development field is maturing in several areas. For instance, our fundamental knowledge of parasite biology and metabolism is going to give us the opportunity to progress much more rapidly in the antiparasite drug development field. The final stages of drug development are of course always slow because the requirements for extensive safety and efficacy testing.

Relative to the fields of neuropsychiatry and neurophysiology, I think we are going to see some very important advances in understanding the brain functions and basic neurophysiology.

Q. How do you respond to critics who say that the Army's mission should not include medical research because there are ample civilian facilities for this purpose?

A. It cannot be denied that the fundamental capability to do research on many of our problems does exist in the civilian medical research community. However, there are major aspects that are missing in the civilian community. The civilian community does not have a complete appreciation of military medical problems. Military medicine is a bonafide specialty of medicine and requires a specific knowledge of military preventive medicine and aspects of combat casualty care which I discussed earlier. Therefore, the people who deal directly with these problems on a full-time basis are best qualified to direct the military's research programs. Therefore, management of our research programs must come from within the military because of an understanding of our unique problems. Civilian research leaves many military problems unsolved. For example, we have a Malaria drug development program because there was a specific, well-defined military requirement and there was no civilian program at all. Military medicine has evolved to fill specific needs. I should point out that military scientists differ very little from their civilian collegues. Military scientists are just oriented toward different problems. It is important to note here that we rely very heavily on civilian scientists as advisors and consultants and much military medical research is done in universities under contract.

It should be stressed also that all of our research is goal oriented.

We are not totally product oriented but we do demand attention to recognized military problems. In the long term, this inevitably results in new fundamental knowledge or a new preventive technology or product.

Q. What are some of the prominent "spinoff" benefits that the civilian community has received as a result of WRAIR efforts?

A. The one spinoff that immediately comes to mind is the Meningococcal Polysaccharide vaccine which has received significant use in the civilian community. Much of our research has been of significant benefit in tropical areas. The Malaysian Government, for example, is quite impressed with our scrub typhus research. Our work on malaria is of immense importance to the tropical areas of the world where malaria is the number one killer. Our research on shock may also prove to be very beneficial for the civilian community.

Additionally, the Rubella vaccine was a direct result of WRAIR's isolation of the Rubella virus. Many vaccines in use today resulted from research investments by the military. The hepatitis "B" vaccine, for example, is being developed as a result of knowledge generated in the 1950's and 1960's by the U.S. Army. In fact, under an Army-sponsored contract, Dr. Saul Krugman first proved that inactivated hepititus "B" virus had a prophylactic effect.

Q. Your assignment at WRAIR encompasses responsibilities as director of a research facility and commandant of a school. What major problems do you encounter in carrying out this type of mission?

A. The single biggest problem I have as an institute director and a research manager relates to the fundamental dilemma of managing long-term programs with funds that are allocated on a sometimes less than annual basis. For instance, it takes five to seven years to develop a single drug, and many vaccine development programs take 10 or more years. Also, some basic research, regardless of its importance, is often open-ended. We are expected to maintain a significant level of effort on a long-term program, yet funding is on a year-to-year basis and frequently oscillates widely because of totally extraneous issues. A program might be moderately funded one year, then be heavily funded the following year because it draws the political favor of someone, and disappear the next year because of someone's disfavor. These variations in funding really make little sense from the research manager's point of view.

The level of funding does not appear to me to be related to the quality of output of a program or to the productivity of a program. The level of funding of a program is too often related to other factors.

Q. You mentioned earlier that vaccine development programs often take 10 years or more. What specifically would you suggest to lessen this development time?

A. This depends on what causes a prolonged development time. If it is a lack of basic knowledge, then it will be very difficult to shorten the development time. Increased investment in basic research may produce a major breakthrough but this cannot be predicted with certainty. There really are no magic answers to this question. Biological research, by its very nature, usually must be done in a sequential fashion. The final stages of development are often slow because of safety testing and requirements for field trials. The development process can often be shortened by additional resources. However, the impact of additional resources is somewhat limited. There is always a point where more money has little additional effect.

In general, there really are very few shortcuts or major breakthroughs in biological research. Biological research involves long-term investments. The returns on investment in biomedical research are potentially very high in prevention of disease, saving dollars and maintaining the effective strength of our fighting forces. We have shown our ability to produce and there is a real need for the products of our research.

BRL Minicomputer Expected To Enhance Experimental Data Quality

Four Researchers at the Army's Ballistic Research Laboratory (BRL) have developed a minicomputer designed to greatly improve the evaluation and assessment of gun and projectile performance in a broad range of ballistic experiments.

Dr. James Walbert, a mathematician, and Mr. James Pilcher, a mechanical engineer, developed the original concept of BRL's new Laboratory Experimental Research Facility (LERF), and, along with Kathleen Zimmerman, a mathematician, and Mr. William Cruickshank, an electrical engineer, have produced a computer capability that will reportedly increase the use and quality of BRL's experimental data.

The aim of the team, assigned to BRL's Mechanics and Structures Branch, was to come up with a minicomputer facility that would speed up the process of translating long data records from BRL's gun and projectile experiments into computer language.

"Analog-to-digital conversion" is the technical term that Walbert uses in describing this "state-of-the-art" system. However, in simpler language, the minicomputer is the "work horse" that will help BRL researchers solve the problems of handling the masses of input data from the wide variety of experimental sources.

The computer center forms the basic link between the world of "real" phenomena information from sensors located either inside the gun or onboard the projectile with the "engineer-designed" world of digital information processing and data communications.

Housed in an immaculate, compact room in BRL's complex at Aberdeen Proving Ground, MD, the LERF also links other data acquisition devices in the Interior Ballistic Division with BRL's CDC 7600 mainframe computer.

Each team member contributed a special expertise to make this "dream" a reality. Software development and installation are credited to Walbert and Zimmerman, who also drew up the computer specifications for acquisition, while Cruickshank was responsible for the analog specifications.

The heart of the facility, to be managed by Zimmerman, is a Hewlett-Packard system 1000-F series minicomputer capable of storing more than a million "bytes," or units of memory as well as 120 million bytes of disc storage.

Preliminary tests demonstrated that the time spent digitizing and processing data prior to analysis can be reduced by as much as 20 percent.

But, according to Walbert, the newest computer facility is just beginning to show its value to ballistic researchers, adding that improved capabilities as well as quicker response times for future projects can certainly be expected.

Digital Mapping On Display

By CPT David R. Gallay

"Can my radars at Outpost Alpha sense movement on the east slope of Hill 407?" . . . "What fields of fire can I expect of a TOW position at the 3d Brigade's strongpost?" . . . "Where will the Vulcan gunners acquire the enemy's low-flying attack helicopters when they guard my river-crossing site?" Typical questions? You bet they are, and commanders and staff of the combined arms team want fast, accurate answers.

Site specific requirements or those that "depend on the situation" must be met as close to *immediately* as possible. Our current, standard terrain analysis products may not be particularly helpful.

Systems using digital mapping will correct this predicament and engineers at the U.S. Army Engineer Topographic Laboratories (USAETL), Fort Belvoir, VA, have managed literally to get "the show on the road" by touring posts with a mobile computer system in order to demonstrate how critical questions about battlefield terrain can be answered in near real time.

Instead of waiting for potential users to visit our laboratories, we took the initiative and decided to take our system to the users. Right now a prototype digital mapping system is in the "field" on a demonstration tour.

Digital mapping, very simply, is the technology of displaying terrain information, generated in a computer from digitized data, onto graphs and overlays. The on-line computer hardware yields the timely response. Good computer software and valid digitized terrain data provide the required accuracy. The Defense Mapping Agency produces the digital elevation data bases.

Introducing a new, technological approach to extract valuable terrain information (even though the new approach is time-saving and more dynamic) on a low budget called for some innovative management and not a little salesmanship.

The prototype system we are demonstrating is called FEED, for Field Exploitation of Elevation Data. Its major components include a computer console with a cathode ray tube (CRT) display, a paper plotter capable of producing overlays at the same scale as any base map, a printer that produces a hardcopy of the CRT display, and a memory storage disc. FEED is van-mounted, hence mobile. Its capabilities are not as extensive as our larger prototypes, but it serves as a useful example of what is being done in digital mapping.

Because FEED is mobile and its militarized components operate independent of temperature control, a "tour" is quite feasible. Our objective for the tour is twofold: to demonstrate the technology of digital mapping to potential users, and to get useful statements of need and performance, in order to guide our continuing development of digital mapping technology.

Given both our objectives and our budget constraints for travel, we are visiting only certain major headquarters, schools and centers, and troop posts. Priority is given to the closest installations, especially in the Southeast where proposed stops include U.S. Army Forces Command, U.S. Army Training and Doctrine Command and Rapid Deployment Joint Task Force headquarters, the Infantry and Aviation Centers, Fort Bragg, Shaw Air Force Base, and the Marine Corps Base, Quantico.

Our staff personally contacts representatives of each of the targeted installations to see if we can give a preview of the demonstrations to a cross section of the installation staffs. The preview is only a 30-minute slide show, but it reveals precisely what the system can do. Slides of the system components, and displays that easily answer the opening questions of this article, demonstrate the utility of using an interactive on-line computer.

CPT DAVID GALLAY is a research and development coordinator at the U.S. Army Engineer Topographic Laboratories. He is a graduate of the U.S. Military Academy, and holds a master's degree in engineering from Purdue University and a master's degree in management from the University of Southern California. He is also a graduate of the Command and General Staff College and is a registered professional engineer (Virginia).

A typical division area of operation with the latest unit dispositions is shown along with an explanation that the display is easily printed on the plotter at the same scale as a personal field map. What the potential users then see is an instant operations overlay. They look at the terrain in three dimensions and then we show that we can easily place a grid on this same view and use UTM coordinates.

After reading through this, it is clear how effective a visual demonstration of fields of fire, acquisition contours and the like becomes. It isn't too far along in the preview when the utility of an interactive system becomes apparent as the viewers imagine and "see" the prospects of rapid sensitivity analysis.

After the preview and after the decision is made that an actual demonstration would be useful, arrangements are made about the time, place, audience, etc. Here again, the most important consideration is a personal one, involving a specific individual - the soldier.

Since it is the soldier who will be using the FEED, we request that a soldier from the local post be selected to serve as our operator during the visit. This person, after only a few hours of training on the FEED system, will bring home to our viewers the evidence that this computer system is clear-cut and comprehensible, even though it produces sophisticated graphics.

The 2-man demonstration team tries to run at least six hourly sessions with 10 spectators per session. After learning the basic capabilities, the spectators are encouraged to use the FEED system themselves. After they prepare their own computer-generated terrain graphic, a hard copy of the graphic is produced as a souvenir.

Throughout the demonstration, the team emphasizes that FEED is not the ultimate in digital mapping. They describe other prototypes that we are developing to handle data ranging from vegetation and lines of communications to cross-country movement assessments and cover/concealment predictions. Yet, our teams point out that FEED clearly exemplifies the fundamentals of digital mapping technology.

After all questions about the system are answered, the team asks viewers to fill out a questionnaire. In general, this survey tells us whether we have accomplished our twofold objective mentioned earlier. Questions concerning the usefulness of digital mapping on the battlefield are asked, followed by who should use it (S2, S3), what display types are needed, where, on the battlefield, should it be used (Division Support Area?). In essence, we ask for user's

statements of need and performance.

Our measures of effectiveness for our objectives are the number of demonstration viewers, and the number of viewer surveys returned with useful comments. Our criteria for success, then, are the amount of interest shown and the feedback we get from viewers; our target for each demonstration day is 40 viewers and 15 returned surveys with useful comments.

The tour continues. Early returns suggest enormous enthusiasm from our viewers. Our viewers understand that FEED, as are our other digital mapping prototypes, is in an early stage of development; even so, FEED could be fielded today but the necessary Army supporting requirement documentation is needed.

Our viewers seem to appreciate our attempt to show them emerging technology, and what could very well be the forerunner of a completely automated terrain analysis system. We seem to have sparked the imagination of our viewers. And, although they may not know it, they are helping to shape a vision of future battlefield terrain analysis systems. If this trend continues, our tour will be highly successful.

Side-Looking Laser Altimeter May Improve NOE Simulations

Mr. Larry D. Webster, an electronics engineer with the Aeromechanics Laboratory, Army Research and Technology Laboratories (AVRADCOM), Moffett Field, CA, has invented a device to improve the capability of simulating nap-of-the-earth flight (NOE). The device, called the Side-looking Laser Altimeter (SLA), is used to determine aircraft altitude above the ground during ground-based simulations.

This project resulted in two patent applications by Webster, one for the overall concept and the other for the design of the slew motor transmission and control. Both have passed the search process and are now in the formal application stage by the NASA Legal Office. It is fully expected that patents will be granted.

The SLA was developed at the NASA-Ames Research Center, Moffett Field. The Side-looking Laser Altimeter reportedly provides accurate, realtime altitude feedback to the aircraft pilot during the simulation and evaluation data to the flight experimenter subsequent to the simulation.

The simulator pilot is provided the extra-vehicular view through the use of a Visual Flight Attachment (VFA) that consists of a model of the terrain that is "flown" over by a servo-controlled TV camera. The purpose of the SLA is to measure the distance between the video probe tip of the VFA and the simulated terrain directly below. Measuring this distance, adding a constant bias term to correct for the vehicles and probe exit pupil, and multiplying by the scale factor of the model gives the scaled pilot altitude.

A Laser beamsplitter, mirrors, follow-up transducer, and a second TV camera that is part of the SLA all travel with the VFA probe and camera as the pilot flies over the terrain. A single raster line in the SLA camera (representing a plane surface projecting forward from the camera) is made to intersect the central axis of the VFA probe.

The Laser's monochromatic dot returned from the terrain is driven into contact with the raster plane using the pitchable mirror actuated by the motor and a microcomputer-controlled servo loop. The geometry of the system will only allow this to happen at the point on the terrain directly below the probe. The angle of the pitch mirror relative to the VFA probe is now a trigonometric function of true pilot altitude. A lookup table of mirror angle versus true altitude provides the system output.

A comparison of the prototype performance with the system design goals shows that the overall prototype performance far exceeded the design criteria. Experience with the prototype has shown that tracking ability and accuracy could easily be improved by a factor of two in future systems. Also, occultation by severe terrain features can be essentially eliminated by duplicating the pitch mirror/camera components and using a redundancy algorithm in the microcomputer.

This prototype has reportedly demonstrated the design concept and NASA is sufficiently impressed with its performance and apparent potential for improving the simulation capabilities that it is anticipated it will be applied to the present VFA systems for general use.

ATTENTION AUTHORS

Do you have an article you would like to submit for possible publication in the *Army RDA Magazine?* If so, we would like to hear from you. Consideration will be given to all articles, based on importance of the subject, factual content, timeliness, and relevance to our magazine. The following are general guidelines for submissions:

- *Length.* Articles should be about 2,500 to 3,000 words. Shorter or longer articles are acceptable, depending on what is required to adequately tell the story.
- *Photos.* Include any photographs or illustrations which complement the article. Black or white or color are acceptable. We cannot promise to use all photos or illustrations and they are normally not returned unless requested.
- *Biographical Sketch.* Include a short biographical sketch and photo of the author/s.
- *Clearance.* Article must be cleared by author's security/OPSEC Office prior to submission.

Articles should be addressed to: HQ DARCOM, ATTN: DRCDE-M, 5001 Eisenhower Avenue, Alexandria, VA 22333. Telephone: Autovon 284-9587, Commercial 202-274-9587.

Development of a Long-Life Coolant System for Military Vehicles

By James H. Conley

With the ever increasing cost and shortage of world oil supplies and the resultant high cost and diminished availability of petroleum derived materials, such as ethylene glycol, the base material for antifreeze compounds, the need to extend the useful life of engine antifreeze/coolants is of paramount importance.

All internal combustion engines are designed to use either an air or liquid cooling system to remove the heat generated during engine operation, as the high temperatures generated in an engine can only be partially converted to mechanical energy.

Sixty-five to 70 percent of the heat generated in the combustion process must be continuously removed from the engine block in order to prevent irreversible damage to the engine. Liquid cooling systems are the most common type used to dissipate the excess heat and carry it to the radiator. Here the heat is transferred to the air, maintaining a safe engine operating temperature of between 190°F and 200°F.

Because of the higher operating temperature of modern military engines and the need for low-temperature protection when a vehicle is not in operation, the most commonly used coolant is an ethylene glycol/water mixture. Ethylene glycol serves to raise the boiling point of the mixture, lower the freezing point and, because it contains inhibitors, reduces the corrosion of cooling system metals.

Two factors that limit the useful life of an antifreeze/coolant are losses related to hardware failure and corrosion related failures caused by inhibitor depletion. Coolant loss is caused by system leaks, bursting hoses, defective pressure caps, and malfunctioning thermostats. All these hardware-related losses can be minimized by proper preventive maintenance.

The most important factor governing the length of time an antifreeze/coolant can be safety used is the condition of the inhibitor systems. Depeletion of an antifreeze/coolant inhibitor system is a normal occurrence that takes place over a period of time in the vehicle cooling system. When the inhibitor depletion reaches a certain point, corrosion of the cooling system metals begins and then progresses at a fairly rapid rate.

Once the corrosion has taken place, the only solution is to remove the antifreeze/coolant, clean the cooling system, and recharge with new fluid. The only other option is to keep the inhibitor concentration at a level that does not permit the corrosion of the cooling system metals to begin. With new technology, now available, this can be effectively accomplished.

The Fuels and Lubricants Division of the Energy and Water Resources Laboratory, U.S. Army Mobility Equipment Research and Development Command, is developing a long-life coolant system, one that will eliminate the need to periodically change the antifreeze/coolant in military vehicle cooling systems.

The system under development is comprised of a spin-on filter/ conditioner unit and an electronic corrosion condition sensor. The filter/conditioner unit is made up of three parts: a forged-steel, double-angled, bracket with predrilled aluminum filter head with inlet and outlet bosses predrilled and tapped 3/8" NPTF for easy connection to heater hose and the spin-on filter/conditioner which screws on the filter head.

The spin-on filter/conditioner contains a filtering medium to trap suspended contaminant that slowly dissolves in the coolant, keeping calcium and magnesium in suspension so they can be filtered out and at the same time introduces buffering agents and corrosion inhibitors to neutralize acids and prevent corrosion of the cooling system metals.

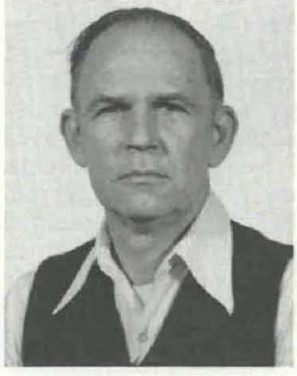
In order to monitor the depletion of the filter/conditioner unit, an electronic corrosion condition sensor is mounted with the electrode directly in the coolant, preferably in the radiator. Advances in solid-state electronics have made it economically feasible to develop a low-cost electrometer capable of measuring the *in-situ* potential of a sensing electrode versus a reference electrode in a vehicle cooling system. This provides an indirect measurement of antifreeze/coolant corrosivity and indicates by optical or acoustic means when the spin-on filter/conditioner unit must be changed.

The reference electrode is of silver, since all the various half cell reactions of silver occur at approximately the same potential. The sensing electrode consists of steel electrically shorted to aluminum to form a galvanic couple. The combination electrode senses corrosivity to steel or aluminum. When sufficient inhibitor is not present to maintain the passive film on steel, the potential of the steel shifts towards the more negative values and readily polarizes the aluminum to these values since little current is necessary to polarize a passivated electrode.

Similarly, when sufficient inhibitor is not present to maintain the passive film on aluminum, the potential of the aluminum will shift to more negative values and polarize the passive steel to these values. Thus, whenever the concentration of the inhibitor is not sufficient to prevent corrosion on either steel or aluminum, the potential of the combination sensor will shift to more negative values.

In practice, a warning device mounted on the vehicle dash board is activated when the potential difference exceeds a predetermined value. One such warning device is a light emitting diode (LED) but other devices can be used. At this point, the spin-on filter/conditioner is simply replaced and the coolant remains noncorrosive to the cooling system metals.

The use of this long-life coolant system will eliminate the need to periodically replace antifreeze/coolant in military vehicles, help conserve declining petroleum resources, reduce maintenance of cooling systems to a minimum and result in a considerable cost saving to the U.S. Army.



JAMES H. CONLEY is a chemist in the Fuels and Lubricants Division of the Energy and Water Resources Laboratory, U.S. Army Mobility Equipment R & D Command. He has attended the University of Deleware and is a member of the Society of Automotive Engineers Hydraulic Brake Systems Actuating Committee, and the Organization for Standardization Brake Fluids and Related Materials Committee.

RDA Magazine
HQ DARCOM
ATTN: DRCDE-M
5001 Eisenhower Ave.
Alexandria, VA 22333

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

RDA MAGAZINE
HQ DARCOM
ATTN: DRCDE-M
5001 EISENHOWER AVE.
ALEXANDRIA, VA 22333

RDA Magazine
HQ DARCOM
ATTN: DRCDE-M
5001 Eisenhower Ave.
Alexandria, VA 22333

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

RDA MAGAZINE
HQ DARCOM
ATTN: DRCDE-M
5001 EISENHOWER AVE.
ALEXANDRIA, VA 22333

RDA Magazine
HQ DARCOM
ATTN: DRCDE-M
5001 Eisenhower Ave.
Alexandria, VA 22333

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

RDA MAGAZINE
HQ DARCOM
ATTN: DRCDE-M
5001 EISENHOWER AVE.
ALEXANDRIA, VA 22333

Readership Survey

(Please Fill Out and Return to Army RDA Magazine)

1. Are You:
   - ☐ Civilian Industry ☐ Civilian Government
   - ☐ Military ☐ Academia
   - ☐ Other _____?
2. If military, indicate below:
   - ☐ Active duty ☐ Reserve
   - ☐ Active duty w/prim/secon SSI of ☐ Reserve w/Mob Des Assignment to RDA-type billet
   - ☐ 51 ☐ 97
   - ☐ 52 ☐ 6-T
3. How many issues have you seen in the past year?
   - ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or 6 ☐ None
4. How soon after publication do you see a copy of the magazine?
   - ☐ The same month it is published ☐ One month later
   - ☐ Two months later
   - ☐ Three or more months later
5. How do you normally get a copy?
   - ☐ It is mailed directly to me
   - ☐ Through intra-office distribution
   - ☐ Read it in the library
   - ☐ Informal routing from friends ☐ Other
6. How much of the magazine do you generally read?
   - ☐ All of it ☐ Most of it ☐ Scan it
7. How useful to you is the information?
   - ☐ Very useful ☐ Moderately useful
   - ☐ Slightly useful ☐ Not at all
8. What is your opinion of the print sizes used?
   - ☐ Too small ☐ Too large ☐ About right
9. Which type of article do you read most?
   - ☐ Bylines ☐ Short news articles ☐ Both
10. Which departments do you prefer to read? (Check as many as you desire)
    - ☐ Conferences and symposia ☐ Awards
    - ☐ Capsules ☐ Personnel actions
    - ☐ Career programs
11. How do you feel about our question and answer interview articles?
    - ☐ Like strongly ☐ Like moderately ☐ Dislike
12. How do you rate the art, illustrations and general layout of the magazine?
    - ☐ Very good ☐ Good ☐ So-so ☐ Poor
13. Relative to your particular needs, how well do Army RDA Magazine articles cover the subjects?
    - ☐ Too superficial ☐ Sufficient depth
    - ☐ Too much depth
14. Compared with previous years, how has the quality of Army RDA Magazine changed in the past year or year and a half?
    - ☐ Improved ☐ Stayed the same
    - ☐ Decreased ☐ Unable to judge/no opinion
15. What changes in content/layout would you like to see? _____

Readership Survey

(Please Fill Out and Return to Army RDA Magazine)

1. Are You:
   - ☐ Civilian Industry ☐ Civilian Government
   - ☐ Military ☐ Academia
   - ☐ Other _____?
2. If military, indicate below:
   - ☐ Active duty ☐ Reserve
   - ☐ Active duty w/prim/secon SSI of ☐ Reserve w/Mob Des Assignment to RDA-type billet
   - ☐ 51 ☐ 97
   - ☐ 52 ☐ 6-T
3. How many issues have you seen in the past year?
   - ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or 6 ☐ None
4. How soon after publication do you see a copy of the magazine?
   - ☐ The same month it is published ☐ One month later
   - ☐ Two months later
   - ☐ Three or more months later
5. How do you normally get a copy?
   - ☐ It is mailed directly to me
   - ☐ Through intra-office distribution
   - ☐ Read it in the library
   - ☐ Informal routing from friends ☐ Other
6. How much of the magazine do you generally read?
   - ☐ All of it ☐ Most of it ☐ Scan it
7. How useful to you is the information?
   - ☐ Very useful ☐ Moderately useful
   - ☐ Slightly useful ☐ Not at all
8. What is your opinion of the print sizes used?
   - ☐ Too small ☐ Too large ☐ About right
9. Which type of article do you read most?
   - ☐ Bylines ☐ Short news articles ☐ Both
10. Which departments do you prefer to read? (Check as many as you desire)
    - ☐ Conferences and symposia ☐ Awards
    - ☐ Capsules ☐ Personnel actions
    - ☐ Career programs
11. How do you feel about our question and answer interview articles?
    - ☐ Like strongly ☐ Like moderately ☐ Dislike
12. How do you rate the art, illustrations and general layout of the magazine?
    - ☐ Very good ☐ Good ☐ So-so ☐ Poor
13. Relative to your particular needs, how well do Army RDA Magazine articles cover the subjects?
    - ☐ Too superficial ☐ Sufficient depth
    - ☐ Too much depth
14. Compared with previous years, how has the quality of Army RDA Magazine changed in the past year or year and a half?
    - ☐ Improved ☐ Stayed the same
    - ☐ Decreased ☐ Unable to judge/no opinion
15. What changes in content/layout would you like to see? _____

Readership Survey

(Please Fill Out and Return to Army RDA Magazine)

1. Are You:
   - ☐ Civilian Industry ☐ Civilian Government
   - ☐ Military ☐ Academia
   - ☐ Other _____?
2. If military, indicate below:
   - ☐ Active duty ☐ Reserve
   - ☐ Active duty w/prim/secon SSI of ☐ Reserve w/Mob Des Assignment to RDA-type billet
   - ☐ 51 ☐ 97
   - ☐ 52 ☐ 6-T
3. How many issues have you seen in the past year?
   - ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or 6 ☐ None
4. How soon after publication do you see a copy of the magazine?
   - ☐ The same month it is published ☐ One month later
   - ☐ Two months later
   - ☐ Three or more months later
5. How do you normally get a copy?
   - ☐ It is mailed directly to me
   - ☐ Through intra-office distribution
   - ☐ Read it in the library
   - ☐ Informal routing from friends ☐ Other
6. How much of the magazine do you generally read?
   - ☐ All of it ☐ Most of it ☐ Scan it
7. How useful to you is the information?
   - ☐ Very useful ☐ Moderately useful
   - ☐ Slightly useful ☐ Not at all
8. What is your opinion of the print sizes used?
   - ☐ Too small ☐ Too large ☐ About right
9. Which type of article do you read most?
   - ☐ Bylines ☐ Short news articles ☐ Both
10. Which departments do you prefer to read? (Check as many as you desire)
    - ☐ Conferences and symposia ☐ Awards
    - ☐ Capsules ☐ Personnel actions
    - ☐ Career programs
11. How do you feel about our question and answer interview articles?
    - ☐ Like strongly ☐ Like moderately ☐ Dislike
12. How do you rate the art, illustrations and general layout of the magazine?
    - ☐ Very good ☐ Good ☐ So-so ☐ Poor
13. Relative to your particular needs, how well do Army RDA Magazine articles cover the subjects?
    - ☐ Too superficial ☐ Sufficient depth
    - ☐ Too much depth
14. Compared with previous years, how has the quality of Army RDA Magazine changed in the past year or year and a half?
    - ☐ Improved ☐ Stayed the same
    - ☐ Decreased ☐ Unable to judge/no opinion
15. What changes in content/layout would you like to see? _____

Readership Survey

(Please Fill Out and Return to Army RDA Magazine)

1. Are You:
   - ☐ Civilian Industry ☐ Civilian Government
   - ☐ Military ☐ Academia
   - ☐ Other _____?
2. If military, indicate below:
   - ☐ Active duty ☐ Reserve
   - ☐ Active duty w/prim/secon SSI of ☐ Reserve w/Mob Des Assignment to RDA-type billet
   - ☐ 51 ☐ 97
   - ☐ 52 ☐ 6-T
3. How many issues have you seen in the past year?
   - ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or 6 ☐ None
4. How soon after publication do you see a copy of the magazine?
   - ☐ The same month it is published ☐ One month later
   - ☐ Two months later
   - ☐ Three or more months later
5. How do you normally get a copy?
   - ☐ It is mailed directly to me
   - ☐ Through intra-office distribution
   - ☐ Read it in the library
   - ☐ Informal routing from friends ☐ Other
6. How much of the magazine do you generally read?
   - ☐ All of it ☐ Most of it ☐ Scan it
7. How useful to you is the information?
   - ☐ Very useful ☐ Moderately useful
   - ☐ Slightly useful ☐ Not at all
8. What is your opinion of the print sizes used?
   - ☐ Too small ☐ Too large ☐ About right
9. Which type of article do you read most?
   - ☐ Bylines ☐ Short news articles ☐ Both
10. Which departments do you prefer to read? (Check as many as you desire)
    - ☐ Conferences and symposia ☐ Awards
    - ☐ Capsules ☐ Personnel actions
    - ☐ Career programs
11. How do you feel about our question and answer interview articles?
    - ☐ Like strongly ☐ Like moderately ☐ Dislike
12. How do you rate the art, illustrations and general layout of the magazine?
    - ☐ Very good ☐ Good ☐ So-so ☐ Poor
13. Relative to your particular needs, how well do Army RDA Magazine articles cover the subjects?
    - ☐ Too superficial ☐ Sufficient depth
    - ☐ Too much depth
14. Compared with previous years, how has the quality of Army RDA Magazine changed in the past year or year and a half?
    - ☐ Improved ☐ Stayed the same
    - ☐ Decreased ☐ Unable to judge/no opinion
15. What changes in content/layout would you like to see? _____

Readership Survey

(Please Fill Out and Return to Army RDA Magazine)

1. Are You:
   - ☐ Civilian Industry ☐ Civilian Government
   - ☐ Military ☐ Academia
   - ☐ Other _____?
2. If military, indicate below:
   - ☐ Active duty ☐ Reserve
   - ☐ Active duty w/prim/secon SSI of ☐ Reserve w/Mob Des Assignment to RDA-type billet
   - ☐ 51 ☐ 97
   - ☐ 52 ☐ 6-T
3. How many issues have you seen in the past year?
   - ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or 6 ☐ None
4. How soon after publication do you see a copy of the magazine?
   - ☐ The same month it is published ☐ One month later
   - ☐ Two months later
   - ☐ Three or more months later
5. How do you normally get a copy?
   - ☐ It is mailed directly to me
   - ☐ Through intra-office distribution
   - ☐ Read it in the library
   - ☐ Informal routing from friends ☐ Other
6. How much of the magazine do you generally read?
   - ☐ All of it ☐ Most of it ☐ Scan it
7. How useful to you is the information?
   - ☐ Very useful ☐ Moderately useful
   - ☐ Slightly useful ☐ Not at all
8. What is your opinion of the print sizes used?
   - ☐ Too small ☐ Too large ☐ About right
9. Which type of article do you read most?
   - ☐ Bylines ☐ Short news articles ☐ Both
10. Which departments do you prefer to read? (Check as many as you desire)
    - ☐ Conferences and symposia ☐ Awards
    - ☐ Capsules ☐ Personnel actions
    - ☐ Career programs
11. How do you feel about our question and answer interview articles?
    - ☐ Like strongly ☐ Like moderately ☐ Dislike
12. How do you rate the art, illustrations and general layout of the magazine?
    - ☐ Very good ☐ Good ☐ So-so ☐ Poor
13. Relative to your particular needs, how well do Army RDA Magazine articles cover the subjects?
    - ☐ Too superficial ☐ Sufficient depth
    - ☐ Too much depth
14. Compared with previous years, how has the quality of Army RDA Magazine changed in the past year or year and a half?
    - ☐ Improved ☐ Stayed the same
    - ☐ Decreased ☐ Unable to judge/no opinion
15. What changes in content/layout would you like to see? _____

Readership Survey

(Please Fill Out and Return to Army RDA Magazine)

1. Are You:
   - ☐ Civilian Industry ☐ Civilian Government
   - ☐ Military ☐ Academia
   - ☐ Other _____?
2. If military, indicate below:
   - ☐ Active duty ☐ Reserve
   - ☐ Active duty w/prim/secon SSI of ☐ Reserve w/Mob Des Assignment to RDA-type billet
   - ☐ 51 ☐ 97
   - ☐ 52 ☐ 6-T
3. How many issues have you seen in the past year?
   - ☐ 1 or 2 ☐ 3 or 4 ☐ 5 or 6 ☐ None
4. How soon after publication do you see a copy of the magazine?
   - ☐ The same month it is published ☐ One month later
   - ☐ Two months later
   - ☐ Three or more months later
5. How do you normally get a copy?
   - ☐ It is mailed directly to me
   - ☐ Through intra-office distribution
   - ☐ Read it in the library
   - ☐ Informal routing from friends ☐ Other
6. How much of the magazine do you generally read?
   - ☐ All of it ☐ Most of it ☐ Scan it
7. How useful to you is the information?
   - ☐ Very useful ☐ Moderately useful
   - ☐ Slightly useful ☐ Not at all
8. What is your opinion of the print sizes used?
   - ☐ Too small ☐ Too large ☐ About right
9. Which type of article do you read most?
   - ☐ Bylines ☐ Short news articles ☐ Both
10. Which departments do you prefer to read? (Check as many as you desire)
    - ☐ Conferences and symposia ☐ Awards
    - ☐ Capsules ☐ Personnel actions
    - ☐ Career programs
11. How do you feel about our question and answer interview articles?
    - ☐ Like strongly ☐ Like moderately ☐ Dislike
12. How do you rate the art, illustrations and general layout of the magazine?
    - ☐ Very good ☐ Good ☐ So-so ☐ Poor
13. Relative to your particular needs, how well do Army RDA Magazine articles cover the subjects?
    - ☐ Too superficial ☐ Sufficient depth
    - ☐ Too much depth
14. Compared with previous years, how has the quality of Army RDA Magazine changed in the past year or year and a half?
    - ☐ Improved ☐ Stayed the same
    - ☐ Decreased ☐ Unable to judge/no opinion
15. What changes in content/layout would you like to see? _____

RDA Magazine
HQ DARCOM
ATTN: DRCDE-M
5001 Eisenhower Ave.
Alexandria, VA 22333

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

RDA MAGAZINE
HQ DARCOM
ATTN: DRCDE-M
5001 EISENHOWER AVE.
ALEXANDRIA, VA 22333

RDA Magazine
HQ DARCOM
ATTN: DRCDE-M
5001 Eisenhower Ave.
Alexandria, VA 22333

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

RDA MAGAZINE
HQ DARCOM
ATTN: DRCDE-M
5001 EISENHOWER AVE.
ALEXANDRIA, VA 22333

RDA Magazine
HQ DARCOM
ATTN: DRCDE-M
5001 Eisenhower Ave.
Alexandria, VA 22333

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DOD 314

RDA MAGAZINE
HQ DARCOM
ATTN: DRCDE-M
5001 EISENHOWER AVE.
ALEXANDRIA, VA 22333

Powder-Filled Structural Panels for Helicopter Fuel Fire Protection

By Charles M. Pedriani

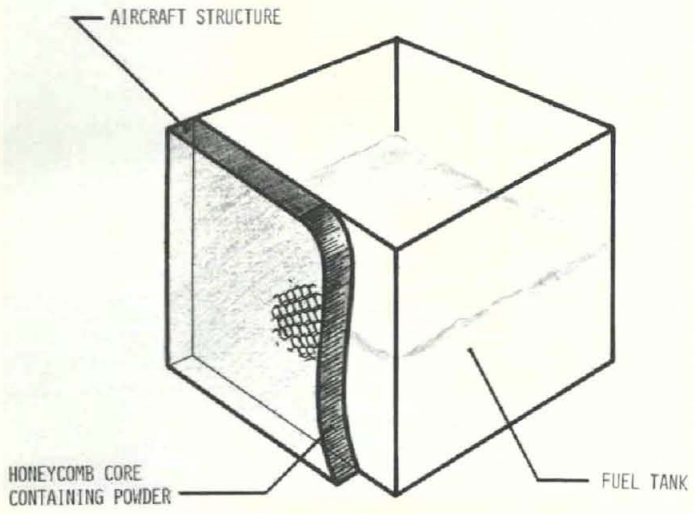


Fig. 1. Schematic Diagram of Powder-Filled Honeycomb Core Structural Panels

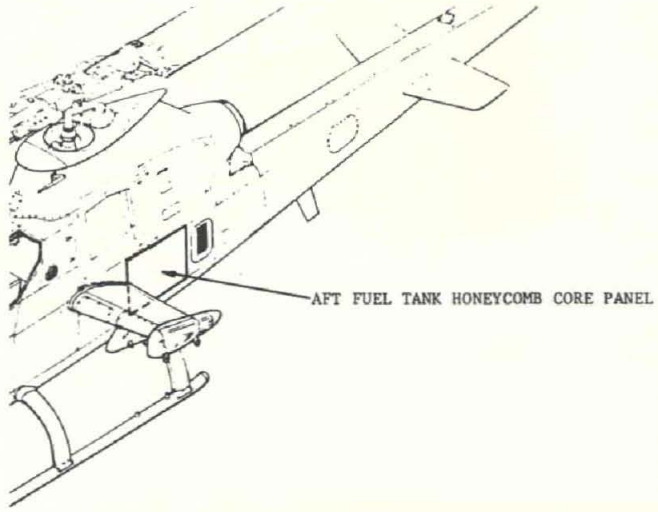


Fig. 2. AH-1S Helicopter Showing Location of Rear Fuel Tank and Honeycomb Core panel

Of all the combat risks faced by Army Aviators, in-flight fire or explosion from a fuel tank hit is certainly among the most dreaded. Furthermore, vulnerability estimates indicate that helicopter conventional fuel tanks can be easily ignited by weapons used to support enemy infantry and armor. However, techniques are being developed at the Applied Technology Laboratory (ATL), U.S. Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, VA, that will prevent such fuel fires from even the most severe of enemy threats.

There are many combat fire scenarios, but the most common involves ballistic penetration of the fuel container followed by fuel leakage (often in a spray or atomized form), which is ignited by either the incendiary from the projectile, hot fragments, or just the impact flash itself.

Preventing or extinguishing these fires is not a difficult task from a technical viewpoint; however, the relatively high weight normally associated with conventional fire-prevention systems has all but precluded their application to helicopters. The new concept of powder-filled structural panels is not only effective in preventing fires, but it is lightweight.

The basic concept from testing showed that if a fire suppression powder could be placed on the fuel tank outer wall where it would be released by the projectile itself at impact, only small amounts of powder would be necessary to achieve fire protection.

These initial tests were conducted on 0.10-inch-thick honeycomb core panels, containing powder, bonded onto existing fuel tank walls. Since many Army helicopters have a honeycomb core structure around the fuel tanks, the natural solution seemed to be to install the powder within the existing honeycomb cells, as shown in Figure 1.

Developing the concepts for practical use, however, was not without problems. Since the panels are a part of the aircraft structure the panel strength and durability could not be degraded by the presence of the powder.

Fine powder tends to interfere with the adhesive between the skin and honeycomb core and to decompose at the high temperatures normally used in the fabrication cycle. The long-term environmental effects of corrosion, vibration, and humidity on the effectiveness of the powder and the life of the panels were also in question.

Based on the results of in-house experiments, ATL awarded a contract to Bell Helicopter to help solve these problems and to develop a powder-filled panel for the rear fuel tank of the AH-1S helicopter (Figure 2). The goals were to design, fabricate, and test a panel that provides fire protection at no weight gain, no strength reduction, and no life reduction, when compared to the existing panel.

The approach to achieve the final goals has two facets: First, the use of composite materials, in lieu of metals, for the panel itself was investigated to save weight and to mitigate the potential corrosive effects of the powders; and second, the latest available fire-extinguishing powders were evaluated to find the lightest, most effective and most stable powder.

Under the initial phase of the contract, Bell fabricated many

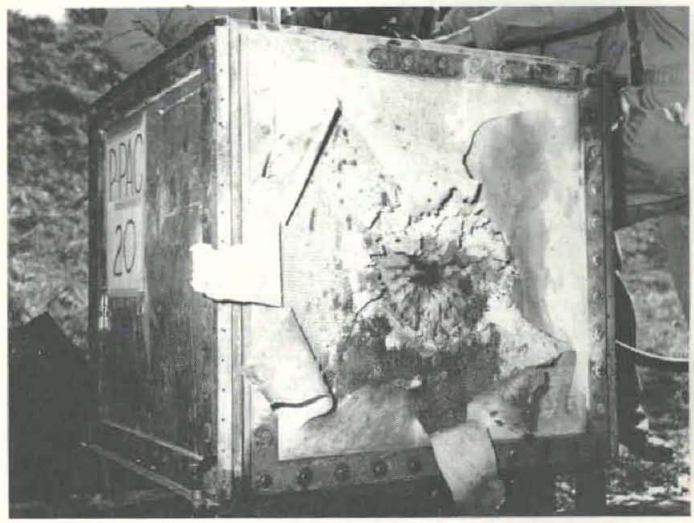


Fig. 3. Powder-Filled Structural Panels for Helicopter Fuel Fire Protection

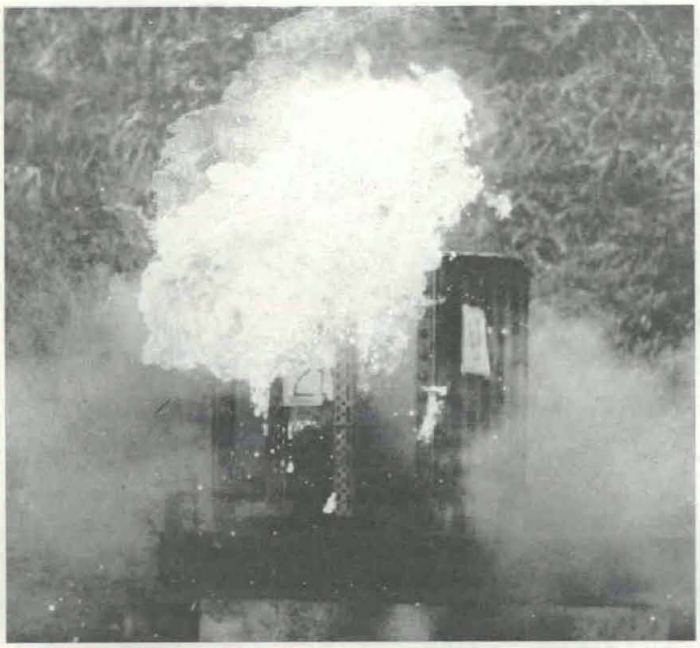


Fig. 4. Comparison of Impact Appearance: Test Without Powder

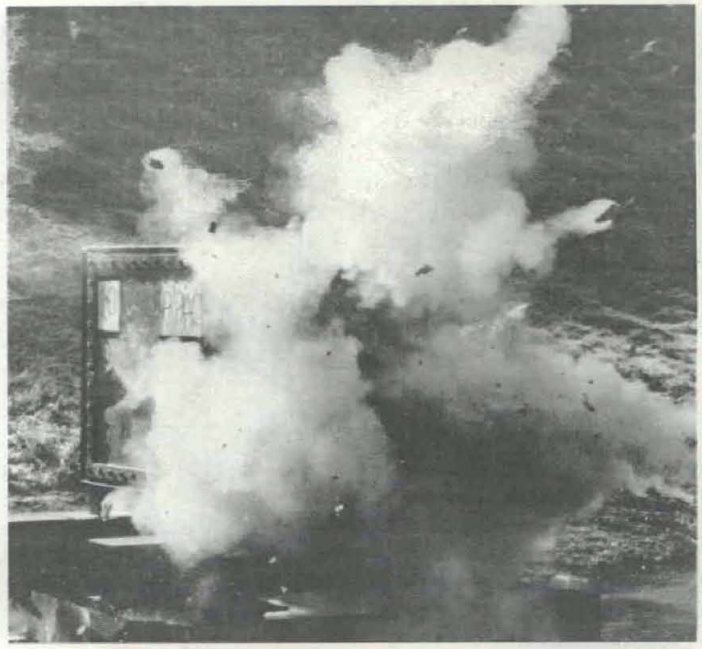


Fig. 5 Comparison of Impact Appearance: Test With Powder-Filled Structure

small (10 inches square) panels for laboratory strength and environmental tests to determine the best choice of materials and fabrication methods. Next, about 20 larger panels (31 inches square) were constructed to gain additional fabrication experience and for ballistic tests conducted at ATL.

Combinations of specimens were made, which included aluminum, Kevlar, and graphite materials, and they contained various types and amounts of fire-extinguishing powder. The ballistic testing conducted at ATL was to determine the optimum type and amount of powder necessary in the panel to guarantee fire prevention.

Results of the first phase were highly successful. Conventional honeycomb core panel fabrication processes required only slight modification to install the powder, while retaining all of the strength and durability necessary for safe flight.

Furthermore, ballistic tests showed that amazingly small amounts of powder were sufficient to prevent fires in spite of severe fuel tank damage/fuel spillage (Figure 3). It appeared that the powder was released quickly enough to be present within the ballistic detonation itself, as shown in the comparative photos taken at impact with and without powder (Figures 4 & 5).

Lessons learned in the initial phase of the contract were applied to the design of three types of powder-filled structural panels for the aft fuel tank of the AH-1S. The first type required no redesign, as it consisted of the current metal panel (titaium outer skin, aluminum honeycomb core, and fiberglass inner skin) with the addition of the appropriate amount of powder.

The remaining two types (one of Kevlar skins with Nomex honeycomb core and one with graphite skins with Nomex honeycomb core) required innovative design approaches to achieve both the high-panel strength necessary to carry aircraft landing loads and the low-weight goals established at the program outset.

Using these designs, 10 replacement panels were fabricated for the AH-1S - four from metal, three from graphite, and three from Kevlar. A few of the panels were subjected to a strength test to confirm their ability to withstand aircraft loads. Others were installed on AH-1S hulk aircraft and ballistically tested under airflow conditions duplicating hover and forward-flight regimes.

Again the results were highly successful. The powder-filled replacement panels were fabricated to the same high standards as the existing panels, with minimum technical difficulty. Strength tests confirmed their ability to carry aircraft loads, and there were no fires during any of the ballistic tests. Furthermore, the weight of the composite powder-filled panels is several pounds less than that of the metal panel now in use.

The development of the concept is continuing to be pursued on several fronts by ALT. The concept itself is being enhanced for use against even high-level threats, and new, more effective powders are being investigated. Also, additional applications are being studied for the AH-1S under the Survivability and Vulnerability Improvement Modification (SAVIM) program and for other Army helicopters that have honeycomb core panels around the fuel tanks.

These powder-filled structures provide a significant measure of fire protection. When used in concert with other techniques, such as nitrogen inerting or active detection/suppression, complete fire protection is achievable. As these concepts find wider use, in-flight fuel fires will become a concern of the past.

CHARLES M. PEDRIANI is an aerospace engineer assigned to the Vulnerability Reduction Group, Safety and Survivability Technical Area, Applied Technology Laboratory, U.S. Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, VA. He has a BS in mechanical engineering from the Pennsylvania State University, and has 12 years experience in all phases of Army helicopter vulnerability reduction.

Aviator Night Vision Goggles With

Sub-Miniature Instrument Display

By SSG Ronald R. Cisco and Paula R. Store

Current joint service tactical doctrine dictates that future aviation combat operations will be conducted primarily under nap-of-the-earth (NOE), low level, or night scenarios. Limited visibility during night flight hinders identification of proper flight cues, makes obstacle avoidance difficult, and interferes with target acquisition and detection. Night vision goggles (NVG) technology has done much to combat these problems and to assist pilots during NOE and terrain flight.

Several years ago, the U.S. Army Aeromedical Research Laboratory (USAARL) became extensively involved in research surrounding the medical aspects of aircrew workload and stress. The research staff that initially began this project numbered 15 and has since grown to over 30 members.

To achieve precise measurements of workload and factors that may be affecting crew stress, a standard issue UH-1H helicopter was refitted with small sensing devices that detect very minute changes in aircraft stability and control.

A way of monitoring the sensors was necessary. A package containing both a digital and analog signal recorder was put together. This system is known as the Helicopter In-Flight Monitoring System (HIMS). It has the capability of monitoring 20 separate channels simultaneously at a rate of 20 samples per second on each channel.

Shortly after the crew stress and workload effort began, it became very apparent that a separate research effort in the visual performance area was necessary. Previous research in moving vehicles had established that visual input comprised 90 percent of the operator input workload. This appeared no less true in the airborne environment.

A device, initially developed to test student reading habits, was modified to be worn and used by a pilot flying a helicopter or small fixed-wing aircraft. This device became the USAARL eye tracking system and uses the corneal reflection technique to monitor where the subject is, in fact, focusing his/her attention (Figure 1).

Eye movement of the pilot is recorded on high-speed motion picture film, scored and then analyzed to determine the scan patterns, fixation points, instrument use and the flight information necessary to maintain stable and safe flight across standard maneuvers required of U.S. Army aviators.

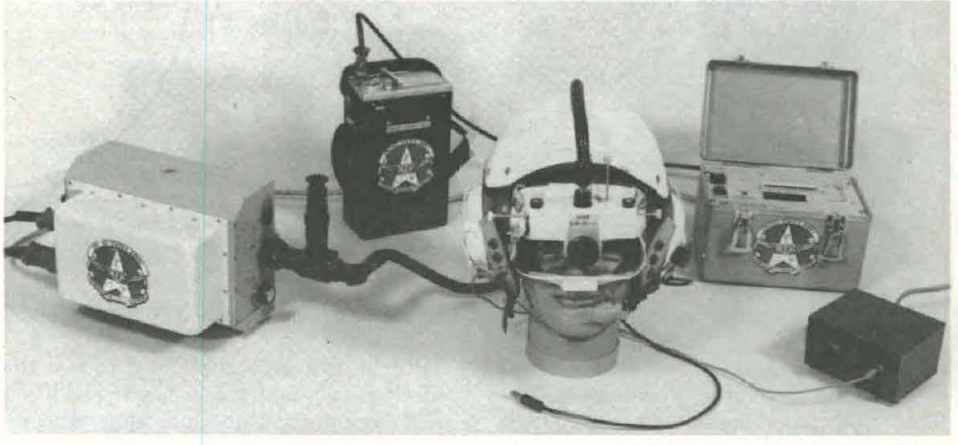


Fig. 1. USAARL Eye Tracking System Using Corneal Reflection Technique

Use of night vision goggles greatly enhances the pilot's ability to see outside the aircraft for night operations, but they create their own unique problems. USAARL's past experience and proven research methods in the area of visual performance research, along with the available equipment, are being used to study some of these problems.

One of the greatest difficulties associated with the NVGs is transitioning from external cues to the instrument panel for information. Should outside points of reference be shrouded in a whiteout (blowing snow), brownout (blowing sand), or weather (fog, etc.), aircraft attitude information derived from outside visual cues can be lost.

Several alternatives have been tried in an effort to alleviate this unique NVG situation. One approach is development and testing of bifocal configured NVGs. They were found acceptable for enroute but restrictive and undesirable for NOE flight or maneuver performance to the ground. A second was to have one or two flight personnel ride in the aircraft to assist the pilot. The pilot wearing NVG visually concentrates outside the aircraft while the other personnel focus their NVG inside the aircraft and provide the pilot with navigation, aircraft system, and in-flight information. A third involved having some pilots flying single-pilot missions, and wearing the NVG, report focusing one of the NVG tubes inside the aircraft and one outside the aircraft.

None of the preceding methods has proven adequate to completely resolve the problems of having flexibility to receive visual cues from either internal instrumentation or external cues while operating with NVG.

Another more-recent promising alternative is the concept of using a subminiature optical display system, which will superimpose aircraft information on the lens of the NVG. This concept evaluation proposal was submitted by the Biomedical Applications Research Division, United States Army Aeromedical Research Laboratory, to the Director of Combat Developments (DCD), United States Army Aviation Center, Fort Rucker, AL. The concept was accepted by DCD as being feasible and action began in 1977 to obtain a device that would meet the specifications for the concept proposal.

The concept of this NVG heads-up system was to present select flight information digitally superimposed on or integrated with pilots' visual field as seen through the NVG. Thus, the pilot could obtain critical flight information without readjusting the goggles' focus from infinity to inside the aircraft. The digital arrangement is shown in Figure 2. Note the arrangement is in the peripheral field of view.

Following procurement, the concept evaluation was completed by USAARL to test the functionality of an integrated display in the "real-world" environment. The subminiature heads-up display was attached to the NVG adding no more than 2.2 ounces to the goggles' two pounds.

The flight information selected to be presented through the display was supported by previous research, which had shown that certain in-flight data were more critical than others, i.e., attitude heading, trim, airspeed, and altitude indications.

For the evaluation, digital airspeed, heading, and altitude were chosen to be displayed at the 9, 12, and 3 o'clock positions, respectively. Technological difficulties, funding and time restraints prohibited the use of a dynamic analog attitude indicator during this concept evaluation. The flight information presented was in 3-digit accuracy.

During research flights, five subject/investigator pilots were asked to fly, utilizing only the NVG in a prescribed flight profile in the USAARL JUH-1H. During the flight, they were to maintain airspeed, altitude, and heading as close to the prescribed parameters as possible. Each pilot reported difficulty in maintaining required attitude, airspeed and altitude, and navigating the required course without verbal assistance from the safety/copilot.

On a second phase research flight, the pilots utilized the NVG, which had been fitted and calibrated with the heads-up display. The same flight profile and parameters were established as criteria for this flight. Each subject pilot, without exception, demonstrated that the flight information provided by the display aided in maintaining closer flight parameters throughout the profile and did so without verbal assistance from the safety/copilot.

Each pilot also reported that the attitude and trim information were essential for a complete display and that an aircraft master caution or warning display would be beneficial. These comments supported previous research results that attitude, airspeed, altitude, heading, trim and caution information comprise approximately 90 percent of all pilot visual activity. This information is essential for safe flight regardless of flight environment, profile or maneuvers, whether the information is gained from aircraft instruments or cues external to the aircraft (trees, clouds, buildings, etc.).

Further research is planned to test the effect on pilot performance by the addition of a dynamic attitude indicator, trim information and a master caution warning light with the current display information. In theory, such a system added to the NVG will provide the pilot heads-up, minimal-required, visual flight information.

Consequently, the pilot should be able to maintain control of the aircraft solely by refocusing on the display, in the event the goggles fail, inadvertent instrument conditions are encountered, or brownout or whiteout occurs during Night Vision Goggles operations. With this new and exciting development, safer flight conditions and mission completion are more of a reality than ever before.

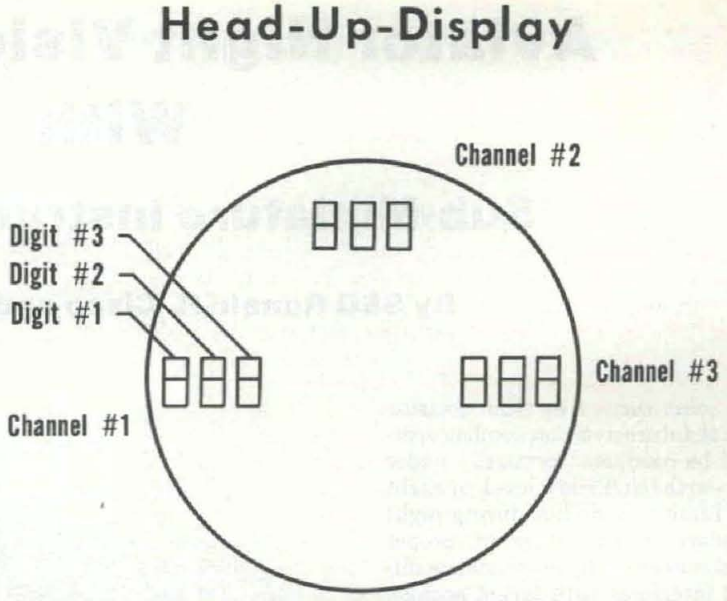


Fig. 2. Digital Arrangement on Mini-HUD Display

SSG RONALD R. CISCO is a primary psychological investigator with the Biomedical Applications Research Division, U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, AL. He is a graduate of the University of Nebraska and has his master's degree from Ball State University, IN.

PAULA STORE joined the U.S. Army Aeromedical Research Laboratory in 1979. She has been involved in the study of visual performance and workload of U.S. Army aviators since 1980. She has a BS degree from Troy State University and is also completing graduate work there.

Capsules . . .

Considerable Progress Reported . . . RDJTF Slated for Separate Command Status

The Secretary of Defense has announced that over a period of three to five years the Rapid Deployment Joint Task Force (RDJTF) should evolve into a separate unified command — with its own geographic responsibilities, Service components, forces, intelligence, communications, logistics facilities and other support elements.

During the short time of the RDJTF's existence, considerable progress has reportedly been made in improving the U.S. strategic posture in Southwest Asia: detailed, joint contingency planning has been undertaken; Service force and support requirements have been identified; joint exercises of rapid deployment forces of all four of military Services have been conducted — some in combination with the forces of other nations in the region; and significant equipment has been pre-positioned to increase the speed with which forces can be deployed.

However, more is needed to increase its power projection capability, including enhanced sealift and airlift, further pre-positioning, improved facilities, and greater sustaining capability. The Administration's recent force structuring initiatives represent significant steps toward speeding progress.

As U.S. capabilities grow, however, the structure of the RDJTF must reportedly grow to keep pace. The first change the Secretary of Defense will direct in the RDJTF's organization will be the assignment of XVIII Airborne Corps, and shortly, other units to strengthen the RDJTF, its Service components and combat units. This will permit better deployability and sustainability of forces in Southwest Asia. Other changes will come later as additional resources become available for the command.

For the time being, relationships among the present unified commands will not change, and the RDJTF headquarters will continue to be located at MacDill Air Force Base, FL. Nor will its mission change. The RDJTF will continue to have a potential for world-wide deployment, but its major focus will remain on Southwest Asia.

Further details concerning evolution of the RDJTF — such as specifics and timing of changes, other forces assigned, headquarters size, and functional responsibilities — will be announced in the future as political military developments permit.

Improved TOW Sent to U.S. Soldiers Abroad

Initial deployment of Improved TOW missiles to U.S. soldiers in Europe has been completed on schedule. Although similar in size and weight to the basic TOW missile deployed since 1970, Improved TOW features a redesigned 5-inch diameter warhead that will penetrate heavier armor.

"This is the first step in major improvements that will keep TOW abreast of the enemy armor threat for years to come," said COL Neil Williamson, TOW project manager, at the U.S. Army Missile Command, Redstone Arsenal, AL.

The new warhead is compatible and can be retrofitted to existing missiles, Williamson said, thereby protecting the Army's investment in fielded missiles and launchers. More than 275,000 missiles have been produced by Hughes Aircraft, TOW prime contractor, for the Army, Marine Corps, and 32 countries.

Improved TOW, the first evolutionary improvement to existing MICOM anti-armor hardware, is intended to counter near-term enemy armor threats.

MICOM and Hughes are continuing development of TOW 2, which will counter even more sophisticated enemy armor with its 6-inch warhead, a new flight motor and improved guidance system. TOW 2 will be available later in this decade.

Other major members of the TOW improvement team, in addition to MICOM and Hughes, are the Armament Research and Development Command, and Firestone.

Black Hawk Program Yields New Benefit

A $2.35 million Black Hawk helicopter composite rear fuselage program, designed to reduce weight and costs, has reportedly yielded yet another plus by providing ballistic protection for the aircraft's fuel cells, according to a recent announcement from the Army Aviation R & D Command.

A significant milestone was passed recently when ballistic testing of Kevlar, glass fibre and graphite panels filled with rigid foam were hit with 23 and 30 millemeter high-explosive incendiary rounds. Tests revealed considerable structure damage was induced but the panels were completely successful in preventing fuel fires.

According to COL Ronald K. Andreson, Black Hawk project manager, "Since fire is one of the major threats to the survival of an aircraft in combat, this test achievement must be considered a significant accomplishment towards demonstrating the fire prevention effectiveness of the composite structure with the rigid foam application." The ballistic testing portion of the composite program took place at Aberdeen Proving Ground, MD.

Principal goals of the Black Hawk rear fuselage helicopter composite program are to reduce manufacturing costs by 35 percent and aircraft weight by 10 percent.

Top 50 DOD Contractors for FY 1980

The following is a list, in decending order, of the top 50 Department of Defense R & D contractors for FY 1980:

Boeing Co., McDonnell Douglas Corp., Martin Marietta Corp., Rockwell International Corp., Hughes Aircraft Co., General Dynamics Corp., General Electric Co., TRW Inc., United Technologies Corp., Raytheon Co., Lockheed Missiles and Space Co., Johns Hopkins University, Aerospace Corp., International Business Machine Co., Massachusetts Institute of Technology, ARO Inc., Honeywell Inc., RCA Corp., Summa Corp., GTE Sylvania Inc., Mitre Corp., Westinghouse Corp., Vought Corp., National Academy of Sciences, Avco Corp., Lockheed Corp., Texas Instruments Inc., International Telephone and Telegraph Corp., Grumman Aerospace Corp., Northrop Corp., Aerojet General Corp., Chrysler Corp., Thiokol Corp., Charles Stark Draper Labs Inc., Sperry Corp., Teledyne Industries Inc., Automation Industries Inc., Science Applications Inc., FMC Corp., Harris Corp., Computer Sciences Corp., Williams Research Corp., Global Associates, Hercules Inc., Bendix Corp., BDM Corp., University of California, Boeing Aerospace Co., SRI International, and Ford Aerospace and Communications.

$2 Million Contract Orders Target Detectors

A contract for more than $2 million was awarded recently to LaBarge, Inc., St. Louis, MO, by the Army Electronics Research and Development Command. The contract calls for production of 829 target detecting devices (M817) for the Chaparral missile.

The M817 target detecting device was designed for the ground-to-air, low-encounter missile. In production since 1976, the device first detects the vicinity of the target, then determines which of many objects is the target, and then finds the proper distance to it, thus determining the optimum time for detonation. This infor-

mation is relayed by signal to the warhead.

The device is an advanced, updated version of the target detecting device designed for the Navy's Sidewinder missile. The present contract, the sixth since initial production, calls for delivery of the completed systems over a 19-month period.

Lasers Add Zap to Mapmaking

A new shortcut to the press plate made possible by laser technology, and spawned by the newspaper industry, could prove to be a boon to U.S. Army map reproduction.

Researchers at the U.S. Army Engineer Topographic Laboratories (ETL) are testing a laser platemaker that uses digital data and an argon-ion ultraviolet laser to expose 4- by 6-foot press plates in 15 minutes. More than 2.7 million picture elements (pixels) a second are transferred from the digital tape to the plate.

The laser platemaker was developed under an ETL contract to EOCOM Division, American Hoechst Corp., Tustin, CA.

Normally, digital data are converted into some form of electromagnetic energy for exposing film, which in turn can be used to transfer an image onto a lithographic press plate. By using the laser platemaker, it is possible to cut the cost of using silver halide films because the laser writes directly onto the lithographic plates.

Because press plates are exposed directly by the laser, tedious film preparation stages are eliminated. It will be possible to get maps faster at lower costs.

Although the laser platemaker was developed for the Defense Mapping Agency to achieve the capability of direct exposure of press plates, it can also be used to expose orthographic film for archival purposes.

BRL Develops Precision Aim Technique

A "Precision Aim Technique" (PAT) that works with the vibrating motion of a helicopter-mounted gun tube or vehicle-mounted weapon system to provide an accurate hit capability, has been developed by the U.S. Army Armament R & D Command's Ballistic Research Laboratory, Aberdeen Proving Ground, MD.

The PAT project is a cooperative effort between BRL's Ballistic Modeling Division (BMD) and the Interior Ballistic Division (IBD). Key personnel are Dr. Mark Kregel, a physicist, Dr. Donald Haskell, mechanical engineer, and Timothy Brosseau and Robert Kaste, both mechanical engineers.

Electro-mechanical devices combined with a computer cause this experimental gun to fire when the aim is precise and to hold fire when the gun wanders off target. The researchers say this is the same theory on which training for sharpshooters is based, that is, the gun is fired only when properly aimed.

Utilizing the PAT concept, a weapon system will either be mounted on a helicopter whose rotors produce forced repetitive vibrations, or mounted on a vehicle which produces forced random vibration, such as one traveling over uneven and rough ground.

To demonstrate the concept, a 20mm M139, self-powered, percussion-fired automatic cannon was set up in an indoor testing range in BRL's Mechanics and Structures Branch.

Both gun (with a long flexible gun tube) and ammunition were modified to fire electrically so that the firing point and action time could be controlled precisely.

The entire gun system was mounted on a flexible mount driven by a motor, belts and pulleys that would provide the broad range of vibrations and amplitudes needed to simulate field conditions. A video display (television) was set up with a hand-held aiming device for selecting the aim point on the target.

Control of the firing time of the gun comes from a computer control circuit that processes signals put out by the sensors placed on the gun-mount system.

Firing tests and demonstrations have been conducted with the weapon system in motion and firing automatically and at targets with the computer controlling the firing point and with the target visually displayed on the TV monitor.

The BRL research team has shown that the weapon gives dispersion patters ("hits" by the ammunition) in automatic fire that essentially equal those obtained when firing groups of single rounds from a stationary, aimed weapon system.

60MM Mortar System Achieves IOC Milestone

The 60mm Lightweight Company Mortar System (LWCMS), developed by the U.S. Army Armament Research and Development Command (ARRADCOM), recently reached a major milestone with the achievement of its initial operational capability (IOC).

To establish IOC, 19 of the mortars and 8,000 rounds of ammunition were recently sent to the 2nd Ranger Battalion and 9th Infantry Division at Fort Lewis, WA, the first units to receive the weapon. An ARRADCOM team took part in the establishment of the IOC at Fort Lewis.

Since development of the LWCMS began in 1972, the Benet Weapons Laboratory (a part of ARRADCOM's Large Caliber Weapon Systems Laboratory) at Watervliet Arsenal, Watervliet, NY, has had total system management up to and including IOC.

Plans are to transfer system management responsibility to ARRADCOM's sister organization, the U.S. Army Armament Materiel Readiness Command (ARRCOM) at Rock Island Arsenal, IL. ARRCOM and the Infantry Center and School at Fort Benning, GA, had representatives at Fort Lewis to train the troops in use of the mortar as a step leading to the IOC.

The LWCMS, the Army's first new mortar in 25 years, consists of the M224 mortar and a family of ammunition for indirect fire. The 47-lb. mortar replaces the M19 60mm mortar in ranger units. The same mortar can be used with a smaller baseplate in the patrol mode reducing the weight to 19 pounds. In infantry, airmobile and airborne rifle companies, it replaces the 93-lb. M29-series 81mm mortar. The 81mm mortar will be retained as a batallion-level weapon.

The M224 has a range os 3,500 meters, nearly twice that of the M19 60mm mortar. The new mortar also has a much higher rate of fire because of improvements in its tube and the use of cool-burning propellant on its M720 high-explosive round. In addition to the M720, the available ammunition for the M19 mortar may be fired from the LWCMS.

The M720 round uses an M734 multi-option fuze. The fuze provides four options: proximity (burst height of 3-13 feet above the target), near surface burst (0-1 foot above the target), impact (functions on contact with the target) and delay (functions .05 seconds after contact with the target).

The LWCMS is going to both the Army and the Marine Corps. It is expected to be completely fielded within one year. The mortar tube and its bipod assembly and baseplate are being manufactured at Watervliet Arsenal.

Ford Aerospace Receives DIVAD Contract

Ford Aerospace & Communications Corp. (Aeronautics Division) of Newport Beach, CA, has been awarded a $159,216,772 contract to proceed into the production phase of the Division Air Defense (DIVAD) Gun System program. This basic contract requires completion of a maturity program, development of logistical support materiel and equipment, and procuring of long lead time items to support a production buy in FY82. The contract contains three yearly options for a total of 276 weapons systems.

The DIVAD Gun System is the Army's key air defense modernization initiative for front line units. It is a radar-directed automatic gun system to defend forward maneuver battalions, the new Abrams tanks, and infantry fighting vehicles against attack by fixed and rotary-wing aircraft. It replaces the standard Vulcan system which had slower reaction time and shorter effective range.

Mounted on a modified M48A5 tank chassis, the DIVAD's armored turret contains twin guns with search and track radar, radar and optical fire control with laser-range-finder, and a digital computer

Ford Aerospace and Communications Corp. and General Dynamics' Pomona Division each developed two prototypes for comparison testing under contracts which began forty months ago. Both companies made maximum use of mature subsystems and components to reduce risk, shorten development and production lead time and to reduce costs.

The first phase of the accelerated program, combined development/operational testing of the contending systems at Fort Bliss, TX, ended late last year. Resulsts of the test have convinced the Army that the schedule for fielding DIVAD by early 1985 can be met.

The Ford proposal utilized the Westinghouse F-16-derived search and track radar, NATO standard Bofors L/70 40mm guns and ammunition with a Ford-developed linkless feed system. Project Manager for DIVAD is COL Charles C. Adsit who administers the program from the U.S. Army Armament Research and Development Command, Dover, NJ.

★ ★ ★

Sorry for the Omission

The article entitled "Viper Nears Completion of Engineering Development Phase," which appeared in the March-April 1981 Army RDA Magazine, should have included the byline of MAJ Michael R. Roddy, III, Program Management/Procurement and Production Division, Viper Project Office. Our apologies for this omission.

In Brief . . .

Weinberger Announces Changes in PPBS

Caspar W. Weinberger

Secretary of Defense Caspar W. Weinberger has announced significant changes in the Planning, Programming and Budgeting System (PPBS) of the Department of Defense, emphasizing, "my objective is not only the revitalization of American military strength but also to be sure it is accomplished in the most effective and economical manner.

He added, "to allow this increase in strength to take place most efficiently and expeditiously, I have instituted changes in the Department's Planning, Programming and Budgeting System. I believe these changes will increase public and Congressional confidence in our capability to match military requirements with military strength and simultaneously reduce costs and save the taxpayers money."

The changes are modifications of the existing PPBS that reflect a shift to greater emphasis on long-range strategic planning, more responsibility to the Services, decentralization, closer attention to cost savings and efficiencies, and general streamlining of the process.

He noted that the previous administration introduced the Zero-Based Budgeting (ZBB) concept, which was designed to show decision-makers exactly what would happen if they cut or added to the budget.

Secretary Weinberger said, "unfortunately, this level of detail did not turn out to be meaningful to senior management. The enormous paperwork required by the ZBB system thus served no tangible purpose."

The ZBB system, as currently structured, has been eliminated. The Secretary, however, did acknowledge that the idea of reexamining the necessity and desirability of continuing each program is a good one.

Secretary Weinberger pointed out that the new management strategy of the DOD leadership will place greater responsibility on the Secretaries of the Army, Navy and Air Force for the development and management of their segments of the Defense Department program. The Service Secretaries have been added to the top management board of the Department — the Defense Resources Board.

Secretary Weinberger emphasized, "that there will be close attention of how well his personal staff and the Services respond to the demands of the new PPBS."

Under the new strategic planning system, the Joint Chiefs of Staff take responsibility, along with the Under Secretary of Defense for Policy, for the development of more comprehensive strategic planning of military objectives, policies and strategies. Moreover, there will be close attention to the resource implications of these policies in order to close the gap between military requirements and resources budgeted.

Within the given policies and resources, the Secretary will look to the Services to recommend the best way to meet the objectives within their budgets. The Secretary also will maintain a strong central staff to assure cross-Service programs analysis takes place in order to guarantee the fullest and best use of budgeted dollars across the entire DOD structure and organization.

Secretary Weinberger charged Deputy Secretary Frank Carlucci with the responsibility of managing the new PPBS process. The PPBS review was conducted by an internal DOD task force chaired by Mr. Vincent Puritano, the executive assistant to the Deputy Secretary of Defense.

Lunn Discusses Materiel Acquisition Problems

Those who know and have heard LTG Robert J. Lunn address an audience are aware that he speaks from the shoulder, in often pithy terms, keying his thoughts and words to the subject about which the audience came to hear. In such an address to Logistics Executive Development Course students recently, the DARCOM Deputy Commander for Materiel Development pulled no punches in discussing problems facing the materiel acquisition community, using specific examples to make his points.

Speaking off the cuff, Lunn began by noting that not long ago he'd been sitting as a student, and many of the same problems he'd heard senior level managers talk about were now his to solve. They have a habit of cyclically reappearing.

Referring to a chart outlining a record of RDTE funds, General Lunn highlighted a trend that seems to repeat itself each year; an upward turn of the curve, reflecting higher expectations in the outyears; however, as the outyear becomes the current year, the curve invariably flattens - usually to the tune of about $1 billion.

He stressed the considerable number of new systems that are now or will soon be entering the Army's inventory, and the need for attention to the supportability of these systems.

Additionally, said Lunn, among the continuing problems were those of modernization: too much time to develop and field a system; risk avoidance; and cost control.

On the third point, he asked the audience, when do you field a system? When can you support it? When do you transition a system? The latter question he remarked, was one of the biggest questions facing the commander of DARCOM! Historically, Lunn remarked, the emphasis from the Pentagon shifts, from field now and use contractor support, to field later when the system is supportable by "green suiters" at the direct support level!

On cost control of developmental programs, Lunn was emphatic in contending it is a major problem, one to which he is still seeking a solution. Pointing to a chart of Army systems requiring Selected Acquisition Reports (SARs) to Congress, the General called attention to the increase in costs of the 17 systems over the past nine months. Inflation, he contended, was not the entire answer. It is a complex problem.

As he looked upon the group, and remarked how he had thought when in their shoes, he ticked off some of what he called his "Lunnisms" - some of his personal philosophy that perhaps would be useful to them in the years ahead - recalling that problems have a way of recurring.

First, it was crucial to learn to communicate - to make your views clear and to be able to understand others. Particularly, understand what your boss wants. Don't be a middle-of-the-roader, and don't be a rock-the-boat type.

To be successful in the management business said Lunn, one must have control. One doesn't have control unless he manages people and/or money. Without the approval/disapproval of at least one of these two elements, said Lunn, one controls nothing. A decision paper that fails to address money and people aspects of a problem is worthless. In reality, without addressing these there will have been no decision - things will go on as before!

There is a need for stability of requirements, he contended. The Army, said Lunn, tells too many people what it wants - without valid requirements; then seeing itself short of dollars to undertake all it thinks it wants, gets industry into development projects for which subsequent requirements disappear. It is a bad practice that is counterproductive.

Turning next to quality of product and productivity, Lunn said, there are very serious problems in the U.S. We have gone, as a nation, from the leader to among the also-rans in these areas. The U.S. singly does not have the productivity we think we have, he continued. Lack of capital investment in industry is a major cause, he contends, and he noted that he wasn't telling the group anything he hadn't said out loud to industry.

Turning to supportability, Lunn contended that we have the problem because we haven't done the things that should have been done. And those responsible need to spell out what needs to be done, not generalize. In elaborating on this point, he cited the conflict of doctrine that says the Army will "fix forward." What does this mean, he asked? There is no definite answer!

The General hit at the differing philosophies and interpretations of procurement evaluations, and source selection authority between the Pentagon and the field. The people at the higher levels too often do not understand the intricacies, said Lunn, and, he added, the same is true for many at DARCOM. The "best and final" approach, Lunn noted, is an inherently bad way to go, particularly when the process encourages the contractor to "buy in." And a contractor who is squeezed into backing way off on cost not only jeopardizes the integrity of the end product, he will invariably find a way usually unpleasant for himself and the Army, to get some of it back somewhere later in the program.

He noted that he'd been hearing talk of the desirability of going back to the "good old ways" of doing things - the technical services approach. To him, this would be a mistake; responsiveness to field Army needs gets lost.

Lunn wrapped up his remarks by saying that he has no problem making decisions; his problem usually is getting good alternative recommendations upon which to base decisions. You do not serve the decision maker by dumping your problem on him, without offering viable alternatives for solving the problem. He concluded by noting the severe loss of institutional know-how, when it disappeared after the last DARCOM reorganization. The technical talent bank at HQ DARCOM is badly eroded. Further, at all levels one has little time to think through problems - most efforts are spent putting out short term fires - which often result in hidden embers and a future fire burning quietly. There is a very real need to attract and retain, at HQ DARCOM, as well as the field commands, highly capable, extremely able people, who can think problems through to viable conclusions, otherwise our managment problems are not solved, just patted down for future frustration.

Sheridan Reviews Personnel, Training Factors

Personnel support and training costs associated with new weapons and equipment have been mounting at such a pace that they no longer are of secondary importance in evaluating total system cost. Rather, they have moved into a position of prominence, even critically, in determining tomorrow's systems.

Indicative of this are two addresses on the subject. One was given by MG Stan R. Sheridan, director of Development and Engineering, HQ DARCOM, to an NSIA/DOD symposium on Personnel and Training Factors in Systems Effectiveness, San Diego, CA, 6 May 1981. The other address (see following text) was given by Dr. Eugene E. Yore, former Deputy for Science and Technology, Office, ASA (RDA).

Sheridan began his remarks by asking whether the Army is developing weapon systems that are so complex at the man-machine level that an unmanageable operations and maintenance environment is being created? If so, can methods be devised to achieve the needed engineering complexity, yet provide a simple soldier-operable man-machine interface in the crudity of a field environment.

The General noted that the subject of complexity or over-sophistication has been the topic of considerable discussion and debate. Some critics have contended that new systems are so complicated they are unreliable on a dirty battlefield. Dr. William Perry, the former Under Secretary of Defense for Research and Engineering, replied to such criticisms, said Sheridan, by noting that complexity was the result of the increasing Soviet threat, but Soviet systems likewise were plagued with the same shortcomings. Sometimes, Perry contended, Soviet complexity not only matched but exceeded ours.

Sheridan commented that his job would be a lot easier if the Army could develop another M4E8 Sherman type tank rather than an M1 Abrams. Unfortunately, such a vehicle couldn't begin to kill a T-64 tank, let alone a T-72 or T-80.

Advanced technology is not the enemy, said Sheridan, it is in fact our only salvation. But it can be of little help unless the soldier-user is brought into the planning at an early stage. We must not underrate his ability nor should we overrate his capability.

Sophisticated weaponry, said Sheridan, means advanced technology, but not "gold plating." Complexity need not be a poor design that should have been detected early or a system that satisfies some engineer's ideas and not what the soldier really needs, simply because the engineer loves to push the state-of-the-art.

Today's servicemen, said Sheridan, can't be as limited as some contend, for industry with its more attractive pay scale has been gobbling up the services' highly trained electronic specialists at an alarming rate. Looking closely then at today's and tomorrow's soldiers, what do they look like?

There is and will be until the late 1990's a short supply of 18-24 year olds. The Army alone, Sheridan said, reportedly will need one of every four eligible high school graduates to man its computer-based, electronically advanced equipment of the 90s. Even today, 13 percent of the Army's enlisted strength must be trained in electronics - double the 1974 requirement.

Against this, the General noted that the math and verbal scores of our school children have been on a steady decline for years.

However, Sheridan said, he believed there was hope for a workable answer. Recognizing and understanding the problem he said, is the beginning of the solution.

Long years of experience had taught him, he continued, that critical personnel and training issues must be dealt with at the earliest point - the conceptual phase, or else one is in for embarrassing trouble. More money must be put up front to refine and mature designs before they become fixed and immutable. From this will come a true representation of personnel and training problems and the potential design solutions.

Personnel and training considerations should play, said Sheridan, an important part in the selection of competitors for advanced development, and later - for full-scale development.

The Navy's "Hardman Concept," Sheridan contended, provided the techniques now being used by the Army Research Institute to determine the personnel and training implications of the Army's new division support weapons system program.

Considerable payoff in the area can be derived, Sheridan noted, from a good reliability and maintainability (RAM) program - a program he said the Army has learned to stress. But again, up-front money is the key.

The partner to RAM is integrated logistics support (ILS). This is now a "front burner" issue in the Army, said the General, for every program. From early attention to this, system components that will have the greatest operation and support and personnel drivers will be identified. High-cost areas then can be sent back for better solutions - such as using skills now available rather than skills the Army may never get.

Sheridan stressed that operability and supportability requirements should be as sacred as system technical, cost, and schedule requirements. The discipline to nurture the breadth of the whole system, from concept initiation to fielding, must be maintained. We must have the discipline, he stated, to reject apparent winners when its ILS plans are seriously deficient. And, we must learn to accept "good enough" rather than pouring money after the usually elusive "best".

As part of the ILS effort, the General noted the Army's new emphasis on technical manuals as a way to enhance personnel utilization and training. The new manuals are called Skill Performance Aids (SPAs). Army contracts now emphasize technical manuals and associated extension training materials, and the specifications call for minutely detailed analyses to insure manuals usable by the average soldier under field conditions. By way of illustrating the magnitude of this new attention, the SPA effort for the new AAH will cost about $18 million.

General Sheridan encouraged industry to utilize the independent research and development provisions of government regulations to look at new approaches to weapons system maintenance training. Companies may find they will receive support and a greater payoff by pursuing new methodologies for predicting personnel and training needs, than in devoting efforts totally to hardware work.

This led him into a discussion of the growing need for training devices and their potential as a high-dollar area of industry attention. A recent Army study showed that the cumulative acquisition cost for training devices alone for 42 major systems developments will exceed 1.5 billion.

He concluded by noting that it is currently possible, on a system-by-system basis, and in the aggregate to determine the number of people and skills needed for future systems. But we cannot determine whether any system is affordable in terms of human resources. However, he was hopeful that technology in these fields would soon allow accurate determination of this sort to be made, determinations that can then be written into Army requirements documents.

Appeals to Government, Industry . . .
Dr. Yore Calls for Better Training Systems

Late last year Dr. Eugene E. Yore, Deputy for Science and Technology, Office of the Assistant Secretary of the Army (RD & A), addressed an Interservice/Industry Training Equipment Conference. His presentation, which dealt with training technology, equipment and systems, follows in summary format. (Dr. Yore is now employed in private industry.)

Dr. Yore began by stating that there are a number of driving forces that elevate the need for more and better training systems. These include the increased number of new weapons planned for the 1980's; the increase in the complexity of operation and tactics; the changes in philosophy as a result of the All-Volunteer Force; and the severe pressures on training resources such as fuel, ammunition and ranges.

Relative to the constraints on training resources, Yore noted that the total DOD energy cost went from $4 billion in 1975 to $9 billion in 1980, and that the cost of ammunition has risen dramatically, forcing a sharp reduction in the amount available for training. Dr. Yore said that forward deployed forces have only 150 rounds of main tank gun ammunition authorized per tank in 1981, compared to 210 rounds per tank in 1979.

Yore indicated that firing range limitations have also impacted on training. For example, operational training under realistic conditions is constrained because of the environmental impact on ranges and the reduced availability of ranges.

He noted that there are a number of inhibitors to training. Each service, for example, is budget constrained. Said he, "One is often faced with the choice of buying one weapon or one trainer." This issue is particularly acute in the Army.

By the end of the 1970's nearly every major weapon system in the field was technologically inferior to the Soviets, said Yore. He stressed that the Army cannot claim to overcome numerical odds with technical superiority, because the Army is numerically and, to a great extent, technically inferior in the field.

Two goals have been set to measure Army development performance. The first is to achieve technological equivalence in our fielded systems by 1985 and, secondly, to achieve technological superiority by 1990. Achievement of these, however, causes a significant procurement funding bow wave.

Dr. Yore noted that another inhibitor of training systems development is the "piggyback" problem. For example, some training systems are developed for use with some major weapon systems. Therefore, if a weapon system encounters delays or cancellations, so will the training system.

Training systems also have unique requirements and costing problems. Unfortunately the training requirement is not always clearly defined when the weapon it is intended for use with is fielded. Yore emphasized that in order for training systems to be funded, significant savings and improvements in training effectiveness must be demonstrated. All of this must be done in an environment of uncertainty about the precise system definition and its tactical use.

There are also a number of problems that industry faces relative to training. These include the broad variety of customers they must deal with; the various training technologies; the small volume associated with training devices. All of these factors, noted Yore, yield high unrecurring costs that cannot be amortized across large volumes.

Dr. Yore stated that there are some new technologies that hold exciting promise for training. These include voice inputting and outputting from computers, visual simulation, and very large-scale integrated technology. Other technologies are also being developed in the behavioral and social sciences.

Yore stressed that there are a number of significant challenges that must be faced by the Services and by industry. OSD and the Services, for example, must continue to look at life-cycle costs. "We in the Services," said Yore, "must push to increase the priority and amount of funding to achieve balance."

Yore added that the Services must try to stabilize training requirements early in the development cycle. We must always strive to define the most austere requirements because we simply can't afford cadillacs, he said.

The science and technology deputy also indicated that the Services must do a better job at defining programs so there can be a better defined marketplace for industry. Joint service programs, standardization of software could help, he said.

Yore challenged industry to focus their investment on the cost of technology, hardware and software, and systems effectiveness. He also called for development of reusable hardware and software in order to get nonrecurring costs down, and for greater industry flexibility.

Additionally, he emphasized that both the Services and industry must: structure training systems development to be amenable to future changes in requirements; clearly demonstrate cost and utility advantages of training equipment; and search for innovative uses of technology.

Dr. Yore concluded his remarks by listing the "facts of life," which training system developers should not forget. They are as follows: requirements are going to be late; systems definitions are sometimes going to change; technology cadillacs are not affordable; and each training system must have a clear, demonstratable cost and training advantage.

Conferences & Symposia . . .

DARCOM to Sponsor Operations Research Meet

The Annual Army Operations Research Symposium (AORS XX) will be held 5-8 October 1981 at the U.S. Army Logistics Management Center, Fort Lee, VA. About 300 Army, academic and industrial leaders are expected to participate in the event that will be sponsored by the U.S. Army Materiel Development and Readiness Command.

The theme of this year's symposium is "Army OR — Supporting the Process of Rational Choice for the Army Today and Tomorrow."

The U.S. Army Materiel Systems Analysis Activity (AMSAA), directed by BG James E. Drummond, is responsible for the overall planning and conduct of AORS XX. For the eighth consecutive year, the U.S. Army Logistics Center, commanded by MG Oren E. DeHaven; the U.S. Army Quartermaster Center and Fort Lee, commanded by MG William K. Hunzeker; and the U.S. Army Logistics Management Center, commanded by COL Billy C. Holland, will serve as hosts.

Attendance will be limited to invited observers and participants. Papers have been solicited to address the theme of the symposium, as well as concerns in operations research/systems analysis. Selected papers and presentations will be published in the proceedings.

Inquiries pertaining to the symposium should be submitted to: Director, U.S. Army Materiel Systems Analysis Activity, ATTN: DRXSY-DI, Aberdeen Proving Ground, MD, 21005. Phone inquiries should be made to Mr. Keith A. Myers, AUTOVON 283-4359 or Mrs. Glenna Tingle, AUTOVON 283-4058.

Awards...

Kracov Receives Meritorious Decoration

DARCOM Deputy Commander for Materiel Development LTG Robert J. Lunn presents Decoration for Meritorious Service to William "Bill" Kracov.

Mr. William Kracov, a physical scientist/technical administrator in the Development and Engineering Directorate, HQ U.S. Army Materiel Development and Readiness Command, recently was presented with the Decoration for Meritorious Civilian Service, the Department of the Army's second highest award for civilian career employees.

Known throughout the Army research, development and acquisition community for his technical knowledge and professional initiative, he was cited for numerous achievements associated with individual soldier, training, and test equipment programs.

Specifically, Kracov was credited with major cost savings resulting from transfer of the Irradiated Food Program from the DOD to the Department of Agriculture, and for his efforts in pinpointing shortfalls in the Armored Full-Crew Research Simulator Program.

Additionally, he was termed one of the "most vigorous" action officers in challenging "gold plating" of draft requirements documents, and was considered a major contributor in restructuring the Army Training Battlefield Simulation System effort.

Believed to be the only HQ DARCOM employee to ever receive the Secretary of the Army's Materiel Acquisition Award, Kracov, is also the Army member on the DOD Steering Committee for Life Support Equipment, and is the DARCOM focal point for the National Training Center and for training devices.

USAARL Electronics Technician Gets Patent

Mr. John H. Hapgood, supervisory electronics technician at the U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, has been granted a patent for development of a video highlight attenuation processor which is expected to have application to military and civilian video systems.

Bright lights cause "blooming" within a televised scene giving the scene on the monitor a washed-out look. Information within and adjacent to the affected areas is lost to the viewer.

Various mechanical methods have been used in the past to overcome scene-related blooming, but each had the disadvantage of losing information within the scene. Hapgood's video highlight attenuation processor suppresses bright lights in the camera's range and resolves scenes so details are visable on the monitor.

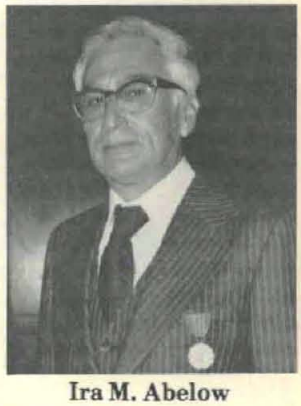
The use of infrared sensors and other video devices on military equipment make the acquisition of detail vital, especially on a battlefield. The device has night and day capability and can overcome blooming from artillery fire and flares.

The device uses an input circuit to receive the video-signal, splits the signal, detects and inverts predetermined peaks of first signal into an intermediate signal, then combines it with the second signal to produce an output signal with the peak portions inverted.

The small (3"x3") device can be used as a separate piece of equipment or it can be incorporated into the camera or monitor with minor modifications. Furthermore, total cost in parts is reportedly under $20.00.

Hapgood has spent 39 years working in the field of radio and television electronics. He has designed circuits to pulse photo cathode of image orthicon tube at various light levels. The first video preamplifier using transistors was part of his work.

Abelow Recognized for Meritorious Service



Ira M. Abelow

Mr. Ira M. Abelow, a physical scientist at the Army's Chemical Systems Laboratory (CSL), has received the Decoration for Meritorious Civilian Service in recognition of major contributions to biological agent detection, warning and decontamination.

Abelow, who was presented the Army's second highest honorary award in ceremonies at CSL's headquarters, has served in Federal Civil Service since 1951, both at Edgewood and at Fort Detrick, MD.

A researcher at CSL since 1971, he is credited with the success of such programs as biological vaccine production, the biological detection and warning system, and the biological decontamination development program.

In addition, Abelow was praised for his efforts in establishing and maintaining the active cooperative technical interchange program with many U.S. allies in the areas of biological defense programs. He also served as a technical project officer on exchange agreements with France, Germany, and the Netherlands.

At Fort Detrick, Abelow conceived, designed and developed pilot and production plans for the production of an anthrax vaccine which was used to virtually eliminate anthrax infections in the wool industry during the late 1950's, as well as a Botulinum toxoid that was used routinely for the immunization of humans during the 1960's.

CERL Picks Smith as 'Outstanding Engineer'

Dr. Edgar Dean Smith of the U.S. Army Construction Engineering Research Laboratory (CERL) has been named the Army Corps of Engineers' Outstanding Engineer of the Year. Smith, an environmental sanitary engineer, was recognized for contributions to environmental engineering.

As leader of CERL's Water Quality Management Team, Smith directed the research of several scientists and engineers in the areas of water conservation, wastewater reuse, and wastewater treatment upgrade. He has also provided consulting services, advice, and guidance to Army personnel and other governmental

agencies in the field of environmental engineering.

As consultant on Rotating Biological Contactor (RBC) technology, Smith travelled to the Republic of China as an invited lecturer. Based upon his initiative, a national symposium/workshop on RBC technology state-of-the-art was held. More than 350 individuals from several countries participated.

NV&EOL Budget Officer Gets Comptroller Award

Ms. Mary E. Betz, budget officer for the Night Vision & Electro-Optics Laboratory (NV&EOL), Fort Belvoir, VA, is the first award winner in the Comptroller Annual Award Program initiated by the Electronics Research and Development Command (ERADCOM). The purpose of the award is to recognize outstanding accomplishment within one of the functional fields of Comptrollership.

Ms. Betz, who has been employed at the NV&EOL since 1966, was cited for her execution of the NV&EOL FY80 RDT&E Program. She was commended on behalf of the laboratory by Dr. Louis M. Cameron, director, NV&EOL.

Mr. Roland Cavatoni, comptroller, ERADCOM, presented her with travel orders to the American Society of Military Comptrollers (ASMC) annual symposium which is being held in St. Louis this year. Ms. Betz will represent the command at the symposium which features nationally recognized speakers and various experts from DA, OSD, and OMB.

The Comptroller Annual Award Program was established in an effort to emphasize significant accomplishments in resource management. Any enlisted member, officer, or civilian currently employed within the ERADCOM may be nominated. Nominations are reviewed by a selection panel, chaired by the ERADCOM deputy comptroller. This panel makes recommendations to the ERADCOM comptroller who makes the final selection of the award winner.

Annual Natick Awards . . . Research, Engineering Achievements Cited

Gold and silver pins for research, engineering, and installation support achievements were presented recently during annual incentive awards ceremonies at the U.S. Army Natick Research and Development Laboratories, Natick, MA.

Drs. Malcolm C. Henry and John A. Sousa, Clothing and Equipment Materials Engineering Laboratory, earned the technical director's gold pin for research for recognizing a natural phenomenon existing with polar bear hair that had not heretofore been fully understood. As a result of their finding, the pair is investigating new concepts from which significant improvements in military cold weather clothing can be visualized, developed and adapted.

Silver pins for research were awarded to Dr. Armand Cardello, Science and Advanced Technology Laboratory, and Mr. Frank Figucia, Clothing, Equipment and Materials Engineering Laboratory.

Cardello was commended for development of sensory psychology techniques of taste and flavor in man and making a major contribution to increasing the knowledge of taste mechanisms as measured at the taste bud.

Textile technologist Mr. Frank Figucia was cited for developing a new ballistic evaluation methodology whereby performance of soft body armor systems can be predicted at a considerable savings in time and cost.

Team awards dominated the selection for technical director's pins for engineering accomplishments. Nine members of the Clothing, Equipment and Materials Engineering Laboratory (CEMEL) captured the gold pin award. The nine, Messrs Harvey Daigle, Daniel DaLuz, Santo Gravina, John Greendale, Stephen Israelian, Richard Lacerte, Herman Madnick, Douglas Swain and Ms. Laurie Rosen expedited the development of the combat vehicle crewman's clothing system which was completed in the unprecedented time of 27 months without a single slippage. The superior clothing system reportedly increases survivability under hostile environments and improves the overall combat effectiveness of the vehicle weapons system.

Two silver pins for engineering were also presented. Dr. Robert V. Decareau, Food Engineering Laboratory, was a winner for his development of an untended hot food dispensing system featuring the use of microprocessing to select and control individual food reheating.

A second silver pin was earned by five employees for designing and implementing an experiment to evaluate an innovative hospital food service system at Moncrief Army Hospital, Fort Jackson, SC. Messrs Ronald L. Bustead, Jr. and Robert T. O'Brien, Operations Research Systems Analysis Office, along with Mr. Bruce Thomas, Ms. Jessie McNutt and Ms. Vera Mason, Food Engineering Laboratory, were cited for producing a viable, cost effective concept for fixed military hospitals which significantly decreases labor requirements yet considerably increases worker productivity.

Natick Commander COL Robert Cuthbertson presented the commander's gold pin for leadership in administration to Mr. William J. Doyle, Engineering Programs Management Office, for outstanding efforts in administering the laboratories' Standardization Program and providing the guidance and motivation necessary to assure the objectives of the program were accomplished in a highly efficient manner.

Silver pins for leadership in administration were received by Mr. Peter DeCosta, Operations Research Systems Analysis Office (ORSA), and Mr. Leo Harlow, Food Engineering Laboratory (FEL). De Costa was cited for the outstanding manner in which he conducted the NLABS cost analysis function, including economic analysis and the commercial industrial type activities program.

Harlow was commended for his performance as chairman of the DOD Food Service Equipment Committee, DOD Food Service facility and Equipment Planning Board, and for organizing a new ASTM Committee, F-26 on food service equipment.

Mr. Spiros S. Dragotakes, Facilities Engineer Office, earned the commander's gold pin for installation support by a wage grade employee for conducting extensive boiler water testing and maintaining a highly efficient boiler plant operation.

The installation support gold pin for general schedule employees was awarded to Ms. Margaret Robertson, Science and Advanced Technology laboratory (SATL), for her outstanding productivity in providing exceptionally accurate and precise chemical analyses of food products.

MAJ Paul L. Caron, FEL and CPT Kerry Wyant (SATL) each were awarded the commander's annual military award for research, development, test and evaluation for their significant roles in conducting extensive performance and acceptance testing of the U.S. Marine Corps Emergency/Assault Food packet.

Mr. Edmund M. Powers (SATL) was named "Inventor of the Year" for his procedure for conducting multiple bacterial tests on solid media. His simplification of the previously standard test method and the considerable time savings it generates is being considered by the Food and Drug Administration as the official test procedure for conducting such tests.

Powers had earned the technical director's silver pin for research for his development of a rapid assay for the enumeration and identification of fecal coliforms in foods.

Personnel Actions . . .

Menetrey Becomes DCSOPS Requirements Director

MG Louis C. Menetrey

MG Louis C. Menetrey, former commander of the U.S. Army Training and Doctrine Command's Combined Arms Test Activity, has assumed new duties as director of Requirements, Office, Deputy Chief of Staff for Operations and Plans, Department of the Army, Washington, DC.

Graduated from the University of California with a BA degree in political science, he also holds an MA degree in international relations from Georgetown University, and has completed the Army Command and General Staff College, the Armed Forces Staff College, and the Infantry School Basic and Advanced Courses.

During 1978-80, MG Menetrey commanded the 4th Infantry Division (Mechanized) and Fort Carson, CO. This followed tours as deputy commander, U.S. Army Combined Arms Combat Development Activity, and assistant deputy commander, U.S. Army Combined Arms Training Development Activity.

Other key assignments have included assistant division commander, 2d Infantry Division, Eighth U.S. Army, Korea; commander, HQ Command, Fort Campbell, KY; and commander, 2d Brigade, 101st Airborne Division, (Air Assault), Fort Campbell, KY.

MG Menetrey is a recipient of the Distinguished Service Cross, Silver Star with Oak Leaf Cluster (OLC), Legion of Merit with OLC, Distinguished Flying Cross with OLC, Bronze Star Medal with "V" device and two OLC, Air Medals, and the Army Commendation Medal with OLC.

Paige Heads Electronics R & D Command

MG Emmett Paige

MG Emmett Paige, commander of the U.S. Army Communications R & D Command, has been selected for a new assignment as commander of the Army Electronics R & D Command, Adelphi, MD.

MG Paige commanded the U.S. Army Communications Systems Agency, Fort Monmouth, NJ, from 1976-79, following tours as commander, 11th Signal Group, Army Communications Command, and deputy chief of staff, Army Communications Command.

He has served also as chief, Voice Network Global Management Branch, Operations Directorate, Defense Communications Agency, Washington, DC; staff officer, Voice Networks Branch, Operations Directorate, Defense Communications Agency; and commander, 361st Signal Battalion, 1st Signal Brigade, U.S. Army Strategic Communications Command, Vietnam.

MG Paige has a BA degree in business administration from the University of Maryland, and an MPA degree in public administration from Pennsylvania State University. He has also completed requirements of the Army Command and General Staff College, Army War College, and the Signal School Basic and Advanced Courses.

His military honors include the Legion of Merit with two Oak Leaf Clusters, Bronze Star Medal, Joint Service Commendation Medal, Meritorious Service Medal, and the Army Commendation Medal.

Kenyon Selected as Aviation Center Deputy

BG Richard D. Kenyon

BG Richard D. Kenyon, deputy director of Requirements and Army Aviation Officer, Office, Deputy Chief of Staff for Operations and Plans, Department of the Army has been chosen for new duties as deputy commander, U.S. Army Aviation Center and Fort Rucker, AL.

A graduate of the U.S. Military Academy, BG Kenyon holds an MS degree in aeronautical engineering from Princeton University, and has completed the Advanced Management Program at Cornell University. His military schooling includes the Army Command and General Staff College, Industrial College of the Armed Forces, and the Engineer School Basic Course.

During 1976-79, he served as project manager of the Black Hawk Helicopter, following assignments at the Army Aviation Systems Command as project manager of the Heavy Lift Helicopter and then as director of Weapon Systems Management.

Other tours have included executive to the Assistant Secretary of the Army (Installations and Logistics); staff officer, Research Technology Division, Army Research Directorate, Office Chief of R & D; and commander, 145th Combat Aviation Battalion, 1st Aviation Brigade, Vietnam.

BG Kenyon wears the Legion of Merit, Bronze Star Medal, Meritorious Service Medal with Oak Leaf Cluster (OLC), Air Medals with "V" device, Joint Service Commendation Medal, and the Army Commendation Medal.

Potts Named MICOM Readiness Deputy

COL (P) William E. Potts, has been named the Army Missile Command's deputy commander for Readiness.

COL Potts served formerly as executive officer to the Army's Deputy Chief of Staff for Logistics. A 1958 graduate of Vanderbilt University, Potts was commissioned an Army second lieutenant through the school's ROTC program. He holds a master's degree in public administration from Middle Tennessee State University.

Among service schools, he has attended both the basic and advanced ordnance courses and is a graduate of the Army Command and General Staff College and Industrial College of the Armed Forces.

He commanded the 82d Airborne Division Support Command at Fort Bragg, NC; the 702d Maintenance Battalion, 2d Infantry Division in Korea; twice served as company commander with the

801st Maintenance Battalion, 101st Airborne Division at Fort Campbell, KY; and was adjutant and company commander with the 101st Division Support Command.

He served also as maintenance and supply advisor to the 1st Corps in Vietnam; was chief of the Mobility Training Department, Ordnance Center and School at Aberdeen Proving Ground, MD; and was assistant Army attache to the American Embassy in Turkey.

Parker Chosen as DCSOPS Requirements Deputy

COL (P) Ellis D. Parker, commander of the 17th Aviation Group, Eighth U.S. Army, has been named to succeed BG Richard D. Kenyon as deputy director of Requirements and Army Aviation Officer, Office Deputy Chief of Staff for Operations and Plans, Department of the Army.

Graduated from the University of Nebraska with a BS degree in psychology, COL Parker also holds an MS degree in public administration from Shippensburg State College, and has completed requirements of the Army Command and General Staff College, Army War College, and the Field Artillery School Basic and Advanced Courses.

From 1978-79, he served as special assistant to the deputy commander, U.S. Army Aviation Center, Fort Rucker, AL. Earlier assignments included special assistant to the Chief of Staff, 82d Airborne Division, Fort Bragg, NC; commander, 82d Aviation Battalion, 82d Airborne Division; and chief, Aviation Division, Office, Assistant Chief of Staff, G3 XVIII Airborne Corps, Fort Bragg.

COL Parker is a recipient of the Distinguished Flying Cross, Bronze Star Medal with two Oak Leaf Clusters (OLC), Meritorious Service Medal, Air Medals, and the Army Commendation Medal with four OLC.

Cameron Succeeds Sheehan as NV&EOL Director

Dr. Louis M. Cameron

Dr. Louis M. Cameron has been appointed director of the Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA. A recognized figure in the field of night vision, Dr. Cameron has been with the laboratory since 1966. He succeeds Mr. Edward J. Sheehan.

Since joining NV&EOL, Dr. Cameron has filled several scientific and engineering positions as a supervisory research physicist and most recently as associate director for Development and Engineering. He received the Department of the Army R & D Achievement Award in 1975 for his efforts in coordinating and developing a set of "common modules" utilized in DOD parallel scan thermal imaging systems.

Dr. Cameron received his BS degree from the University of Richmond and his MS and PhD degrees in physics from George Washington University. He is the author of numerous scientific papers and presentations and enjoys membership in several professional and scientific societies, including the American Physical Society, Washington Philosophical Society and IEEE.

Career Programs . . .

Aeronautics Institute Elects Murphy as Fellow

Dr. Charles H. Murphy

Dr. Charles H. Murphy, chief of the Launch and Flight Division at the Army's Ballistics Research Laboratory (BRL), has been elected a Fellow of the American Institute of Aeronautics and Astronautics (AIAA), in recognition of outstanding contributions to flight mechanics of projectiles, missiles and re-entry vehicles.

AIAA, a scientific and engineering society dedicated to the advancement of the arts, sciences and technology of aeronautics and astronautics, has raised less than 600 of its membership of 25,000 aerospace scientists and engineers to the status of "fellow."

Dr. Murphy, a member of the Army's Senior Executive Service, joins the ranks of Wernher Von Braun, German-born American scientist and retired MG John B. Medaris. These were the only other Army personnel tapped for AIAA fellowship.

Murphy's contributions to the field of aerodynamics includes a theory allowing design modifications to shells. He was awarded the Army Decoration for Meritorious Civilian Service in recognition of this theoretical work.

In addition, he was responsible for a number of advances in gun technology as the U.S. director of U.S.-Canadian Project HARP, a technology that has helped produce the new Army Copperhead projectile as well as set the height record of 111 miles for gun launched projectiles.

Dr. Murphy was Baltimore's AIAA Engineer of the Year in 1966, was honored with BRL's R.H. Kent Award in 1969 and received the 1976 AIAA Mechanics and Control Flight Award as well as the Army's prestigious Research and Development Achievement Award in 1979.

Surratt Chosen for CSL Executive Training

Mr. Ned L. Surratt, a chemical engineer who began his Federal civil service career at Edgewood in 1962, has been selected for technical executive training at the Chemical Systems Laboratory (CSL).

Before his selection as the 39th civilian employee to participate in the 6-month training program, Surratt was assigned to the Munitions Development Branch in CSL's Munitions Division.

The program includes a 3-month tour of duty in the CSL headquarters in the Office of the Deputy Director, and a similiar stint at the headquarters of the Army Materiel Development and Readiness Command (DARCOM) in Alexandria, VA.

He has research experience in analytical and physical chemistry, as well as in product assurance and both air and ground munitions. In 1978 he was awarded the prestigious Army R & D Achievement Award for his work on the development of the Army's M687 binary munition.

ARRADCOM Establishing EM Propulsion Laboratory

The U.S. Army Armament R & D Command has reported that within the next year it will establish its own electro-magnetic (EM) propulsion laboratory. It is expected to feature an EM rail gun launcher capable of accelerating two-thirds-of-a-pound projectiles to unprecendented speeds.

EM propulsion, which is the same basic force that spins electric motors, has the potential of firing projectiles faster than is possible with chemical propellents.

EM technology is also believed capable of launching aircraft, powering levitated ground transportation systems, performing ultra-high velocity experiments, and initiating fusion reactions.

Since the turn of the century EM propulsion had been attempted by various countries without much luck until a rail gun was fired successfully in Australia in the early 70s. This started a scattering of other EM projects around the world but they lacked central management or funding.

ARRADCOM scientists decided in 1977 that electromagnetically produced pressures have important advantages over chemical combustion pressures for gun propulsion purposes. Three ARRADCOM scientists from the Large Caliber Weapon Systems Laboratory (LCWSL) wrote a paper asserting this proposition and presented it at the Technology Trends Colloquium in Annapolis, MD.

This paper led to high-level DOD interest in the technology and to a series of technology assessment and development efforts. Joint funding for many of these was provided by the two designated DOD co-managing organizations, ARRADCOM and the Defense Advanced Research Projects Agency.

In conjunction with these efforts, a Technical Advisory Panel made up of highly-regarded university and industry personnel was formed by ARRADCOM and has provided important technical resources. A DOD Working Group in EM Propulsion, has coordinated the interests and efforts of all the Armed Services.

After the Army was named the lead Service in demonstrating the care technology, ARRADCOM scientists were given the task of developing the program plan, and the command now manages many aspects of the program including technology assessment, and preliminary utility and system studies. Additionally, the LCWSL and the Ballistic Research Laboratory are conducting theoretical efforts, and experiments are being set up at both labs.

Because EM propulsion uses specific amounts of electric energy, it offers many possible advantages over chemical propellants, according to command officials. These include uniform acceleration, lower vulnerability because propellants aren't present, blast and signal reduction, ability to fire different-shaped objects, and better control.

However, the greatest advantage of EM propulsion is the potential speed that can be achieved. Chemically propelled projectiles can only travel at speeds approaching sound speeds at high pressure because that's as fast as the burning gases can expand. "Theoretically, in EM propulsion devices the velocity in a magnetic field is the velocity of light (almost a billion feet a second) which means there are really no limits short of the speed of light and the material limits of the launching device which in these kinds of accelerations are subject to great forces," says an ARRADCOM official.

The long-range potential for EM propulsion relates to launching large masses directly into space and small fuel pellets into each other at such great speeds that a fusion reaction occurs. The basic technology for EM ground transportation systems has already been developed by MIT and the Japanese, and ARRADCOM officials say the technology is "already available" and just awaiting application for launching aircraft.

"The energy involved where things start getting interesting is not stupendous," said an official, "only about a megajoul, which is what you have in a battery or a martini. The trick is reportedly to get the energy where you want it in the appropriate timeframe - one hundredth of a second. In other words, a power compression cycle is needed.

In many other rail guns developed in the U.S., Australia and elsewhere, capacitors are used to store and deliver the energy in the "appropriate timeframe." But capacitors at present are too large to be used practically in most weapon applications.

ARRADCOM's launcher, developed primarily by command and Westinghouse personnel, is different. Its energy source can store up to 15 megajouls in a minute. The energy then is transferred into a rotating machine called a homopolar generator which again stores the energy and, when needed, delivers it in a fifth of a second into an inducting torodial coil.

In milliseconds, the coil can dump the energy into one of two parallel copper rails from which the rail gun's name is derived. The electrical current or pulsed power surges down the rail, passes through the projectile or a conducting material behind the projectile (arc) and returns down that opposite rail. The current thus creates a magnetic field, which it interacts with (the Lorentz Force) and causes it to accelerate the projectile.

"Another way of putting it," said a command official, "is that all this energy, being confined in a small volume is a pressure which pushes the only movable part — the projectile."

Section of electromagnetic rail gun launcher, made in Australia, is checked by a research physicist in ARRADCOM's Large Caliber Weapon Systems Laboratory.

DEPARTMENT OF THE ARMY

Headquarters
U.S. Army Materiel Development & Readiness Command
5001 Eisenhower Avenue
Alexandria, VA 22333

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
DEPARTMENT OF THE ARMY
DoD-314

CONTROLLED CIRCULATION RATE
PENDING