ARMY RESEARCH AND DEVELOPMENT

March-April 1973

AVIATION TECHNOLOGY Page 24

SPEAKING ON . . .

The Automobile as a Social Machine

Dr. Robert L. Sansom

In addressing the recent 1973 International Automotive Engineering Congress and Exposition at Detroit, Mich., Robert L. Sansom, U.S. Environmental Protection Agency Assistant Administrator for Air and Water Programs, stressed the automobile as a major energy consumer—in view of the current national energy crisis—as well as the largest contributor to environmental pollution, as follows:

★ ★ ★

The American public is beginning to recognize that the far-reaching benefits offered to our society by the automobile are, in selected areas of the country and in selected uses, outweighed by the social cost of the use of this machine.

The automobile provides us with a personal means of transportation that is essential to our way of life. Yet with nearly 85 million cars on the road today, this machine has become the single most important source of urban air pollution. It is a major contributor to the high levels of urban noise and congestion. It is a user of over 30 percent of the land area in some of our large urban areas. It is a killer of more Americans annually than have died in the entire 11 years of our involvement in Vietnam. It uses nearly 14 percent of the total energy consumed in the United States.

The Environmental Protection Agency has been properly urged to justify the cost its actions are imposing on society by giving an account of the social and economic benefits that will accrue from an environmental clean-up. Shouldn't the automobile be put to the same test?

The all-pervasiveness of the automobile makes it a societal phenomenon whose costs and benefits must be weighed and carefully balanced. This meeting is an important part of the effort to devise such a societal accounting. In my view, the machine will, in most respects, pass its societal accounting; in others, it will prove to be an overweight waster of our natural resources.

At the Environmental Protection Agency, our interest has primarily been focused on the problem of automotive air pollution, but today I will deal only briefly with this subject and focus instead on the automobile's contribution to the impending "energy crisis."

Energy Consumption. In 1970 mobile machines, better known as cars, trucks and buses, consumed over 90 billion gallons of petroleum products, while accumulating 1.1 trillion miles on our roads. By volume, this is equivalent to 2.1 billion barrels of crude oil, or in the energy jargon of the day, 6 million barrels of crude oil a day. This is more than 40 percent of all of the petroleum products consumed in the United States in 1970 by all sources, stationary and mobile.

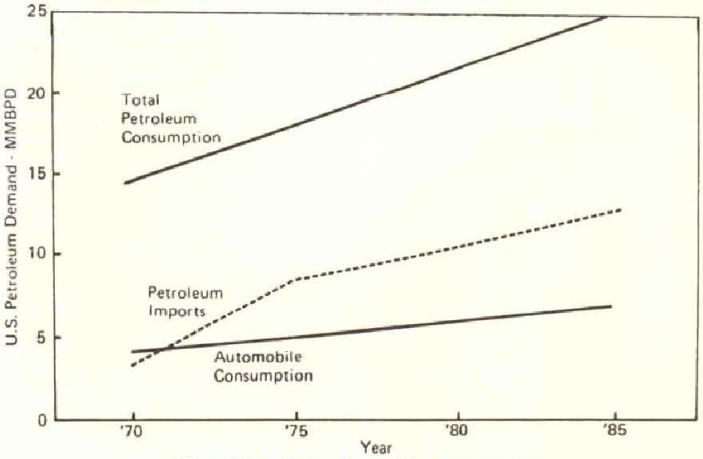
The automobile consumed approximately 70 percent of the petroleum used by all motor vehicles. This is equivalent to 4.3 million barrels per day or nearly 25 percent more crude oil than was imported into the United States in 1970. It is important to recognize that 55 percent of this consumption occurs in urban areas and 30 percent for trips of 10 miles or less.

Projections through 1985 indicate that petroleum will continue to be the source of over 40 percent of our total energy. Graph 1 shows a National Petroleum Council estimate of the projected growth in domestic and foreign oil availability through 1985. The graph has been segregated into total consumption, oil imports, and automotive consumption.

It is interesting to note that unless our domestic resources are developed more thoroughly, by 1985 over 50 percent of our total petroleum needs will have to be met by oil imports.

The balance of payments implications of this situation are staggering. At current prices the oil imports projected for 1985 will cost the United States nearly $15 billion. All merchandise imports in 1970 totaled only $40 billion. At the projected prices of $10 to $15 a barrel, the cost of oil imports could

(Continued on page 26)



Graph 1. Petroleum Consumption

ABOUT THE COVER:

When fixed-wing fighters could not provide the close-in protection needed to support troop-carrying helicopters, the first helicopter gunships were developed. Shown on the front cover (top to bottom) are the "Hueys"—UH-1B "Iroquois," UH-1D "Iroquois," and the Cobra attack helicopter. The back cover shows a UH-1D discharging troops on a mission in Vietnam. The supporting article, authored by BG William J. Maddox Jr., director of Army Aviation, ACS-FOR, begins on p. 16.

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

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FEATURES

DEPARTMENTS

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Selective Scanner. . .

Contract Requires Small Water Purifier for Infantry

Development of a hand-operated brackish water purifier that an infantryman will be able to carry easily in about one-quarter cubic foot of space is the objective of a contract awarded by the U.S. Army Land Warfare Laboratory.

Intended to weigh about 11 pounds, the purifier will operate on the "reverse osmosis" principle developed for large-scale water purifiers under contract with the U.S. Army Mobility Equipment R&D Center. It is to be capable of purifying one and one-half pints of water in two minutes.

The unit will have a continuous length of ¼-inch-diameter braided membrane wrapped in several layers around a support tube. Feedwater will be drawn through an inlet filter into a hand-driven pump, where it will be pressurized and sent to the reverse osmosis membrane module.

A major portion of the pressurized feedwater stream will pass through the reverse osmosis membrane and will be recovered as permeate or processed water. The remainder leaves the module as concentrate and is discarded.

Large-scale reverse osmosis water and waste purification systems, developed by the same contractor, Philco-Ford Corp., are currently being marketed nationwide for municipal and industrial water treatment and processing of certain streams.

Delivery of the first portable units is scheduled this year.

Weather Resistance Added to Torsion Springs

Weather resistance is being built into torsion springs through use of improved elastomeric compounds at the U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, Va.

Three compounds formulated by the Materials Research Division indicate they could provide torsio-elastic springs capable of maintaining a relatively constant spring rate through a temperature range of + 160° F. through −40° F.

The most suitable of the three compounds, which are based on epichlorohydrin ethylene oxide (ECO) blends—propylene oxide, and dimethl siloxane, respectively—will be selected after evaluation of full-scale springs now being fabricated.

Under development primarily for use on the tank-propelled mine-clearing roller, the elastomeric springs are envisioned for use in automobiles, snowmobiles and other vehicles.

The development was initiated following cold-weather failure of neoprene rubber springs on the roller. Allowed to stand under stress, they could not return to neutral upon its removal.

The torsio-elastic springs are expected to recover rapidly, minimizing loss of the ground contact necessary for roller operation. In addition to low-temperature flexibility, they also exhibit resistance to oil, water, microorganisms, humidity and heat.

Army Seeks Elimination of Helicopter Tail Rotors

Design of a system hopefully intended to lead to elimination of the tail rotors in U.S. Army helicopters is ordered under a recent $85,000 contract announced by the U.S. Army Air Mobility Research and Development Laboratory (AMRDL).

Paul F. Yaggy, director of the laboratory at Ames Research Center, Moffett Field, Calif., said the design calls for a fan buried in the tailcone of a helicopter, blowing air down the tailcone to the tip end. There turning louvers will deflect it sideward to provide the required yaw control force.

The 10-month contract requires a system capable of replacing the tail rotor in a conventional single-main-rotor helicopter. With the fan buried internally, the noise signature of the conventional tail rotor may be substantially reduced. Detectability characteristics of the aircraft in combat will be correspondingly reduced.

The project engineer is Frederick A. Raitch, Aeromechanics Technical Area, Eustis Directorate, AMRDL, Fort Eustis, Va., and Perry G. Foster of the same unit is the contract specialist.

MICOM Evaluates Roland II Defense System

A jointly developed German-French air defense system is under evaluation by the U.S. Army Missile Command (MICOM), Redstone Arsenal, Ala.

About 20 representatives of Germany and France who were instrumental in the Roland II system development recently participated in a demonstration of the system at the arsenal. The system mounts ground-to-air missiles, radar and fire control equipment on a single-tracked vehicle which carries a 3-man crew.

Testing at the arsenal will require about three weeks and includes aircraft tracking exercises. Following this initial evaluation, the system will be transferred to Fort Bliss, Tex., for actual firing exercises.

Evaluation of Roland II by MICOM completes a 2-year program which has involved similar tests with two other foreign-developed air-defense systems. The French Crotale was evaluated in 1971 and the British Rapier was tested during 1972.

Purpose of these evaluations is to determine how well the foreign systems meet U.S. Army requirements for a low-altitude, forward-area air-defense system.

BWL Modernization Project Nears Completion

A $1.5 million construction project to create a centralized complex of laboratory research facilities is nearing completion at the Benet Weapons Laboratory, Watervliet Arsenal, N.Y.

Initiated in 1971, the modernization program is centered primarily around existing facilities. High-pressure, high-strain-rate, and fracture mechanics laboratories will comprise the Materials Engineering Division where fatigue testing of gun tubes, breech mechanisms and other weapons components will be performed.

Other activities of the Materials Engineering Division will include physical and mechanical metallurgy, chemical, spectroscopic and vacuum deposition laboratories, and metallographic and mechanical testing facilities.

The centralized complex will include facilities for the Computer Science Office, accommodations for staff members of the Applied Mathematics and Mechanics Laboratory, and the Research Directorate administrative offices.

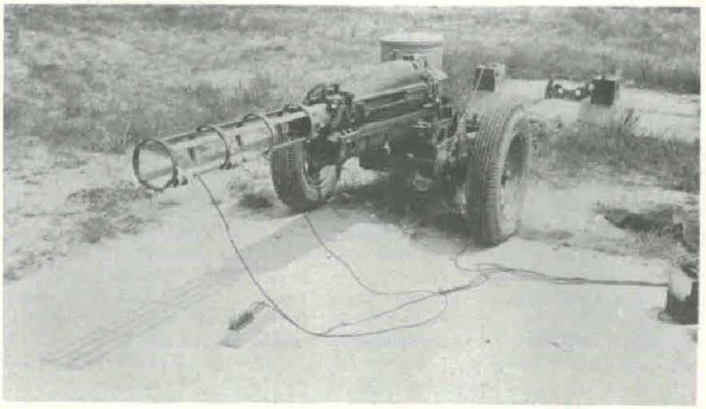
The contract construction project is being supervised by the U.S. Army Corps of Engineers, New York district.

Fuze Performance Test Procedures Improved

An improved technique for evaluating fuze performance during in-bore travel environments for all tube-launched projectiles is reported by the Harry Diamond Laboratories, U.S. Army Materiel Command.

The technique enables fuze engineers to conduct low-cost tests establishing the fuze parameters, and to perform a launch environment evaluation prior to finalizing the design.

The improved system, a modification of the simple and reliable hard-wire system connected to the moving projectile, can monitor projectile velocities up to 1,600 feet a second. Direct



MODIFIED HOWITZER records fuze information from initial projectile movement up to 42 inches outside the gun tube.

recording provides projectile information such as the acceleration, the performance of the safing and arming components, and the power supply output. Other electrical component behavior also is recorded from initial movement to distances up to 42 inches outside the gun tube.

HumRRO Developing New Test Training Techniques

UTRAIN, an experimental program of instruction for U.S. Army trainers and training managers, will be tested and developed by the Human Resources Research Organization (HumRRO) under a one-year contract.

The Army is adopting a "systems engineering" approach to training and education. Since a great deal of training occurs outside of formal educational centers, the Army has given commanders full responsibilities for training within operating units.

UTRAIN will be conducted by HumRRO Division No. 2 at Fort Knox, Ky. The team will initially analyze requirements in the newly decentralized Army training system. Current Army methods of instructions will be reviewed prior to formulation of a training management program geared toward systems and engineering principles.

HumRRO has served as the Army's principal source of research and development to improve training and education techniques for more than two decades.

Lance Missile Passes Initial Service Tests

Lance, the Army's newest battlefield missile, recently passed its first annual service practice, with all six missiles fired landing on target in the desert wilderness near White Sands Missile Range, N. Mex.

Under command of LTC Lowell G. Smith, troops from the Fort Sill, Okla., 1st Battalion, 12th Field Artillery manned the Lance aboard its highly mobile self-propelled vehicle, designed to provide fire support beyond the forward edge of the battlefield.

The battalion, the first to be equipped with Lance, now has the mission of providing troops and equipment for Lance training at the Field Artillery School at Fort Sill. Tests proved that Lance, carrying an 8-man crew, can maneuver in the desert environment as well as swim inland waterways. It can be transported by planes or helicopters and can operate under all weather and terrain conditions.

HDL Develops Fluidic Powered Ammunition Fuze

Completion of advanced development of a fuze for beehive ammunitions, incorporating a fluidic (air) activated power supply and solid-state electronics, is announced by the U.S. Army Materiel Command's Harry Diamond Laboratories.

Tests have been conducted successfully, using a 75mm howitzer, to determine if the fluidic power supply was capable of supporting the electronics to arm the munition within 15 feet of the gun barrel. Functioning within five feet of the gun and initiation of the arming sequence inside the blow-by gases were established.

Named for the 5,000 flechettes that are packed and arranged similar to the honeycomb of a bee, the beehive round is distinguishable by its scatter-gun effect in combat effectiveness in a broad area.

Tri-Service/AEC Unit to Certify Munitions Data

Formulation of standards intended to insure that munitions systems will operate safely and properly in electro-magnetic fields is the goal of a newly organized unit at Picatinny Arsenal, Dover, N.J.

Initiated under a Department of Defense standardization program, the Group to Establish Criteria for Certifying Munitions Systems to Electro-magnetic Fields (GECCMSEF) is a tri-service and Atomic Energy Commission organization formed at the request of the U.S. Army Materiel Command.

The Army does not yet have official criteria for the electro-magnetic field intensities (radio frequency and microwave) various weapons must be capable of withstanding. Considerable information has been collected on how these high-intensity fields can have a harmful effect on electro-explosive devices and electronics equipment, and how they may also cause problems with guidance and control systems.

The GECCMSEF has already calculated the maximum field intensities weapons can be exposed to in a variety of environments. Based on this data, a tri-service group will draft military standards on the field intensities weapons must withstand. Certification of a weapon will be based on these standards.

Additionally, an analysis of data from direct-drive testing of a weapon system is being conducted. Hopefully, these tests will allow certification of weapons for operational exposure to higher intensity fields than presently possible, and may also permit use of lower-powered equipment for tests at less expense.

Slated also for GECCMSEF development are criteria for test safety factors, electro-magnetic firing characteristics of electrically exploded devices, and static charge standards.

MICOM Awards $120.7 Million to Improve Hawk

Improved Hawk missiles and associated ground support equipment will be delivered to the Army under a $120.7 million contract awarded recently by the U.S. Army Missile Command.

Major improvements in electronic technology make the Improved Hawk a much more reliable and accurate air defense weapon than its predecessor, the basic Hawk missile system deployed since 1960, the MICOM announcement said.

The production contract with Raytheon Co. covers a new missile guidance package, larger warhead and an improved motor propellant, among other changes. The missile is delivered from the production line to the launcher as a certified round requiring no maintenance by soldiers in the field.

Much of the ground support equipment has been modified to include built-in test equipment for ease of maintenance. An electronic data processor has been added to assist soldiers in target engagements and significantly reduce reaction time.

Redeye 'Fly-Before-Buy' Tests Prove Successful

Demonstration "fly-before-buy" flights of the Redeye shoulder-fired, heat-seeking guided missile were conducted recently at the White Sands (N. Mex.) Missile Range and Fort Bliss, Tex., and termed "an unqualified success."

A majority of the firings resulted in direct hits on the small tow targets with over-all results exceeding acceptance requirements. The Redeye missiles were selected at random from production lots.

Redeye, a self-contained weapon system, is designed for use by frontline troops against low-altitude aircraft, and is fired in much the same way as an infantry rifle.

Army R&D Newsmagazine Shifts to AMC Building

Relocation of the editorial staff of the *Army Research and Development Newsmagazine* from the Office of the Chief of R&D to the U.S. Army Materiel Command is scheduled early in April. The physical move will be from the Highland Building, 3045 Columbia Pike, Arlington, Va. 22204 to the new AMC *Building at 5001 Eisenhower Ave., Alexandria, Va. 22304, ATTN: AMCRD-PS-NM.*

The Newsmagazine continues as a Department of the Army periodical, with no change in responsibility for serving all elements of the Army R&D community. Thus the 12-year relationship with all activities of the Office of the Surgeon General and the Office of the Chief of Engineers is unaffected.

The Newsmagazine staff will function as a part of the AMC Research, Development and Engineering Directorate, but will be placed not far from the AMC Information Office on the seventh floor, just below the directorate. The staff welcomes a continued flow of high quality material from all Army R&D sources, and the opportunity to serve effectively the R&D community.

R&D News . . .

Forecast Sets CY 73 R&D Effort at $30.1 Billion

Research and development expenditures totaling $30.1 billion in the United States during 1973 will reflect an increase of about 3.5 percent in real purchasing power, after discounting about four percent for inflation, as compared to statistics for CY 1972. CY 1973 could be the beginning of a sustained growth in R&D spending.

That is the prediction in the annual R&D forecast prepared by the Columbus Laboratories of Battelle. The increase is based on National Science Foundation estimates that total 1972 expenditures, when all figures are in, will be approximately $28 billion.

Industry is expected to account for the largest portion of the predicted increase, percentage-wise, though the federal government will continue to be the largest source of funding. The forecast is: government, $16.3 billion; industry, about $12.2 billion; colleges and universities, about $1.1 billion; and not-for-profit institutions, such as Battelle, about $442 million.

On the basis of these predictions, the federal government will be the source of about 54 percent of the R&D funds spent in 1973; industry, about 41 percent; colleges and universities, 3.8 percent; other not-for-profit sources, 1.5%.

The forecast notes that although it will not be possible to determine the full impact of the turnaround on R&D funding for at least another year, it appears that federal support has begun what could be a gradual but sustained rise.

The turnaround has resulted, the forecast observes, because the mounting concern over continued economic conditions has made budgetary deficits an acceptable device for stimulating the domestic economy. Growing concern with environmental and social problems has increased awareness of the need for more civilian-oriented R&D in such areas as energy, transportation and health. Also, there is a growing trend on the part of the states and localities to fund and conduct research.

The increase in federal support, the forecast cautions, must not be taken to imply that earlier forms of pro-R&D thinking have regained their former ascendancy. On the contrary, Congressional and public concern persists and has given rise to a number of changes in federal control of R&D contracts.

In other words, support is again moving upward—at least for the moment—but the ground rules have changed. They are distinctly more strict.

According to the President's budget message of late January 1973, the rise in Department of Defense R&D obligations from fiscal 1971 through fiscal 1974 is expected to be 19 percent higher than 1971 (as reported by the NSF).

The forecast notes that there has been some shift from federal government funded military-space-nuclear R&D to support of social programs.

Funds allotted to the Department of Defense (DoD), the National Aeronautics and Space Administration (NASA), and the Atomic Energy Commission (AEC) have dropped—from a 91 percent share of the 1961 R&D total to an estimated 77 percent in 1972, a decline of 14 percentage points.

Of the $2.2 billion increase in total federal R&D obligations expected between fiscal 1971 and 1973 (as reported by the NSF), 40 percent is destined for DoD, NASA and the AEC. However, of the total dollar increase in government R&D obligations from fiscal 1960 to 1973, about 64 percent still goes to DoD, NASA and the AEC.

The federal government is the dominant *source* of research funds, though industry *performs* about 69 percent of all research and is, in its own right, a substantial source of R&D dollars. The Battelle forecast sees industry *performing* $20.7 billion of R&D (about $12 billion government-funded) out of the predicted 1973 total of $30.1 billion.

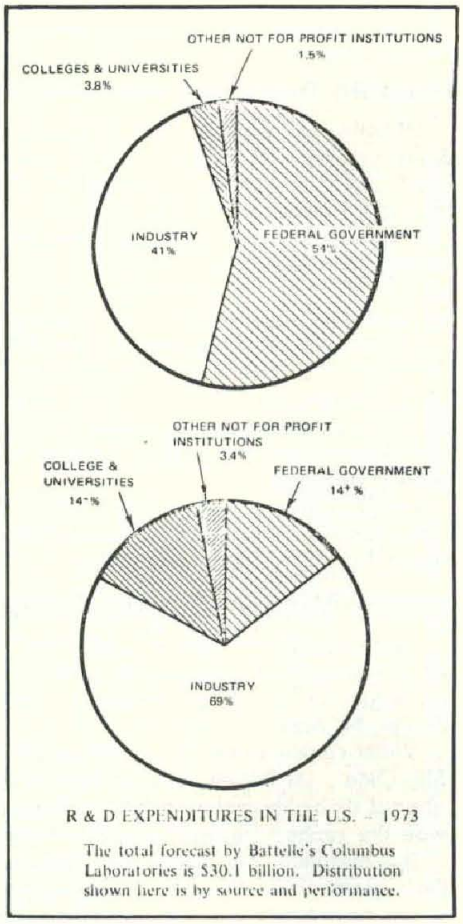
Total industrial support of R&D is expected to be $12.2 billion. Of this, $12 billion will be performed by industry, $72 million by university or college laboratories, and $111 million by other nonprofit organizations.

For industry as a whole, corporate sales and total R&D support are expected to rise by 9.2 percent and 7.8 percent, respectively, from 1972 to 1973; while the funds it supplies for research conducted other than in in-house laboratories will rise by 14.5 percent.

The forecast says it is too early to observe whether this generally improved forecast of industry R&D indicates a significant turnaround in industry thinking and/or motivation. Federal procurement policy continues to exert upward pressure on industry funding as would-be federal contractors carry out R&D in order to qualify for federal contracts. Thus, the growth of the industrially-funded proportion of total industry R&D performance continues.

Since 1968, industry has funded more than half its total performance. In 1970, preliminary NSF survey results set this figure at 56 percent. For 1973, Battelle estimates, it will be 58.2 percent.

Estimating corporate funded R&D by broad industry groups, the forecast identifies the top supporters as: (1) transportation equipment (including aircraft and aerospace) and missiles, with 1973 R&D expenditures of about $2.9 billion; (2) electrical equipment and communication services, $2.5 billion; (3) chemicals and allied products, $2.0 billion; and (4) machinery, $1.6 billion.



R & D EXPENDITURES IN THE U.S. – 1973

The total forecast by Battelle's Columbus Laboratories is $30.1 billion. Distribution shown here is by source and performance.

Together, these four industry groups will provide an estimated 73 percent of the R&D forecast for 1973; they will support a large share of non-in-house R&D—56 percent for 1973.

Not-for-profit institutions—colleges, universities, and independent organizations—fund their own research and also conduct research supported by federal agencies and by industrial firms. The 1973 forecast is that these institutions will provide 5.3 percent of all funding and that they are expected to perform about 17.0 percent of the total. This compares with 4.0 percent and 11 percent, respectively, 20 years ago.

The growth in not-for-profit R&D performance has been accompanied by little shifting within that sector. For example, in 1953, the academic community (universities and colleges) performed 80.2 percent of the not-for profit total. The forecast is for no 1973 change in ratio.

Battelle economist Dr. W. Halder Fisher prepared the 1973 forecast. Data sources included the fiscal-year figures of the U.S. Bureau of the Budget, National Science Foundation, the McGraw-Hill Survey—Business Plans for R&D Expenditure, and analyses conducted by the Technical and Business Planning Research Section of Battelle-Columbus.

U.S., Britain Join in Technical Cooperation Program For Lightweight Ceramic-Metal Fabrication Research

A collaborative program is being conducted by The Technical Cooperation Program, Panel 2 (Inorganic, Non-Metallic Materials) to investigate lightweight ceramic-metal composites fabricated by liquid metal infiltration into porous ceramic bodies.

Principal investigators on the project are George E. Gazza, research ceramic engineer with the U.S. Army Materials and Mechanics Research Center, and Dr. Michael W. Lindley, principal scientific officer with the Admiralty Materials Laboratory, United Kingdom.

Materials fabrication and testing are carried out at the AMMRC while detailed characterization is being pursued at the AML. Research in this area began in June 1971, during an exchange of scientists between AMMRC and AML, at which time Dr. Lindley was on temporary assignment to the Ceramics Research Division, AMMRC. (See *Army R&D Newsmagazine*, Jan.-Feb. 1972, p. 7.)

The prime objective of the program is to produce, on an economical basis, high-strength, high-elastic modulus materials which possess, for some cases, a limited amount of ductility. Both single-infiltrant and dual-infiltrant systems are being studied. Dual infiltration represents a unique concept for producing graded or gradient multiphase materials.

The principal single-infiltrant systems being studied are aluminum boride (AlB_{12})/aluminum, aluminum boride (AlB_{12})/silicon, silicon hexaboride (SiB_6)/aluminum, and boron/aluminum.

Selection criteria for ceramic materials included low theoretical density, high hardness, high elastic modulus, and potential chemical compatibility with the selected infiltrants.

Fabrication of ceramic/aluminum systems is performed by infiltrating aluminum into the porous ceramic compact at temperatures between 1100–1250 C., under 1000 μm pressure of argon. For ceramic/silicon systems, temperatures between 1500–1650 C. are used.

Test specimens were machined from the infiltrated compacts for purposes of determining modulus of rupture (MOR), and elastic modulus. During bend testing, strain measurements were made from SR-4 strain gauges attached to the tensile surface of the bend specimens.

Figure 1 shows a plot of modulus of rupture versus strain for some experimental compositions. It is apparent that the aluminum boride/aluminum infiltrated material merits further investigation, with properties determined as 45,000–50,000 psi MOR, $25–30 \times 10^6$ elastic modulus, and 6–7 percent plastic strain.

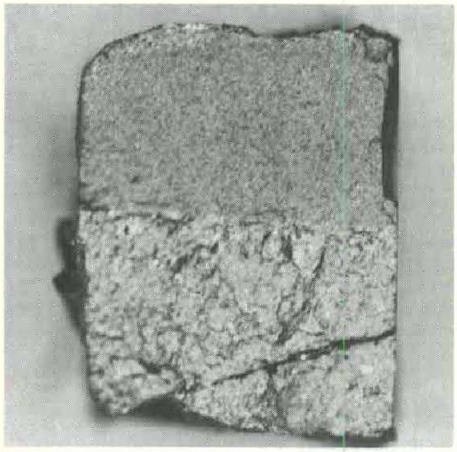


Fig. 2. Fracture surface of B_4C/Si (upper)-SiB_6/Al infiltrated specimen (lower)

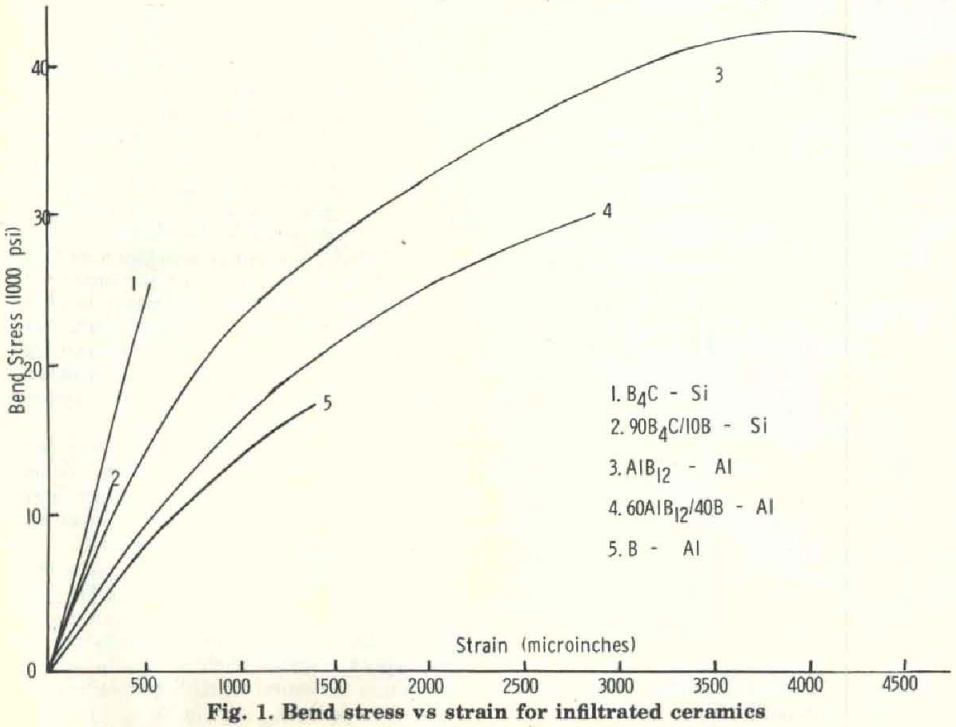


Fig. 1. Bend stress vs strain for infiltrated ceramics

Dual infiltration of ceramic compacts to produce graded or gradient materials was accomplished by infiltrating silicon into one side of a ceramic compact to a predetermined depth, and then infiltrating aluminum from the other side until an interface is formed.

The predetermined depth for initial infiltration can be fixed by using various particle size factions of ceramic to control the infiltration rate, or by using two different ceramic powders, pressed together, each with selective wettability with the particular infiltrants used.

Figure 2 shows a fractograph of the dual-infiltration system boron carbide/silicon—silicon hexaboride/aluminum. The change from brittle to ductile-type fracture can be observed across the interface. Several variations in dual system compositional construction are apparent and these will be developed and evaluated as infiltration parameters are defined and optimized.

Principal applications of such materials are seen in areas of hardface, abrasion-resistant materials and impact-resistant materials with enhanced structural capabilities.

Army Type Classifies Gyroscope, 420-Gallon Water Purifying Unit

A water purification unit capable of processing 420 gallons per hour and a lightweight azimuth, gyro surveying instrument were recently type classified Standard "A" by the U.S. Army. This designates each item as the most satisfactory of its type for current needs.

The water purification unit was designed and developed in-house by the U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, Va., and is the smallest in a family of transportable units.

It incorporates the same coagulation, diatomite filtration, and chlorination principles as larger units currently in use. Weighing about 1,000 pounds, its light weight and compactness permit ready transportability by helicopter or three-quarter-ton truck.

Intended use of the new unit is to support dispersed tactical forces in Army field operations. Purification of local water is preferred to transporting water because of the excessive weight involved in the latter.

The gyro surveying instrument, developed by the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Va., was designed for use by artillery survey organizations to determine rapid, accurate true azimuths for survey, fire direction and target acquisition.

It is a man-portable north-seeking gyroscope capable of determining true North with extreme accuracy without the need of celestial or landmark sightings. Components of the instrument include a gyroscopic reference unit with a theodolite and reference mirror, an electronic control unit, a tripod, a transit case with backpack accessories and a wind shelter. The unit is contained in a case.

LWL Announces Handheld Radar Device

Radar detection capabilities of U.S. Army field units may soon be improved with a new device developed by the U.S. Army Land Warfare Laboratory (LWL), Aberdeen Proving Ground (APG), Md.

Identified as the Handheld Radar Reflector/Detector, the lightweight unit can provide a soldier with knowledge he is under the illumination of hostile radar before exceeding its detection threshold. It also permits ground surveillance radar operators to identify friendly forces in a monitored area.

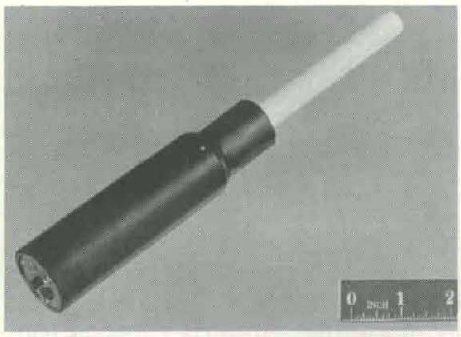
Developed by LWL under contract with the AVCO Corp., the device consists of a cylindrical teflon rod antenna terminated in a brass waveguide. It is 12 inches long, one inch in diameter and weighs 11 ounces.

Incident energy emitted by suspected radar is modulated by diode switching and reflected back to the radar. This reflected signal simulates a doppler return similar to that received from a moving target, but at a higher frequency. No modification of the radar is required to receive the transponder signal.

A light-emitting diode in the unit also is activated by the radar energy, providing a visual indication that an area is under surveillance. Powered by a small battery, the unit emits no radiation and is capable of operating for extended periods of time. Once activated, the device is directed like a flashlight or slowly scanned in azimuth.

The most impressive feature is the capability of providing field units with evasive radar detection information. The detector also may be used to identify returning patrols and locate remote units without revealing their positions.

Prototypes of the device have been built for use at various radar operating frequencies and have been tested at APG and Fort Huachuca, Ariz.



INCLUDED IN THE PACK of the individual soldier, the Handheld Radar Reflector/Detector is 12 inches long, 1 inch in diameter, and weighs approximately 11 ounces.

Army Modifies Contract for Heavy-Lift Helicopter

Design, development and flight evaluation of a prototype heavy-lift helicopter (HLH) with a payload capability of 22.5 tons is authorized under a $56.5 million contract modification announced recently by the U.S. Army Aviation Systems Command, St. Louis, Mo.

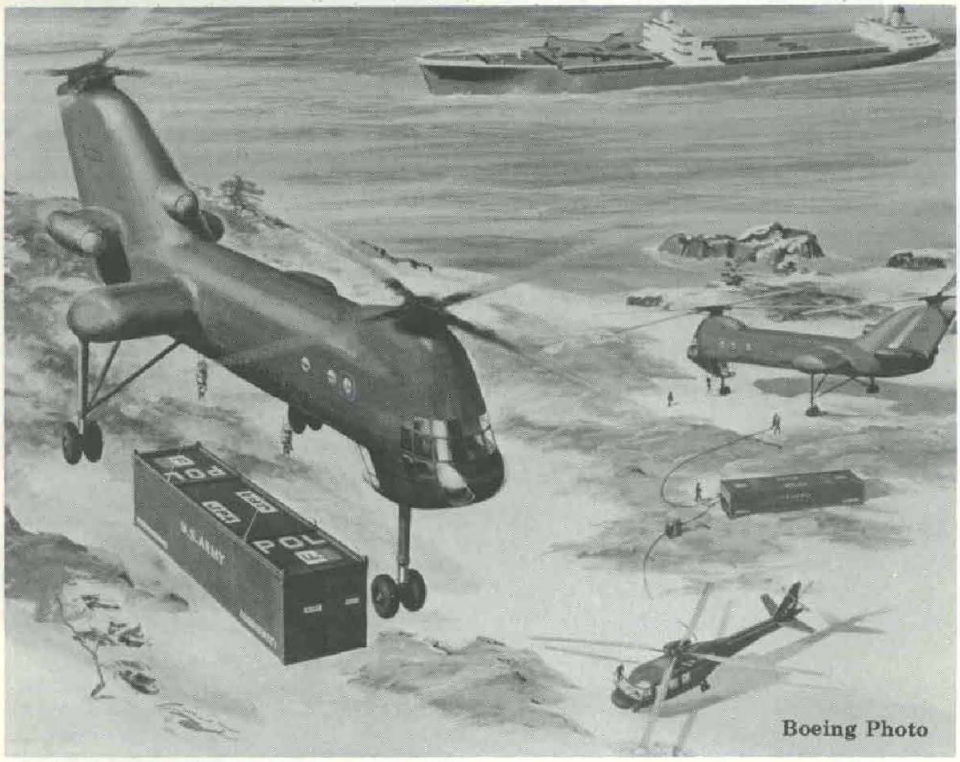
The HLH program extension with Boeing Vertol Co., a division of the Boeing Co., provides for the first flight of the prototype during the summer of 1975. Following the first flight, the aircraft will undergo a Boeing flight test program leading to formal flight evaluation by the U.S. Army.

The prototype design, development and flight evaluation contract modification is termed an "austere prototype program" as a logical extension of the Boeing ATC (Advanced Technology Concept) program for the HLH. Components thoroughly tested in the ATC program will be used in the prototype.

A Boeing official said the program will demonstrate that the aircraft can be "the world's most efficient HLH with both commercial and military applications."

Weighing more than 2½ times as much as the CH-47C Chinook, currently produced for the Army by Boeing, the HLH reportedly will be able to transport all logistical containers forecasted for military or commercial use as well as all of the equipment items in the Army airborne and airmobile divisions.

R & D NEWS



Boeing Photo

BOEING Heavy Lift Helicopter (HLH) is shown (artist's concept) transporting a 5,000-gallon fuel container from an oil tanker to a refueling site where another HLH and a Utility Tactical Transport System helicopter are serviced from a container.

National Bomb Data Center Aids U.S. Law Enforcement Operations

Rapid response to information requests pertinent to terrorist bombing activities across the nation is a responsibility of the National Bomb Data Center (NBDC), established in 1970 at Picatinny Arsenal, Dover, N.J.

Operated by the arsenal's Munitions Support Directorate and the Federal Bureau of Investigation, the NBDC was originated by the Law Enforcement Assistance Administration (LEAA), U.S. Department of Justice, under contract with the International Association of Chiefs of Police.

An agreement with the Department of Justice transferred the center from its original location in Gaithersburg, Md., to Picatinny.

The center prepares and distributes data on bombings and provides technical advice on bomb disposal to public safety agencies. Specific services to more than 4,000 recipients nationwide include publication of technical documents aimed at improving the security of potential targets, including information on various explosives and bomb disposal services.

Additionally, the center provides a 24-hour consultation service; performs test and evaluation of bomb handling equipment; develops instructional material including visual aids for law enforcement personnel classes; and maintains a National Technical Information Center containing bombing incident reports, test books and other publications.

An example of the NBDC work was performed last year. The New York Police Department made immediate contact with the center following the discovery of an envelope bomb mailed to an Israeli diplomat.

Photos of the explosive device were forwarded to the center for examination. Twenty-six hours later NBDC issued technical bulletins to 3,200 law enforcement agencies nationwide. Quick response such as this helped to alert other activities which might be targets for similar threats.

Joint Report Issued on Impact-Induced Hearing Loss

Knowledge about impulse-noise-induced hearing loss has been advanced by results of nearly two years of joint research at Case-Western Reserve University Medical School and the U.S. Army Medical Research Laboratory, Fort Knox, Ky.

In a recent report that will be published as a 1973 supplement to the professional publication, *Acta Otolaryngologica,* the research team explained experiments conducted with 11 rhesus monkeys. Results suggest that loss of high-frequency hearing is the earliest sign of noise-induced hearing loss. Conversely, the experiments indicated that low-frequency hearing was improved after noise-induced ear damage. These findings support results of earlier research by other investigators using different techniques. Further validation tests are planned.

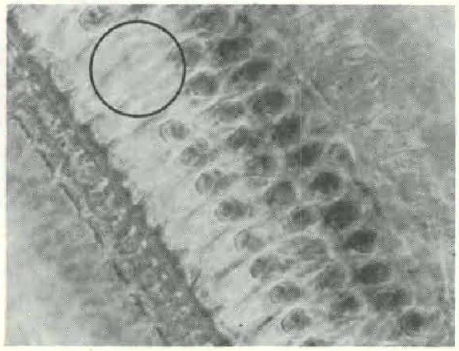
Experimentation was conducted at the U.S. Army Medical Research Laboratory, using the monkeys to evaluate the effectiveness of standard audiometric tests in detecting physiological and anatomical ear damage.

The behavioral testing of monkey hearing and the impulse noise exposure at Fort Knox were supported by the Biomedical Stress Division of the U.S. Army Medical Research and Development Command. Histological analyses were made at Case-Western Reserve Medical School under support from the Hartford Foundation in New York City.

CPT (Dr.) George Luz, LTC (Dr.) John Fletcher and Dr. James Mosko, USAMRL psychologists, worked with MAJ William Fravel, M.D. octolaryngologist, on Army team.

Dr. Luz said a newly developed histologistical technique, surface preparation of the cochlea in the ear, was used. Researchers at the University of Illinois and the University of Michigan are credited with developing it.

Case-Western Reserve University Medical School team members during the research project included Valdemar Jordan, M.D., Marilyn Pinheiro, PhD, Kazuo Chiba, a Japanese medical doctor, and Armando Jimenez, M.D.



DAMAGED COCHLEA taken from a monkey exposed to impulse noise illustrates the pattern of hair-cell loss typical of this exposure. Lost hair scar is circled.

MICOM Announces Antitank Technology Progress

Prototype development advances in Short-Range, Man-Portable, Antitank Weapon Technology (SMAWT), announced in March by HQ U.S. Army Missile Command, Redstone (Ala.) Arsenal, have demonstrated again the Army in-house laboratories' capabilities in a united effort.

Understandably, the MICOM announcement was tinged with prideful exuberance, attested by MAJ Steve Walker's statement as chief of the MICOM Antitank Assault Concept Team: "We have taken our rocket from the drawing board to a complete component prototype. . . ."

MAJ George Kopcsak, who monitors the SMAWT program for the Office of the Chief of Research and Development, HQ Department of the Army, joined in praising the achievement, but more cautiously.

Nevertheless, he was firm in calling the SMAWT prototype development an outstanding performance involving collaborative effort by scientists, engineers and technicians in numerous Army in-house laboratories. He pointed to the need of extensive testing and further developmental work to reduce the weight below the current 8-pound missile.

The U.S. Army's continuing search for methods of producing the ultimate tank-killer for use by the individual infantryman, MAJ Kopcsak said, must be turned to a weapon minimizing weight an infantryman must carry.

One of the keys to the prototype is an advance in propulsion technology. The Propulsion Directorate developed a carborane propellant with a high burning rate and insensitivity to temperature factors. Advances in composite fiberglass technology by the Ground Equipment and Materials Directorate resulted in lightweight launch tubes.

Other MICOM elements credited with significant roles in the prototype effort include the Aeroballistics Directorate for in-depth design tradeoffs and analysis, the Test and Evaluation Directorate and the Advanced Systems Concept Office. MAJ Walker cited help from AMC units such as:

Picatinny Arsenal and the Harry Diamond Laboratories, a dual-safe warhead; Frankford Arsenal, sight; Human Engineering Laboratories, mating man and equipment; Ballistic Research Laboratories at Aberdeen (Md.) Proving Ground, technical evaluation; Army Materials and Mechanics Research Center, materials fabrication and analysis; Army Materials Systems Analysis Agency, effectiveness studies of the prototype.

MICOM's accelerated developmental program was initiated in 1972 when the U.S. Army Materiel Command ordered a technology competition between the rocket version and a recoilless rifle version under development by the Weapons and Munitions Commands.

Army Expert Monitors NASA's Rocket Launches

In watching the awesome television spectacle blast-off of mighty Saturn rockets for an Apollo flight to the moon, have you ever thought about what might happen if an abort explosion occurred?

NASA officials at the John F. Kennedy Space Center have been constantly alert to that possibility, though such a blowup did not occur in the moon landing and exploration program. Nevertheless, that explains why no one except the astronauts was allowed within two miles of the launch pad during blastoff.

If such an explosion had occurred, however, NASA would have required a record of its intensity for comparison with baseline data gathered at normal launches—to help determine what caused it and to set up new safety procedures for later launches.

In filling that need, a U.S. Army agency responded to a NASA call for assistance—specifically, to measure and record the shock wave of a Saturn blastoff, as an abort pad experiment. Pressed into service was the Terminal Ballistics Laboratory at Aberdeen (Md.) Proving Ground and an expert in the Explosion Kinetics Branch.

TBL gave the assignment to Ed O'Leary, who participated in all of the Apollo launches and earlier worked on the Gemini program. His role required that he have blast sensors set up in specified areas at all times when propellants were on board a rocket.

Developed by TBL physicist Ralph Reisler, the sensors are about the size of a coffee can and contain tape recorders. The blast measurement of each Apollo takeoff was recorded in rising and falling intensity for the launch blast duration.

Following each launch, O'Leary brought the instruments back to TBL. Using a telecordex digital readout system, he transcribed the data recorded on the tapes and forwarded it to the Space Center's safety office for analysis.

Even though the Apollo missions are over, TBL will continue to participate in the national space program. Skylab, the orbital space workshop, is scheduled for its first launching Apr. 30, and O'Leary plans to be on hand for that.

MOON ROCKET BLAST ANALYSIS is conducted by physicist Ralph Reisler (left) and technician Ed O'Leary at Terminal Ballistics Laboratory, Aberdeen (Md.) Proving Ground. Reisler holds a tape recording of the shock-wave accompanying the Apollo 17 launch. The tape was contained in canister-type sensor (foreground).

Error Made On Project Manager

The *Army Research and Development Newsmagazine* editorial staff offers a collective apology to BG A. B. Crawford Jr., who *is project manager* for the Army Tactical Data Systems (ARTADS), HQ U.S. Army Electronics Command.

An error was made recently in announcing that Grady H. Banister Jr. had been appointed to that position; instead, he is the *deputy* project manager for ARTADS in addition to serving as a principal adviser on all aspects of tactical data systems development.

APG Testing Nonpollutant Powdered Paint

Powdered paints requiring neither solvents nor fluid carriers are undergoing feasibility tests in the U.S. Army Coating and Chemical Laboratory, Aberdeen (Md.) Proving Ground, for possible U.S. Army acceptance.

Qualities of the powder paint samples manufactured by numerous commercial firms are being examined, along with electrostatic spray application. Dip and air spray application methods have been used practicably or experimentally by various commercial firms for several years, including tests by two major U.S. automobile manufacturers.

C&CL chemist William H. Deaver reported recently that the Army testing program was initiated last October at the C&CL. Methods of application, he said, are being checked as precisely as qualities of the powder paints. Though this product was introduced as early as 1952, worldwide recognition of its potential has come in recent years.

Some advantages of powder paints are that they do not run, sag or drip. They reduce substantially the bulk of storage and transport of conventional paints carrying solvents or fluid bonding agents. Because they can be reclaimed readily, powder paints can be economically "shot" out of a special gun in greater volume. This provides the economic payoff of higher line production speeds, automation and less employes.

In view of the current concern about minimizing environmental pollution, a major benefit of powder paints is that they do not pollute; they have no hydrocarbons or other solvent pollutants to discharge into the air or wasted material to flush down a drain or clutter a filter pump.

In the C&CL testing program, very fine powder—of a grain size usually below 100 microns—is sprayed from the gun after having passed an area of high voltage in which every grain is electrostatically charged.

The powder is sprayed onto a grounded metal object, where it adheres until it has lost its charge (it can remain adhered up to 8 days, depending on the system and the care taken). The time is sufficient to fuse the adhering powder in an oven and form an adherent, continuous layer.

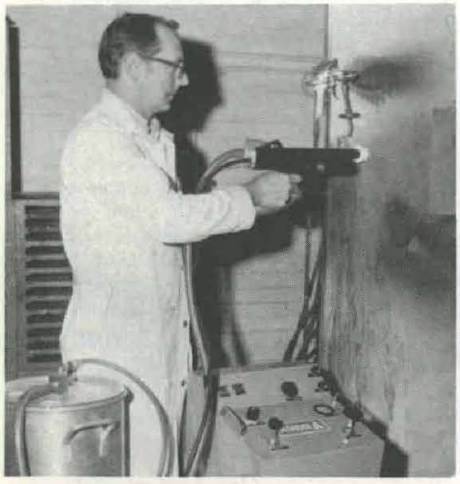
The powder deposited on the articles is of uniform thickness due to the fact that all particles have the same electrostatic charge. They therefore tend to repel each other after leaving the gun and do not tend to conglomerate.

Deaver cited advantages of the electrostatic spray system for powder paints as: thinner coating possible (less than 100 microns); thinner substances can be used (even metal foils); one surface coating is possible; coating costs are lower; and small amounts of powder are sufficient to initiate spraying. Lower oven temperatures are used for fusing, which means less expensive ovens.

Electrostatic spraying causes the powder coating to "wrap around" corners and edges, completely covering all areas, particularly in irregular items. The system can also provide a heavy coating in one spraying which is the equivalent to four coats of liquid paint spray.

The only problem encountered in the APG tests, Deaver said, is the time needed to convert to another color. While the system recirculates excess powder ejected from the spray gun, the paint room must be entirely free of the one color before a second is used. Otherwise, a mixing of colors might occur. In a large operation, separate rooms for various colors might eliminate this technicality.

In Europe today, powder painting constitutes 10 percent of the entire metal finishing market. Projected figures, however, are for 30 percent market use by 1975 and 50 percent use by 1980. Currently, the system in North America constitutes from 1 to 3 percent of the market, with 15 percent projected by 1975 and 30 to 50 percent market use by 1980.



POWDER PAINT TEST is conducted by William H. Deaver, a chemist in the Coating and Chemical Laboratory, Aberdeen (Md.) Proving Ground. The funnel-like cylinder contains the powdered paint, while the controls (bottom right) regulate the spray gun and electrostatic charge.

New Crashworthy Seats May Cut Aircraft Toll

Passenger survival rates in military helicopter accidents give promise of being improved substantially by experimental crashworthy seats developed by two U.S. Army research and development activities.

Designed to attenuate without serious injury crash forces up to 48 g's, the seats are an innovative mix of state-of-the-art, energy-absorbing devices and occupant restraints—developed in response to findings of a 1971 safety study.

Announcement of the new seats was made recently by the U.S. Army Agency for Aviation Safety (USAAAVS), sponsor of the study by Berner and Sands, and the U.S. Army Aeromedical Research Laboratory (USAARL), Fort Rucker, Ala.

Study findings included statistics showing 93.5 percent of U.S. Army aircraft accidents were survivable but accounted for 39.5 percent of fatalities.

Working with the U.S. Army Aviation Center and other Army agencies, the USAAAVS design team, headed by Joe Haley of the Systems Research and Technology Division, concentrated on both forward and rearward-facing seats. Sideward-facing seats were ruled out due to the difficulty of providing adequate lateral restraints for occupants.

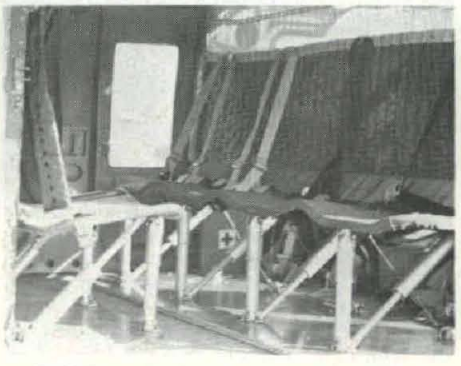
Additional importance was placed on the seat development program due to increased Army emphasis on acquiring new helicopter systems for the field Army of the 1980s. The seats are suspended from the aircraft ceiling by a series of stainless steel cables. Additional features include:

- Stainless steel screen seat pans designed to deform under impact-loading without providing an impulse rebound to the occupant. SAE 4130 steel seat frames are dished slightly to provide a measure of lateral restraint.
- A combination of torso and lap belts with an inertial lock eliminates manual adjustment and permits one-handed locking or unlocking.
- Easy folding and storage to the ceiling of the aircraft leaves the helicopter cabin deck uncluttered when desired.
- Aluminum "inverted tube" (a General Motors-developed energy absorber) seat legs are used to anchor the seat to the floor of the aircraft. This provides excellent impact load attenuation by directing compression of the seat legs along a flared ogee load path.

Although a slight weight increase exists with the new seats, no difficulties are anticipated since new helicopter systems are expected to have increased structural strength.

Presently, two rearward-facing seats and one forward-facing seat have been completed at Fort Rucker. They are installed in USAARL's Bell JUH-1 helicopter for ingress and egress testing. The second rearward-facing seat will be used for static loading tests.

Construction of five additional seats is being funded by the Directorate for Research Development and Engineering, U.S. Army Aviation Systems Command. Both series of seats have been slated for advanced dynamic testing by the U.S. Navy Aerospace Crew Equipment Laboratory, Warminster, Pa.



Stainless steel wire mesh seat plan

Torso and lap restraints

Army Materiel Command Reorients QRI Program To Stimulate Responsive Industry Proposals

Reorientation of the Qualitative Requirements Information Program (QRI) to stimulate industry into submitting a larger number of acceptable solution proposals for timely or fairly immediate problems was announced in March by the Army Materiel Command.

Termed an action to be "more responsive to the needs of industry," the revised program is intended to "provide industry with fewer but significant research and development problems, and solicit assistance in solving them."

Previous emphasis has been upon soliciting assistance from industry on an unfunded basis. Current austerity of R&D spending in industry has shifted the AMC approach to "concentration of those R&D problems for which proposals can be funded," it was explained.

Each AMC subordinate command will "increasingly conduct formal QRI briefings for the release of specific QRI problems." Long-range and continuing R&D problems will be presented to industry primarily through advance planning briefings, and through the Technical Industrial Liaison Offices (TILO) at HQ Department of the Army, AMC and subordinate levels.

Attendance at QRI briefings will be open to any profit or nonprofit firm or individuals with an R&D capability to solve a specific QRI problem. The price of admission will be registration in the QRI Program. Briefing notices will be published in the Commerce Business Daily and mailed to all QRI registrants.

Good news to industry representatives who have wearied of filling several registration forms in the past is that the procedure is now simplified—"can be accomplished in minutes."

Only three forms are involved, DD Forms 1540 and 1541 and a Policy Agreement, which will be available at all QRI briefings and may be completed on-the-spot. Registration provides:

- Official access to the Defense Documentation Center (DDC), Cameron Station, Va.
- Automatic multiple registration with any other AMC activities responsible for fields of interest the registrant indicates on DD Form 1540.

Registrants also can be certified by the QRI officer with whom they are listed for need-to-know access to classified and limited access documents in the DDC.

For organizations without a current defense contract, this certification can be of significant assistance in obtaining documents pertinent to military related or military potential R&D programs.

Industry responses to QRI problems are submitted in the form of Unsolicited Proposals, which must be annotated to reflect the QRI problem number as stated at the QRI briefing. Proposals are reviewed by an Army Technical Review Panel consisting primarily of the QRI officer, project engineers, scientists and directors funding specific QRI problems.

Proposals selected will form the basis for a sole-source procurement from the firms submitting them. In many cases, only a portion of a proposal may be funded initially. This enables the government to obtain sufficient data to prove out the effectiveness of the proposed solution before proceeding into a complete solution.

QRI registration packets are available at any Defense Contract Administration Services Office (DCAS), any Army QRI Office, and any Army Advance Planning Briefing for Industry. Registrations may be mailed to an appropriate QRI Office or delivered in person.

Organizations registered in the QRI Program prior to 1972 that have not recently received QRI mailings are advised to contact an appropriate QRI Office to update their registration. In many cases, the original point of contact within a company for QRI has left so that mailings are returned by the Post Office as not deliverable.

Addresses and points of contact of QRI offices within the Department of the Army may be obtained by contacting the following personnel by phone, by written request, or in person:

Mr. Hal Davidson
Pentagon, Room 3E368
Telephone: OXford 54622 or 52362
Address: Department of the Army
ATTN: DARD-AOT
Washington, DC 20310

Mr. Robert P. O'Brien or Mr. Henry A. Snell Jr.
New AMC Building, Room 8N48
Telephone: Area Code 703-274-9870 or 9869
Address: U.S. Army Materiel Command
ATTN: AMCRD-PS-TILO
5001 Eisenhower Avenue
Alexandria, Va. 22304

LWL Flare Reduces Delivery Aircraft Vulnerability

Aircraft can illuminate ground targets from an extended standoff distance by using a flare system announced recently by the U.S. Army Land Warfare Laboratory (LWL), Aberdeen Proving Ground, Md.

Principal advantages of this 2.75-inch rocket-propelled newly developed flare are a reduction in aircraft vulnerability and an element of surprise. All flare systems now in use by the Army require direct overflight of the target for successful deployment.

LWL initiated development of the flare system in 1969 following a request from HQ U.S. Army Vietnam. The initial problem encountered by LWL was adjusting the exceedingly high velocity of the normal warhead to permit deployment of the main parachute carrying the flare.

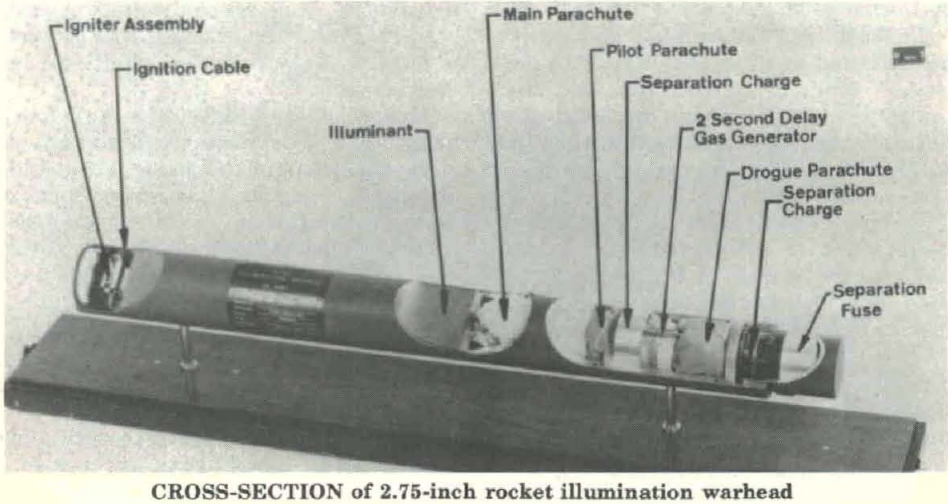
COBRA helicopter fires a 2.75-inch flare to illuminate a target (artist's concept).

Modification of an existing fuze with a pyrotechnic delay helped to reduce rocket speed to about half the initial velocity. The flare is then separated from the rocket motor. Velocity is further delayed by a drogue parachute preliminary to deployment of the main parachute and a slow decent of the flare over the target area.

Ninety-three rocket flares were evaluated in Vietnam in conjunction with missile firings, night area surveillance and interdiction operations. Using an AH-1G Cobra as the flare ship, 15 flares were fired singly and in pairs. Illumination proved sufficient to enable the UH-1B TOW missile helicopters to engage targets at night.

Night area surveillance and interdiction operations also were conducted using three helicopters—one at low altitude for enemy detection and two at higher altitude for flare and fire power support. All operational tests reportedly showed that illumination from a pair of rocket flares was adequate in detection and engagement of the targets.

The warhead, identified as XM257, 2.75-inch rocket flare, is under further evaluation by Project MASSTER (Modern Army Selected Systems Tests, Evaluation and Review) at Fort Hood, Tex. Upon completion of these tests, the new system will be considered for standard type classification by the Army.



CROSS-SECTION of 2.75-inch rocket illumination warhead

National Security Objectives . . .
Weapon Systems We May Face—and Better Have

Director of Defense Research and Engineering Dr. John Foster Jr., who has announced his intention to resign but was still at his desk with no designated successor at press time, gave the keynote address on the above topic in a national security meeting of the American Institute of Aeronautics and Astronautics in Washington, D.C., as follows:

* * *

The stated topic for this session is an intriguing one: "Weapons Systems We May Face—and Better Have." I suppose that, to some, the topic could imply that we should just calculate all the weapons the Soviets are likely to have and then go out and buy the same number of the same things for our side. Fortunately, knowledgeable people won't buy that wrong approach to national security.

The topic could imply also, however, that we should look at the equipment of potential adversaries, assess their capabilities against us and our allies, and then insure that we have appropriate military capabilities—not necessarily the same weapons. That is, in fact, one useful way of addressing the sufficiency problem. We have all used it many times.

But that approach has its drawbacks. It tends to confine our thinking to one mold, and it is too easily used to justify existing practices and policies.

There is still another approach to military security that is used often in the defense community: Estimate what our technology can provide in new systems and then look for military applications. This approach can be successful, but I see too many attempts to force a fit.

There is, it seems to me, a better way to look at our national security needs and to meet defense objectives. I wish to emphasize that better way today.

In brief, it is to emphasize the need to identify and resolve deficiencies, bearing in mind that we must also look for cheaper ways to do a job and for better performance at a fixed cost.

To do this, the government first specifies national security objectives; the defense community measures existing military capabilities to perform the necessary missions; and, finally, we move to close the gaps that careful analyses, tests or conflicts reveal.

Today I will outline briefly our national security objectives, describe effective ways to identify deficiencies, and then show how we can approach the vital task of eliminating the deficiencies. The process involves all of us, so I hope it becomes a lively topic for your discussion. But, more important, I hope that the philosophy of deficiency resolution becomes a more integral and central part of our thinking about national security.

Let us turn first to our national security objectives. These are determined by the President on advice of his National Security Council, with the help of policy and staff people in the relevant Department. In brief, our major objective is to preserve vital national interests without war—that is, to deter war at all levels through a clear ability, in conjunction with our allies, to fight effectively if necessary.

Deterrence is not just a military responsibility. The Armed Forces complement diplomacy and provide a necessary force for peace. By and large, deterrence works. But it is a delicate art, and our weapons and strategies must always be adjusted, exactly as our diplomacy is adjusted to fit changing situations.

For instance, we keep the Sixth Fleet in the Mediterranean to help secure the southern flank of Europe. It has helped deter military actions and limit conflict. But the military and diplomatic climates in the Mediterranean area change.

A constant infusion of proven technology is necessary to enable the Fleet to carry out its tasks. Therefore we must continually assess the limitations of a sea-based force to effectively deter war in the Mediterranean and constantly look for ways to improve its performance. Equally important, we must search for basically different approaches to security there.

That is one example, but there are dozens more. In every area of military responsibility, we must always look for deficiencies, find economical fixes, and seek new solutions. Clearly, this process is not easy. How do we go about finding deficiencies?

It is a devilishly difficult task. A military capability is made up of a chain of many links—command, control, communications, logistics, trained personnel, weapons and their maintenance, the strategy and the tactics to be employed. It is not enough to make any single link overwhelmingly strong. That is why a tenfold improvement in any one military function seldom results in a major over-all improvement—unless we are strengthening the weakest link.

The salient difficulty, which occurs in all countries and has been evident throughout history, lies in the need to make a timely determination of the weak links in military capability and strengthen them or find a way around them.

For the United States, with its widely ranging obligations, the difficulty is compounded by the fact that we are not the side that will determine when or where, or in what kind of situation, or at what level of force we will have to respond. The aggressor sets the scene.

Nevertheless, there are several feasible ways of finding our deficiencies. Although none is perfectly sufficient, all are useful and necessary. We can be effective if we use a combination of approaches and an iterative process.

- We must understand the stated national objectives. They cannot, of course, cover every contingency, but they do meet defense needs for guidance.
- We must understand the capabilities of the forces that we now have, based on their demonstrated performance in conflict or in realistic operational tests.
- We must explicitly describe any deficiencies.
- We must make sure that, where deficiencies are known to exist, top priority is given to their economical resolution.
- We must use hard thinking and careful analysis by able people to provide us with insight into the nature of changes required for future systems and tactics.
- We must fully exploit the test and evaluation of new systems and equipment, particularly in valid simulations of the operational environment, including adversary forces.

Let me caution you that each step has its inadequacies. Wartime experience shows that we can identify deficiencies and move quickly to resolve them. The results can be spectacular. Gunships, night-vision devices, precision-guided munitions, electronic jamming, ground sensors, and many other effective techniques rose out of the need to eliminate deficiencies exposed in the Vietnam conflict. All this technology, if we are only vigilant enough to preserve and exploit it, will contribute to the deterrence of future wars.

It is terribly hard in peacetime, however, to be sure what our capabilities really are. Operational test and evalua-

tion, no matter how careful the simulation, is after all not the real thing. Even the results of thoughtful analyses too often are interpreted by others as, at best, just another view of the situation and, at worst, as an effort to rock the boat. Everlasting vigilance is necessary if the correction of deficiencies is to receive top priority.

As a nation, we have excelled in eliminating equipment deficiencies that emerged as a result of a crisis. We are less expert, however, at discerning mission-area deficiencies, before the fact, and finding truly creative solutions. We do reasonably well at eliminating component deficiencies, which is akin to product improvement. Here, the operator is very aware of defects in his weapon, and the engineer can understand and correct them.

But the destroyer commander on convoy duty whose ship is becoming marginally effective, too costly to buy and operate, cannot be expected to make a mission analysis and suggest that the solution might be a surface-effects ship or a submarine which would eliminate the need for his type of ship. The bomber wing commander, correspondingly, would be in no position to advocate ground-controlled, remotely piloted vehicles to eliminate a deficiency in bombers' penetration capability.

It is feasible, however, for industry, the Military Services, and the Office of the Secretary of Defense, by looking at the broader issues, to find and validate mission deficiencies and propose efficient solutions.

If we can devote more attention to providing intelligence where it is critically needed, improving assessment, and isolating real deficiencies, each approved program will have a heritage that can be traced clearly from national security objectives, through the military capability needed to achieve them, to the identification of a specific deficiency that the particular program will eliminate.

We have met with some success in the past by using the approach of selecting promising new technology and then identifying applications that improved our capabilities. But this approach—a solution looking for a problem—too seldom strengthens our weakest link. This approach can be useful, but if it is overemphasized, as it has been, then too many systems are started and later terminated. This wastes enormous sums of money—and we still have our deficiencies.

Unless we emphasize the programs that are founded on valid deficiencies and also represent demonstrably effective solutions, we waste millions, we diminish deterrence, and we risk lives and property. (Italics added.)

On the other hand, the rewards of successfully using deficiency resolution are substantial and obvious. Many of our existing weapon systems were designed to meet real needs. The Triad of our strategic retaliatory weapons has provided our strategic deterrent for many years. There are other effective programs as well, many proposed by industry without prodding by the Department of Defense.

Some are vital subsystems, and some are complete weapon systems: the A-4, the EA-6B and the C-130 gunship, for instance, fill what were formerly major deficiencies. Electronically steerable radar arrays, forward-looking infrared, towed sonar, the F-4's electrooptical target-identification system, are successful programs that were suggested by industry, essentially independently.

Of course, some truly brilliant ideas that offer quantum jumps in our capability to eliminate major deficiencies have rough sledding in the DoD. This is another reason we must analyze and propose in terms of deficiency resolution.

In discussing this problem of our deficiencies, I have highlighted some points that I believe are important. Most important of all, of course, is the answer to the question, "What should we do?"

- First, we must devote a specific effort by competent people to the task of identifying salient deficiencies.
- Second, we must make a diligent search for programs or new approaches that remove the most critical deficiencies.
- Third, we should adopt the best features of our wartime ad hoc resolution of deficiencies to our normal management processes.

It's not going to be easy. For these ideas to reach fruition, several substantive actions are required.

All of us must change our perspective on weapon systems. The number of people in this country who are concerned about weapon systems, pro and con, is much larger than the number who are searching for critical deficiencies. This is an imbalance in motivation that we must change. We should avoid taking an advocacy position on weapon systems until we have evaluated our relevant deficiencies. When I say "all of us," I mean those in the Office of the Secretary of Defense, our key military men, and those in industry.

All of us must take on the responsibility of searching for, validating and proposing approaches to eliminating military mission deficiencies. A weapon system born of a critical deficiency should be more economical in the truest sense of the word.

To accomplish this, the Military Services and industry must completely understand the evolutionary process by which the actual hardware emerges. A marketing analysis, rather than a selling approach, now becomes necessary. A more "top-down" rather than "bottom-up" philosophy is required. We must organize around problems as well as solutions.

Sure, it's fiendishly difficult; the system tends to discourage you, but over a period of 2 or 3 years the mistakes will be visible whether you like it or not, so it is best to do it right from the start. (Italics added.)

The record is clear that, where the Secretary of Defense believes there is a deficiency, he will fund an attractive solution. Secretary Packard demonstrated this in his support of the Air Force's defense-suppression programs, the Navy's Condor missile, and the Army's guided artillery rounds.

We can institutionalize this approach by providing suitable incentives. When we perceive deficiencies at the OSD (Office of the Secretary of Defense) level, we will initiate efforts to eliminate them. The use of IR&D (independent research and development) funds to find ways of correcting critical deficiencies will now receive preference over their use to develop technology for its own sake.

The sort of positive action I am advocating will require constant effort to overcome the inertia of bureaucracy. I see that inertia every day. The fundamental thoughts behind the DCP (development concept paper), the DSARC (Defense Systems Acquisition Review Council), prototypes, design-to-cost and fly-before-buy practices, and new initiatives are sound.

With the passage of time, however, these good things are sometimes used as means to other ends—to delay a program or to bury the real issues in paper and procedures. But, because we are convinced of the soundness of these approaches, we are determined to smoke out ulterior motives, distortion and inadequate work and continue doing a better job.

We need to change attitudes in the DoD so that the good things about wartime ad hoc approaches can be preserved and adopted where appropriate. We need to do problem-solving with groups of smart people—teams that organize, solve problems, and dissolve—clearing the way for new teams and new problem-solving. Of course we will continue unrelentingly our major efforts to streamline the process of weapon-system acquisition, following Dave Packard's principles.

We must continue our efforts to preserve, nurture and apply the technology proven in Vietnam. We must be able to provide competent, continuing net assessment to maintain a clear picture of

(Continued on page 18)

Pressure Measurement in a High-Temperature Environment

By Henry A. Pontious and Clifford Bevelheimer
Technical Support Directorate, Picatinny Arsenal.

Capabilities of experimental ammunition to withstand long-term environmental conditions at worldwide storage areas are under investigation by engineers of the Technical Support Directorate at Picatinny Arsenal, Dover, N.J.

Results of the experiments are helping to assure that munitions are designed to function properly even after many years of peacetime storage.

Pressure buildup has been found to be one of the major problem areas in storing certain munitions. Standard environmental testing capabilities at the arsenal have been augmented recently by accurate measurement of this pressure buildup under extended storage testing in either a natural or a man-made high-temperature environment.

In natural environments such as hot desert areas, temperatures on exposed metal surfaces frequently have exceeded 140° F. in the experiments. Accelerated testing in environmental chambers subjects both the test item and the transducer to much higher temperatures.

In laboratory and in field tests, it has been demonstrated that even high-precision, temperature-compensated, pressure-transducers may show instability of as much as several percent of full-scale output under these conditions. National Bureau of Standards, Technical Note 497, "The Effects of Extended High-Temperature Storage on the Performance Characteristics of Several Strain-Gauge Pressure Transducers," provides data on the instability of a small sample of several types of pressure transducers under high-temperature storage conditions.

The Army's problem was to determine and overcome the transducer characteristic changes for a large-scale test program. After some preliminary small-scale tests, a total of 60 (plus a few spare) bonded, strain-gauge, flush-diaphragm transducers were purchased from a single manufacturer. Forty were 1,000 psi capacity and were standard catalog items with the specifications given in Table 1. Twenty were 100 psi capacity of the same type, but were a nonstandard range item.

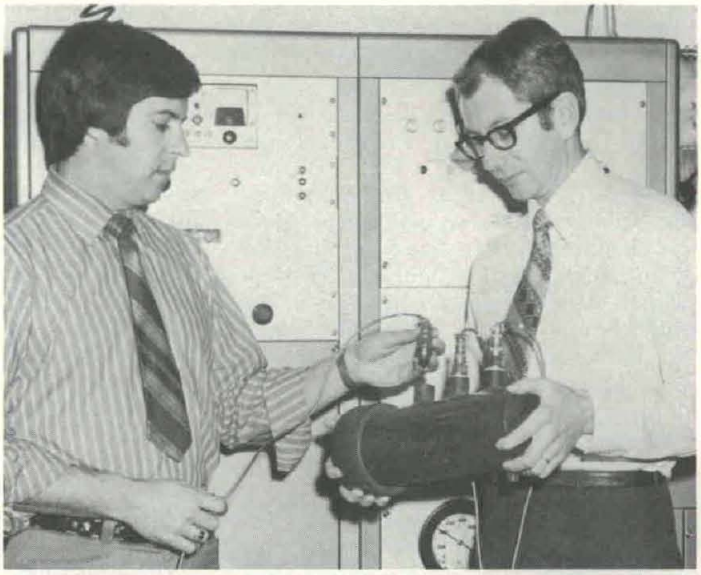
TABLE 1

Manufacturer's Transducer Specifications for 1000 psig Transducers

Range: 0-1,000 psig
Sensitivity: 3mv/v nominal
Excitation: 10v dc or ac recommended
Input impedance: 350 ohms nominal
Output impedance: 350 ohms nominal
Operating temperature: —100° F. to +275° F.
Compensated range: 0° F. to +200° F.
Thermal sensitivity shift: Less than 0.01% full-scale F.
Thermal zero shift: Less than 0.01% FS/° F.
Non-linearity Hysteresis: Within ±0.5% FS
Repeatability: Within 0.1% FS

Test Procedure. The transducer evaluation procedure consisted of an initial series of transducer characteristic measurements, an 8-week temperature cycling with periodic calibrations, and a final series of characteristic measurements. Principal measurements taken during these periods were zero output, sensitivity, thermal zero shift, and thermal sensitivity shift. The 8-week temperature cycling was conducted essentially as follows:

On Monday morning, all transducers were calibrated at room temperature (approximately 75° F.) after which they were brought up to 175° F. and held there until Friday. On Friday afternoon, all transducers were calibrated while still at 175° F., and then allowed to cool to room temperature and remain for the weekend. This cycle was then repeated for a total of eight consecutive cycles. Excitation voltage of 10 vdc was applied continuously for the eight weeks.



THE AUTHORS, Clifford Bevelheimer (left) and Henry Pontious, assemble transducers into an experimental test cylinder used to monitor pressure changes when subjected to extended temperature cycling in environmental chamber at Picatinny Arsenal.

Tests were conducted with the transducers mounted in pipe manifolds inside an oven. All transducer signal and manifold pressure lines were brought out through the oven walls to allow calibrations to be made on all transducers of each capacity while under temperature conditioning.

Oven temperature was monitored and regulated with thermocouple controllers. An automatic beam-balance type pressure calibrator was used to pressurize the transducers for calibration tests, and a digital millivolt meter was used to measure transducer outputs.

Test Results. One pressure transducer became defective early in the initial tests with an open circuit and was replaced. Thereafter, all transducers functioned satisfactorily to the end of the test. Data on the principal transducer characteristic changes investigated over the 8-week temperature cycling are shown in Figures 1 through 4. Results are plotted on a cumulative basis, with the ordinate reading the number of transducers measuring greater or less (reading up or down as required) than the abscissa value.

Ambient Long-Term Zero Change. Figure 1 shows the ambient (75° F.) zero change at the end of one week and at the end of eight weeks of temperature cycling. After eight weeks, for example, five of the 1,000 psi transducers had shifted negative by more than 0.5 percent and one had shifted positive by more than that amount. Fourteen of the 100 psi transducers shifted negative by more than 0.5 percent and one shifted positive by more than that amount. Fourteen of the 100 psi transducers shifted negative by more than 0.5 percent and one shifted positive by more than that after eight weeks.

Zero changes in the 1,000 psi transducers during the eight weeks varied from +1.1 to —0.4% full-scale (FS) (+11 to —4 psi) after only one week, and +2.6 to —1.3% FS (+26 to —13 psi) after eight weeks. Changes in the 100 psi transducers ranged from +0.1 to —2.0% FS (+0.1 to —2.0 psi) after one week, and +2.1 to —2.7% FS (+2.1 to —2.7 psi) after eight weeks.

Thermal Zero Shift. Of the forty 1,000 psi transducers, four exceeded the manufacturer's specifications of less than 1.0%FS/100°F. (0.01%FS/°F.) for thermal zero shift both be-

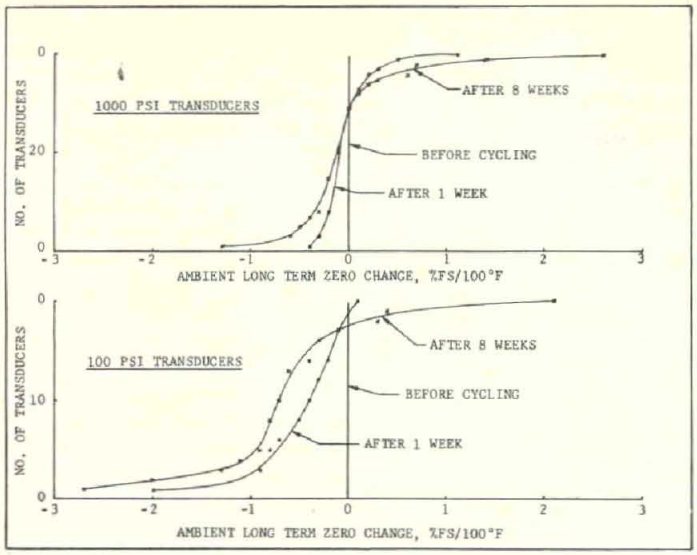


Fig. 1. CUMULATIVE FREQUENCY DISTRIBUTION on the ambient long-term zero change of forty 1,000-psi transducers and twenty 100-psi transducers under 75° F. to 175° F. cycling test.

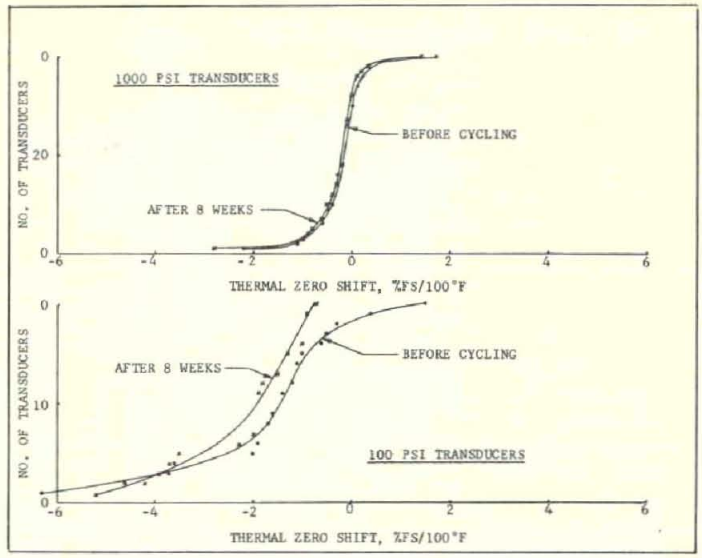


Fig. 2. CUMULATIVE FREQUENCY DISTRIBUTION on the thermal zero shift of forty 1,000-psi transducers and twenty 100-psi transducers under 75° F. to 175° F.

fore and after the test. Stability of this characteristic, however, was good for all 40 transducers as shown in Figure 2.

The largest change in the thermal zero shift factor occurring at any time during the eight weeks was 0.6%FS/100° F., and the average change was less than 0.2%FS/100° F. Figure 2 shows much greater variations, however, in the 100 psi transducers. Most of these transducers exceeded 1.0%FS/100° F. thermal zero shift both before and after the test. Thermal zero shift values ranged from —6.3 to +1.5%FS/100° F. initially, and from —5.2 to —0.7% FS 100° F. at the end of the test. Changes in this factor due to the temperature cycling were also much greater, varying from —4.5 to +1.7%FS/100° F.

Ambient Long-Term Sensitivity Change. Figure 3 shows that relatively small changes were found in the ambient sensitivity of most transducers of both capacities during the cycling tests. All of the 1,000 psi transducers and all but two of the 100 psi transducers changed less than 0.25% FS. The two larger changes were 0.35 and 0.95% FS.

Thermal Sensitivity Shift. In reviewing Figure 4, all 1,000 psi transducers were within the manufacturers' specifications of less than 1.0% FS/100° F. (0.01% FS/°F.) thermal sensitivity shift both before and after the 8-week temperature cycling.

The largest change in this factor was 0.30% FS/100° F., and only one transducer sensitivity factor shifted in the negative direction. Three of the twenty 100 psi transducers had a thermal sensitivity shift greater than 1.0% FS/100° F. before the cycling and three also exceeded that level afterward. One transducer sensitivity shift changed by —1.10% FS/100° F., and all others changed in the positive direction by amounts of 0.07 to 0.90% FS/100° F.

The most significant characteristic changes occurred early in the test period. Average data values are given in Table 2 for transducer characteristic changes during both the first four weeks and the second four weeks of cycling tests.

Changes in some parameters are found to be small and nearly the same for the two periods, while others with large changes during the first four weeks are shown to be greatly reduced for the second four weeks.

(Continued on page 14)

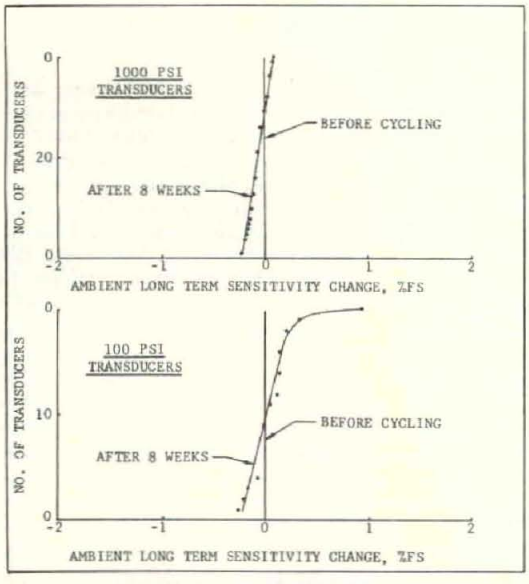


Fig. 3. CUMULATIVE FREQUENCY DISTRIBUTION on the ambient long-term sensitivity change of forty 1,000-psi transducers and twenty 100-psi transducers under 75° F. to 175° F.

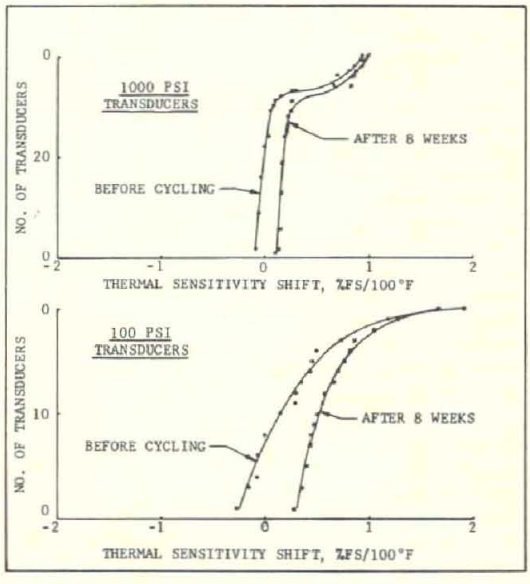


Fig. 4. CUMULATIVE FREQUENCY DISTRIBUTION on the thermal sensitivity shift of forty 1,000-psi transducers and twenty 100-psi transducers under 75° F. to 175° F.

Pressure Measurement

(Continued from page 13)

TABLE 2
Average Transducer Characteristic Changes of Forty 1,000 psi Transducers and Twenty 100 psi Transducers Under 75° F. to 175° F. Temperature Cycling Test. (Numbers were averaged without regard to sign)

	First Four weeks		Second four weeks	
	1000 psi	100 psi	1000 psi	100 psi
Ambient long-term zero changes, % full-scale (FS)100° F.	.29	.93	.09	.16
Changes in thermal HP zero shift, %FS/ 100° F.	.10	.91	.07	.31
Ambient long-term sensitivity change, %FS	.09	.21	.09	.12
Change in thermal sensitivity shift, %FS	.10	.29	.08	.28

Data from these tests show, in general, a smaller %FS change in the measured characteristics for the 1,000 psi transducer than for the 100 psi transducers. The parameters showing the largest change during the first four weeks, and the biggest improvement during the second four weeks, were ambient long-term zero and thermal zero shifts on 100 psi transducers.

A significant improvement is also seen in the long-term zero change on the 1,000 psi transducers. Sensitivity changes were generally smaller than zero changes, and it was found that many transducers with larger sensitivity changes during the first four weeks recovered somewhat the second four weeks.

Many of the smaller changes measured in these tests are within the calibration and measurement accuracy of the test equipment and the repeatability of the transducers. These numbers are given for reference and for completeness of the data. No attempt was made to define precisely the various small error components (less than 0.15%FS) in these tests; only the larger errors caused by long-term characteristic changes were of interest in the test application.

Summary. Gradual changes occur in the operating characteristics of strain-gauge transducers when they are subjected to elevated temperature conditions, even though these temperatures are well within the manufacturer's specified temperature compensated range. These changes may result in measurement errors greater than allowed to the manufacturer.

Characteristic changes vary from one transducer to another, and may be positive in some and negative in others, even under the same conditions. The largest changes generally occur during the first week or two, and then begin to stabilize, so that after several weeks less transducer characteristics change.

The special procedures used in these tests were highly effective in eliminating unsuitable transducers and in increasing the stability, and therefore the accuracy, of transducers to be used for highly critical long-term environmental tests. These procedures may be used for other applications requiring accurate pressure measurements under long-term elevated temperature conditions.

MATERIEL ACQUISITION . . .

Army Materiel Command's BG Meyer Details Six Basic Policies

Addressing the Armed Forces Management Association at a recent meeting in Washington, D.C., U.S. Army Materiel Command Director of Research, Development and Engineering MG Stewart C. Meyer discussed "Materiel Acquisition in the Army." He outlined six basic acquisition policies, as follows:

Faced with increasingly complex materiel systems that have been taking longer to develop and have included sharply increased costs, the Department of Army and AMC have been seeking ways of acquiring those systems more quickly and economically.

During the next few minutes, I will be discussing with you the new materiel acquisition guidelines contained in Army Regulation 1000-1, which sets forth six basic policies for systems acquisition in the Army.

The First Basic Policy is Shortened Requirements Generation Time. In the new approach to materiel requirements generation, any major command or staff element in the Army or any industry/contractor source can state a materiel requirement and submit it to HQ Department of the Army.

These requirements are called ROCs (Required Operational Capability). In approximately four pages, they contain the statement of need, time frame, threat/operational deficiency, operational/organizational concept, essential characteristics, technical assessment and cost assessment.

The ROC provides a simple concise statement of the required operational capability which HQ Department of the Army can process to an early decision. It avoids entirely the preparation of detailed, initial requirements documents, with supporting documentation, prior to obtaining a review of the required operational capability and a DA decision based on competing priorities.

ROCs for major systems are approved by the Army Chief of Staff who, simultaneously with approving the ROC, also directs the formation of a HQ DA task force composed of the materiel developer, combat developer, user and DA staff members.

The task force is responsible for the expeditious preparation of a draft development concept paper (DDCP), a concept formulation package (CFP), and a final report which contains elements of the development plan (DP). Supported by Army agencies and commands as necessary, it is disbanded on order of the Army Systems Acquisition Review Council (ASARC), upon completion of its assigned tasks. At this time a project manager assumes responsibility.

The advantages of ROC procedures are:

- Improve the facility for all responsible sources to submit requirements.
- Reduce time necessary to prepare the requirements document.
- Provide for early HQ Department of the Army review and decision.
- Through the use of the task force, minimize the time consumed while increasing control and emphasis on the definition of materiel requirement performance characteristics and supporting analysis for selection of technical solutions.

The Second Basic Policy is High-Level Decision-Making. For major weapon systems, decisions will involve the top managers of the Army, who will participate personally in face-to-face deliberations.

The Department of Army has, through establishment of the Army Systems Acquisition Review Council (ASARC), formalized its facility for conducting reviews and providing decisions on all major systems acquisition. It is similar to the Defense System Acquisition Review Council (DSARC).

The ASARC is designed to provide for Department of the Army reviews and decisions based on a project manager's briefing supported by a draft development concept paper (DDCP). Such reviews will normally be conducted at ASARC I, II, IIa and III program milestones.

Members of the ASARC who will participate in face-to-face deliberations to arrive at decisions are the Vice Chief of Staff, Assistant Secretary of the Army (Financial Management), Assistant Secretary of the Army (R&D), Assistant Secretary of the Army (Installations and Logistics), Deputy Under Secretary of the Army (Operations Research), Assistant Chief of Staff for Force Development, Comptroller of the Army, Chief of R&D and the Deputy Chief of Staff for Logistics.

Program reviews and required decisions for non-major systems will be accomplished by in process reviews (IPRs) and be the responsibility of the materiel developer such as AMC, with the exception of those non-major systems for which the Department of the Army specifically decides to retain IPR approval authority.

The Third Basic Policy is Shortened Development Time. The materiel acquisition guidelines set forth the goal of approximately six years from entry into the validation phase to attainment of initial operational capability. I will touch on the essential factors.

(Continued on page 21)

SCAMP . . .

Frankford Arsenal Automates Small-Caliber Ammunition Tests

By James D. Nicolo*

Completely automated ballistic testing for the Small-Caliber Ammunition Program (SCAMP) has been installed at Frankford Arsenal, a U.S. Army Materiel Command facility in Philadelphia, Pa., it was announced recently following four months of extensive testing.

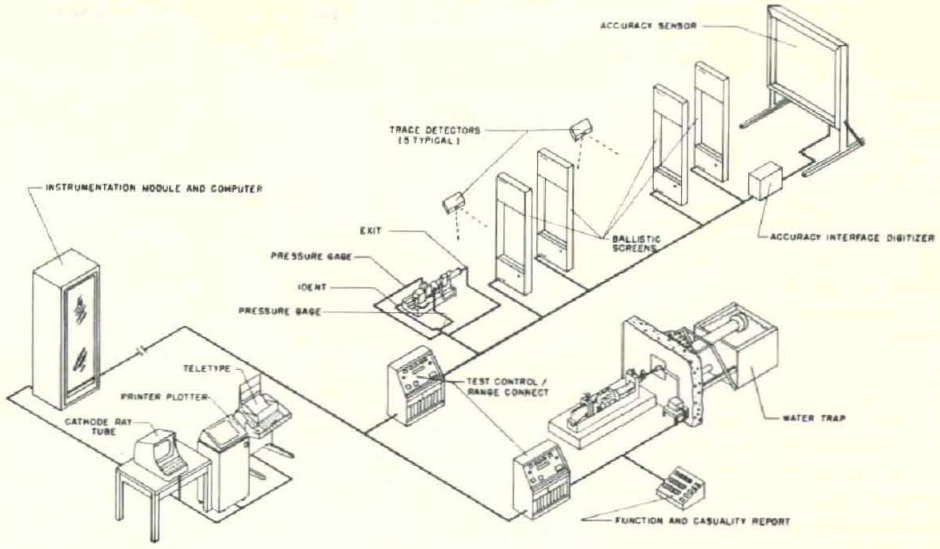
Thousands of rounds of ammunition have been tested on the Ballistic Test Submodule (BTSM) with satisfactory results during the acceptance and "debugging" period. The BTSM offers, for the first time, an integrated production test and data processing system capable of testing simultaneously different caliber ammunition in several ranges.

This capability assumes great significance when considering the modernization of small-caliber ammunition plants where new generation production equipment will manufacture and package ammunition in a continuous high-speed process. Testing to assure product quality must therefore be performed in the shortest time possible to avoid delays in packaging ammunition.

Instrumentation is housed in two basic range types. On one range, testing is performed to evaluate functional performance of the ammunition in an actual weapon. The other range has various sensors located on the test weapon and along the projectile flight path for detection and measurement of different ballistic parameters, including pressure, velocity, trace and accuracy.

To measure ballistic gas pressures, the system employs piezoelectric-type transducers contained in the test weapon barrel at two points along its length. After propellant ignition and subsequent burning, voltages generated by impingement of the gases on the transducer are used to determine peak pressures as well as pressure-time relationships.

Measurements of projectile velocity use photoelectric screens located at fixed distances along the flight path. As the projectile passes through each screen, it is sensed by interrupting the photoelectric plane. Velocity can be computed by electronically measuring the time it takes for the projectile to travel from one screen to the other. The BTSM is designed to employ a 4-screen arrangement for increased system reliability.



FRANKFORD ARSENAL Automated Ballistic Test Submodule

To evaluate performance of tracer ammunition, the system employs light detectors placed at various points along the projectile flight path. Since visual observation is the usual method of trace evaluation, the BTSM method offers significant savings in manpower. Using photodiodetype detectors, the increase in light intensity caused by the ignited tracer mix in the rear of the bullet can easily be detected as it passes each detection unit. Debugging and acceptance testing indicated that this method of trace detection is more reliable than human observers.

Accuracy measurement is accomplished with a system using four aluminum acoustic rods arranged to form a 4-foot target area through which the projectile passes at some distance from the test weapon. Acoustic sensors at the ends of each rod sense the shock waves generated as the projectile passes through the target area.

Using the difference in actuation time between the sensors on each rod and the speed of sound in the rod material (aluminum), the actual coordinates locating the projectile in the target area can be computed. The horizontal rods serve to establish the X coordinate and the vertical rods are used to establish the Y coordinate. Since the system can operate using two rods, the 4-rod system provides increased system reliability.

During final acceptance testing, it was determined that the BTSM is accurate to .01 inches when compared with the current method of using paper targets.

Range control is provided through specially designed units linking the test ranges with the computer. The units are used for converting sensor analog signals to digital format and inputting the type of test to be performed and the type of ammunition. They also provide the means for remote firing of the weapon, and alert the test technician of problems that could be a safety hazard.

A very important design feature of this unit is that it stores all data taken from each shot until the computer is free to receive it. This feature provides for independent range-computer operation, greatly improving system efficiency.

BTSM data-processing equipment includes a minicomputer, CRT terminal and high-speed printer-plotter. Capable of handling up to 13 ranges and 10 different types of ammunition, the computer takes data from the ranges, possibly running different types of tests on different kinds of ammunition, tabulates the data, compares it to known standards and prints out the results, all in "real time." Plots of accuracy dispersion and pressure/time curves are given.

With the successful delivery of the BTSM, officials of the Small-Caliber Ammunition Modernization Program report they are now in a position to fulfill plans for equipping small-caliber plants with completely automated ballistic test systems.

* *Mechanical engineer, Modernization Engineering Branch, Manufacturing Technology Directorate, Frankford Arsenal, Pa.*

Out of the Technological Eggshell . . .

Combat-Proved Helicopters of Southeast Asia Conflict Pacing Emergence of New Family of Advanced Aircraft

By BG William J. Maddox Jr.

Which came first, the chicken or the egg? Throughout time that question has provoked controversy. In the U.S. Army, the question is very similar: Which comes first, the concept or the hardware?

In the aviation business, the concepts and the hardware are well scrambled—no pun on the egg sequence is intended. What we do know is that the helicopter pecked its way through the technological eggshell and appeared before the world in an operational state during World War II. The concepts for employment of the helicopter in the World War II environment were markedly different from the concepts that made the helicopter a central figure in the Vietnam war.

Relative to hardware, as we look back on the career of the helicopter, we find that the 1940s constituted a period of emergence, the 1950s a period of expanding technology and improvisation, and the 1960s a decade of combat-proof operations and preparation for a completely new generation of hardware.

Conceptually, the period of emergence looked to the helicopter for its medical evacuation and command and control applications—with a prospect of a limited troop carrier role in areas well behind the front lines. Some visionaries in the U.S. Army and the Marines considered that the helicopter might even assault hostile beaches and shuttle infantry troops into jump-off locations along the forward edge of the battle area.

The improvisation period brought the first stirrings of what is now the airmobility concept. The Korean war showed many people that more use could be made of helicopter technology. Visionaries experimented with then current airframes, and infantry machineguns and rockets.

Consequently, the prospect that the helicopter could perform all five functions of land combat became clearer. If the helicopter could perform reconnaissance, command and control, logistics, and that inseparable team of firepower and maneuver, then self-contained airmobile forces were a possibility.

If this concept could be achieved, the combat capabilities of the individual soldier and the military unit could be dramatically expanded. The long approach march to the objective area for the infantrymen could be remarkably shortened. This, then, would result in a fresh soldier arriving in battle ready to fight without having to undergo the attrition of enemy fire as he approached the point of decision.

Almost everyone in U.S. Army aviation knows that the Howze Board, under the chairmanship of General Hamilton H. Howze, set the conceptual framework for what we now know as airmobility. This occurred in 1962, the same year that the U.S. Army conducted its first combat assaults in Vietnam. The ensuing combat-proof decade pretty thoroughly established that the helicopter was a sine qua non for the Vietnam war.

Where the French had failed, in the 1945–1954 period, to close with and destroy the enemy, the helicopter now made the difference. On the ground the French ran the roads with their *groupes mobile* and usually fought from fixed strongpoints. The problem of closing with the Viet Minh often was not overcome. Aerial mobility was accomplished by parachutists who immediately lost their mobility when they reached the ground.

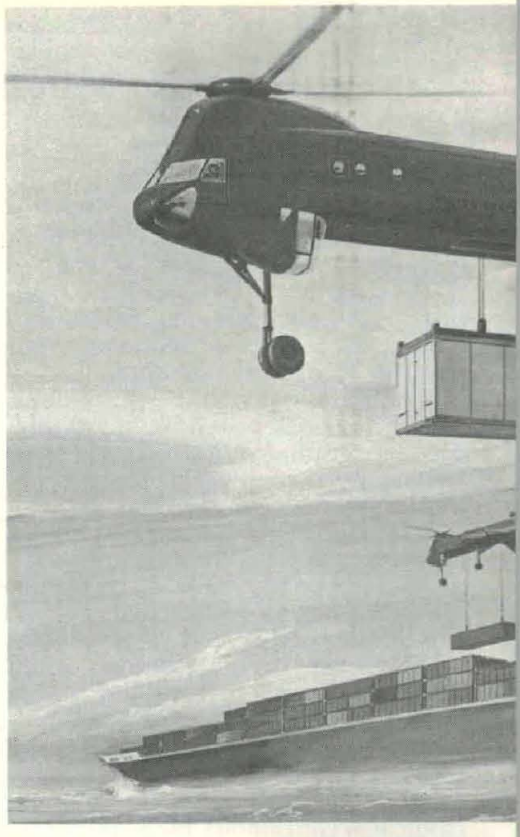
It was this lack of ground mobility and the limited airmobility of the French that helped the Viet Minh to set the stage for the decisive battle of the war at Dien Bien Phu.

In the 11 years that the U.S. Army practiced airmobility in Vietnam, no U.S. battalion-size element was ever cut off and over-run. When a fire base or a patrol base was established, the ground troops had the benefit of reconnaissance by observation helicopters, of firepower from helicopter gunships, of resupply and evacuation by aerial cranes, command and control, logistics, reinforcement capability, and medical evacuation by the Huey helicopter.

The first helicopter gunships were the Huey "A" models, which were provided to give troop-carrying helicopters protection during combat assaults. The A model, incidentally, performed a triple function. It maintained surveillance around deployed troops, scouted landing zones before suppressing them, and also provided firepower.

Early combat experience showed that a helicopter designed for the delivery of ordnance was needed. The outgrowth was the COBRA attack helicopter. To accomplish the reconnaissance mission, a true scout helicopter was selected. Together the COBRA and the light observation helicopter, or "scout," became the heart of the air cavalry team.

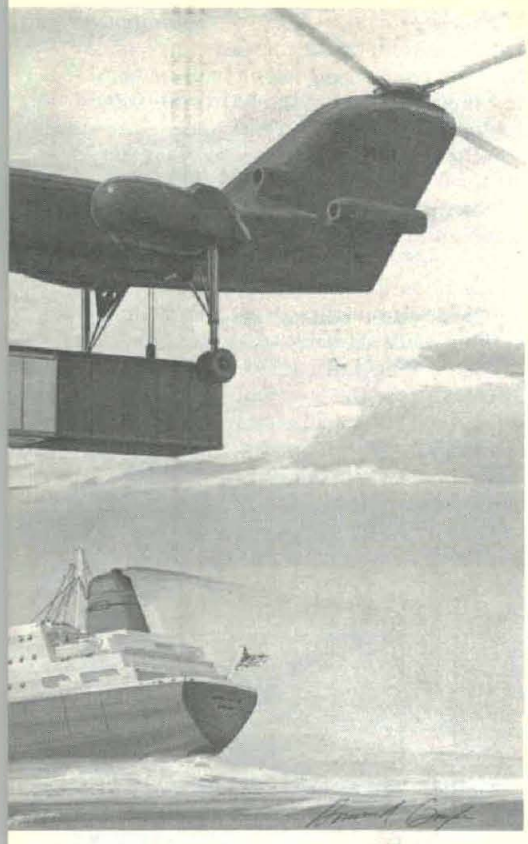
Combat statistics show that this cavalry team caused more contact with enemy forces than any other means on the battlefield. Where the infantryman had to search for contact, the air cavalry team was an essential ingredient. During this decade of combat proof, the hardware was often generated from deficiencies of equipment already in use.



Boeing Heavy Lift He

Based upon the 11 years in combat in Vietnam, the U.S. Army has amassed some strong opinions for the equipment that it will need for the 1980s. While no new, exhilarating concepts have been evolved for the future, the Army has done a great deal of thinking about the requirements for battlefields different than Vietnam. The concepts generally remain firm but the need for material improvement becomes more stringent.

Sikorsky UTT



ter (artist's concept)

We anticipate a more sophisticated environment where we may be dealing with armor heavy forces protected by accurate radar-directed antiaircraft weapons. Such an enemy could well be found in Europe but might also be located at other points of confrontation. It should be noted that the 1972 North Vietnamese offensive utilized highly modern equipment which had not appeared on previous battlefields.

Before the new aircraft developments for the 1980s are discussed, it would be well to review the important question of survivability. The helicopter often is accused of being highly vulnerable because it appears to be more fragile than conventional ground combat equipment.

S-70 (mock-up)

In Vietnam the statistics show that the helicopter survived and fought effectively in any level of combat activity. When the intensity of combat increased, as it did in the Ashau Valley in 1968, and in Laos in 1971, losses were up.

Proportionately, however, the helicopter losses did not go up higher than losses of conventional artillery, armor and infantry equipment.

For the 1980s, the U.S. Army has three major developments under way, with one new requirement standing in the wings in hopes of getting approval next year.

The first of these is the Utility Tactical Transport Aircraft System, or UTTAS, which went on contract to Boeing-Vertol and Sikorsky last August. This aircraft is to be the Army's first true aerial squad carrier. It is designed to carry 11 fully equipped infantrymen and their crew-served weapons, plus a helicopter crew of three.

The UTTAS performance will be a capability to hover out of ground effect at 4,000 feet on a 95°F. day and climb vertically at 500 feet per minute.

The engine for such a powerful craft was developed during the Army's advanced technology program, terminating in a competition won by the General Electric Co. Its T-700 engine will be utilized in a twin configuration on the UTTAS. The first engine is scheduled to be tested in March and no major problems have been encountered to date.

Reliability and maintainability are the key objectives of the UTTAS program because its development was based on the lower life cycle costs of the UTTAS as compared to a fleet of inventory helicopters with the same lift capacity. Field maintenance on the engine will be accomplished with only 10 common tools. This is 6 percent of the standard issue tool box. Standardized engine components will permit component replacement in the field without removing the engine from the aircraft.

The UTTAS engine is smaller, consumes less fuel per shaft horsepower and weighs less than current engines of the same power range. Incidentally, each engine will produce 1,500 shaft horsepower. The UTTAS also will provide a 40 percent increase in speed and range over current lift ships.

The airframe boasts improved materials, designs and lubricants, which should provide a 300 percent increase in component life expectancy. Periodic maintenance inspections now performed each 100 hours will be extended to 300 hours.

With UTTAS, a 170 mph infantryman will become a reality. Thus, the UTTAS is one of the Army's "big five" priority items.

ANOTHER MEMBER of the Army's big five family is the Advanced Attack Helicopter, known as the AAH, which is now undergoing source selection. Proposals have been received from Bell Helicopter Co., Boeing-Vertol Co., Hughes Helicopter Co., Lockheed California Co., and Sikorsky Aircraft. The source selection to pick two winning contractors should be completed by late May.

The two winners will fabricate air-

(Continued on page 18)

BG (MG designate) William J. Maddox Jr. has served since September 1970 as Director of Army Aviation, Office of the Assistant Chief of Staff for Force Development (ACSFOR), HQ DA.

Enlisting in the horse Cavalry in 1942, he received a commission upon graduation from Officer Candidate School in 1944. Following World War II he received an Army Liaison Pilot rating.

After two tours of duty in Korea, BG Maddox was assigned to Japan in 1954 as flight detachment commander for the Military Assistance Advisory Group and as aviation adviser to the Japanese Ground Defense Force. During 1961–64 he was plans officer in the Office of the Chief of R&D, HQ DA.

Assigned to Vietnam in 1965, he assumed command of the 13th Aviation Battalion (Delta Battalion) supporting the IV Vietnamese Corps in the Mekong Delta. During this period the Delta Battalion won the U.S. Presidential Unit Citation, the Vietnamese Cross of Gallantry with Palm and the Vietnamese Fouragerre of the Army Colors.

Extending his tour in Vietnam, BG Maddox then served as senior adviser to the 21st Infantry Division of the Vietnamese Army, commanded the 3d Brigade, 25th Infantry Division, and was later assigned as CO, 164th Aviation Group in the Mekong Delta.

Prior to assuming his present duties he was special assistant to the Director of Army Aviation, ACSFOR.

BG Maddox earned a BA degree in journalism from Michigan State University in 1957 and a master's degree in international relations from George Washington University in 1965. He has completed the Army Command and General Staff College, National War College, and the DoD management systems course.

His military honors include the Silver Star with three Oak Leaf Clusters (OLC), Legion of Merit with four OLC, Distinguished Flying Cross with seven OLC, Soldier's Medal, Bronze Star Medal with "V" device and three OLC, Air Medal with "V" device (127 awards), Army Commendation Medal with "V" device and two OLC, and the Purple Heart with three OLC.

Combat-Proved Helicopters of Southeast Asia Conflict Pacing Emergence of New Family of Advanced Aircraft

(Continued from page 17)

frames for competitive flyoff in 1975, leading to a further source selection for a single contractor to perform systems integration. The AAH will include night-vision instrumentation for pilot navigation and copilot gunner target acquisition and destruction. Mounted with a 30mm automatic cannon, the TOW missile and aerial rockets, the aircraft will be a heavy tank killer.

The AAH will be somewhat less capable than the CHEYENNE helicopter, which was terminated last summer because of high estimated production costs. However, the AAH should be procured for about $1 million less per aircraft, as insured by a $1.4 to $1.6 million design-to-cost objective for recurring production costs.

As a further means of keeping costs within this goal, contractors have been authorized to deviate from the stated performance characteristics, providing a cost-effectiveness advantage accrues to the government.

Army aviation program leaders believe that this cost goal and deviation authority will allow sufficient flexibility for innovative approaches, and provide the most effective AAH at the best cost.

Performance characteristics of the AAH are similar to those of the UTTAS so that the two aircraft should be compatible on the battlefield. Until the AAH is fielded, the Army will depend upon another development now under way. This is the integration of the combat-proven TOW missile into the COBRA airframe.

The TOW was successfully demonstrated in combat last spring when it destroyed 27 tanks and numerous other hard targets in the Kontum and Quang Tri areas of Vietnam. However, the two aircraft mounted with the TOW system were both old UH-1 R&D aircraft. The COBRA is the Army's first-line attack helicopter, combat proven throughout the past five years.

To perform the heavy logistics functions in a theater of operations, the HLH (Heavy Lift Helicopter) development is under way at Boeing-Vertol Co. The project is in the advanced component development stage for the rotor system, the power train, and the cargo handling gear. A contract was signed in January with the contractor to tie the components together in a single prototype aircraft scheduled for flight in August 1975. Power will be provided by three 8,000-shaft horsepower engines manufactured by Detroit Diesel Allison.

The U.S. Army HLH will have a vertical-lift capability greater than the Russian MI-12 helicopters, the world's largest, and more than twice the lift of our current helicopters. The HLH, a tandem-rotor machine, is designed to lift a 22.5-ton payload in two 25 nautical mile radius round trips under stringent weather conditions. The aircraft must hover out of ground effect at sea level on a 95°F. day.

HLH development under way will provide the Army with a vertical-lift capability far greater than any of our current helicopters, including the CH-54A "Flying Crane," shown above sling-lifting a 2½-ton truck.

Utilization of the HLH will be primarily in logistics tasks at ports, airfields and depots. It should help to solve the port congestion problem because it will be able to move standard milvan containers directly from ships in the roadstead to dispersed locations ashore. It should also interface with the C-5 and other heavy transports for airfield clearance.

Among the HLH exciting advanced concepts will be a quadruple-redundant, fly-by-wire flight-control system that will electronically transmit control inputs. No mechanical back-up system is contemplated.

The Boeing-Vertol program will demonstrate a scaled-down version in the Model 347 CHINOOK next fall. Elastomeric bearings will be utilized in the rotor hub to reduce the number of parts by two-thirds over current systems. Stall flutter damping and redundant load parts will be utilized to assure 100 hours of operation in event of failure. This aircraft undoubtedly will have commercial application after it has demonstrated its capability to move almost all types of military equipment in the inventory.

AERIAL SCOUT. Standing in the wings, awaiting approval, is the aerial scout. The Army expects to conduct concept formulation for a light observation-type helicopter which will be optimized for the air cavalry and artillery observation role. The aircraft should contain target-acquisition equipment and a night-vision capability to permit it to operate in team with the Advanced Attack Helicopter on a round-the-clock and adverse weather basis.

Precise outlines of the development at this time must await a task force effort but the conceptual people can be thinking hard about how the hardware should look and act.

While the U.S. Army is busy on a HELLFIRE laser-guided missile, a tilt-rotor advanced development effort, and numerous items of airmobility equipment, the main outlines for airmobility objectives of the 1980s are visible in the developments already mentioned.

This leads us back to the egg and the chicken. The best answer to the hardware versus the concepts argument is that once the cycle is started, the hardware and concepts interact to the proliferation of each. This is how the U.S. Army has moved in a few years to an inventory of 12,000 aircraft. This also is how the Army helicopter has become an indispensable member of the Army land battle team.

AH-1G "Cobra," the Army's first-line attack helicopter, will undergo integration of the TOW missile system into its frame.

National Security Objectives . . .

(Continued from page 11)

our national security objectives and the military capability required to attain them.

I am sure that some of you will assume that what I am proposing is simply the eye of another needle that must be threaded on the way to weapon-system development. Not so. We must insure that those concepts which lead to efficient solutions of real deficiencies have a much *easier* path to deployment. The process from decision point to decision point, as ever larger sums of money are approved, must insure that the programs have the proper heritage. These critical steps should be reaffirming to a sound program rather than stultifying.

The only programs that should survive all the way through the acquisition process are those that will remove a critical deficiency or reduce our costs in the future. We need improved performance at fixed cost, and we need existing performance at less cost. But what we *must* have is confidence that national needs are met—without critical deficiencies.

DA Approves Industrial Training Program for Officers

The Department of the Army has recently approved a pilot program to train selected officers with civilian industry for one year in all phases of research and development, management, procurement and supply functions.

Initially, the Training With Industry (TWI) Program will be limited to five officers from each of three closely related officer special career programs—Research and Development, Logistics, and Procurement.

Selection for the training will be made by the Office Personnel Operations, based on qualifications and requirements of positions. It is anticipated that as the program expands applications may be submitted by interested officers.

An officer selected for the training will be assigned directly to a major civilian firm as a working member of the company; he will receive full pay and allowances as well as an authorized PCS move to the industry training.

Service obligation is incurred and R&D personnel who receive this training will subsequently be assigned to project manager positions where their expertise can best be utilized. Participation in TWI does not replace civilian and military education, but is designed to supplement it in the "real world."

Another program initiated in December 1972 was assigning an R&D Officer Program member to the Guided Weapons Systems Course at the Royal Military College of Science in Shrivenham, England. This course is designed to develop an officer's understanding of science and technology and their application to defense problems.

A master of science degree in engineering (guided weapons systems) is awarded upon completion of the course. Selection procedures are in progress to nominate another R&D Program member to attend the course beginning January 1974.

National JSHS to Focus on New Geological Concepts

"The Restless Earth" is the theme of the 11th annual National Junior Science and Humanities Symposium," which will draw six representatives from each of 32 regional JSH symposia throughout the United States to the U.S. Military Academy, May 9-12. About 100 adult junior science symposia leaders, including teachers, will participate.

One of the fascinating newer concepts of science, Plate Tectonics—sometimes termed "the new geology," and the subject of two pioneering studies sponsored by the Advanced Research Projects Agency, Office of the Director of Defense Research and Engineering—will be the focus of major attention.

Both of the reports bear the same title, "Seismology and the New Global Tectonics." Published in November 1968 and October 1969 by the Lamont Geological Observatory of Columbia (N.Y.) University, they have stimulated widespread scientific interest in plate tectonics theory.

Keynote speaker is Prof. William R. Muehlenberger, Department of Geological Science, University of Texas at Austin, who in recent years has added to his scientific reputation as a lunear geologist consultant serving NASA.

The banquet speaker is Dr. Walter Pitman, Lamont Doherty Geological Observatory, Columbia (N.Y.) University, who will discuss polar drift, magnetic forces and various aspects of plate tectonics theory and determinations to date.

Featured in the "science address" is Dr. Tanya Atwater of Scripps Institute, La Jolla, Calif., a young lady who has distinguished herself by her recent work in plate tectonics. Dr. Diskin Clay, professor of classics at Haverford (Pa.) College, is programed to present the humanities address.

COL Lothrop Mittenthal, commander of the U.S. Army Research Office in Durham, N.C., which will sponsor the symposium on behalf of the Army Chief of Research and Development, will give the address of welcome.

Donald C. Rollins, director of the JSHS program, said this year's symposium will set a record for total participation, but that the 1974 meeting will have entries from four additional regions—with new sponsors at Louisiana State University at Baton Rouge, the University of Texas, Indiana State University and the University of Missouri at St. Louis. This addition will extend the JSHS Program to provide representation from states having 77 percent of the U.S. population.

HumRRO Issues FY 72 Publications Guide

The Human Resources Research Organization (HumRRO) has issued its *Bibliography of Publications and Presentations During FY 1972.*

Included are publications by staff members in professional journals and presentations at professional and military meetings. Items are classified under the research code name (Work Unit or Research Project) or under the type of research effort to which they relate.

Additional information may be obtained from: Human Resources Research Organization, 300 North Washington St., Alexandria, Va. 22314

NVL Aids Rescue Efforts At Building Collapse Site

When a section of a 24-story apartment building collapsed Mar. 2 during construction at Bailey's Crossroads, VA, killing 14 workers and injuring 34, the U.S. Army Night Vision Laboratory (NVL) at nearby Fort Belvoir was called for search and rescue operations. The Air Force also provided floodlights designed to illuminate runways.

Using 5 high-powered Xenon searchlights provided through the Army Electronics Command installation, an NVL team of 18 men was on the scene from sun-down to sun-up until Mar. 10 in response to the call from Fairfax County officials. The 24-hour-a-day search for trapped persons was terminated for safety reasons.

Three 1kw searchlights and a 2.2kw light mounted on jeeps and a truck-mounted 20kw light provided enough illumination to enable workers at night to clear the rubble with near-daylight efficiency. With the five Army searchlights operating simultaneously, the minimum-peak-beam candlepower was 1.25 billion.

Four hand-held searchlights also were furnished by the NVL for "spot" illumination of damaged areas.

The NVL effort was coordinated by Lawrence Hyer of the Support and Evaluation Technical Area. Searchlight operations, logistics and maintenance were provided by MAJ Andrew Synnott, SSG Clifford Hightower, SSG Wendell Whitaker, Joseph Walsh, James Miller, Robert Nystrom, Marvin Long, PFC Dale Anderson, Jack Hildreth, Charles Thompson, Richard Seemiller, Carol Cutchall, James Clodfelter, SP5 John Schindel, SP4 William Scoville, PFC Raymond Nagel and PFC Steven Ingram.

Fairfax County authorities expressed appreciation to the Army and Air Force and said that without the lights, operations at night would have been nearly impossible.

Dr. Zahl, Former ECOM Research Director, Dies

One of the most illustrious exemplars and the most outspoken advocate of the challenges and the opportunities of a career in Army science, Dr. Harold A. Zahl, former director of research, U.S. Army Electronics Command, died early in March. He was 68.

In the September 1961 edition of the *Army Research and Development Newsmagazine,* Dr. Zahl authored a long feature article headlined: "30-year Army Career Scientist Cites Government Service Rewards."

Soon after he received his doctorate in physics from the State University of Iowa in 1931, Dr. Zahl embarked on what he often called "the fun and the excitement" of being an Army scientist. He retired in 1966 for "health reasons" but continued as an ECOM consultant to his death.

Dr. Zahl's career was an exciting one, spanning the electronics pioneering developments, the emergence of radar as a critical science in World War II, and the evolutionary growth into the miracles of electronics today.

Two of his inventions contributed importantly to that growth and to the World War II story of radar. The "Zahl Tube," VT-158, pushed radar into the megacycle operating range. His expertise drew him into the early Bikini Islands atom bomb tests, and he assisted in the design of the first U.S. satellites.

Numerous honorary awards came to him for outstanding achievements, including the Harry Diamond Award of the Institute of Electrical and Electronics Engineers. He also was the first Army scientist to achieve the prestige and salary of appointment to a Public Law 313 position—limited by Congress in number and reserved for personnel "who have attained a level of competence and national eminence which make them outstandingly qualified."

Affiliated with numerous professional societies, and a founding member of the Armed Forces Communications and Electronics Association, he served on the national boards of directors of the IEEE and the AFCEA.

Known for many professional journal publications during his career as an Army scientist, and the author of numerous technical reports, he turned to literature as a "second career" following his "retirement" in 1966.

He authored two books, "Electrons Away, or Tales of a Government Scientist" and "Radar Spelled Backwards," both evidencing his zest for governmental intrigue and excitement during World War II and his rollicking humor.

Funeral services in Holmdel, NJ, where he owned a 55-acre farm on which he resided during his long career as an Army scientist, attracted hundreds of associates and many high leaders of research and development.

FLIGHT FOOD . . .
NASA Benefits From Natick Labs' 25 Years of Research

By Mary V. Klicka

Civilian byproduct or "spin-off" benefits from NASA's Manned Space Flight Programs have received considerable publicity—such as medical monitoring systems and miniaturized electronic equipment—but NASA has benefited similarly from U.S. Army food processing and preservation research.

Nearly a quarter century of R&D efforts by the U.S. Army's Natick (Mass.) Laboratories and forerunner organizations, conducted on behalf of all the U.S. Armed Forces, provided the basic scientific know-how for NLABS to respond adequately to NASA's call for special space flight food.

Expertise acquired in developing convenience-type, ready-to-eat packaged foods—designed to meet the rations requirements of military men in any environment in any part of the world—enabled NLABS' scientists to contribute to the rehydratable and bite-size foods used for Project Gemini, in response to NASA's appeal.

While the early Apollo menus, produced by industry under a NASA contract, principally upgraded Project Gemini menus, NASA had expressed a strong desire to increase the variety of foods used on Apollo moon flights.

The opportunity for NLABS to help NASA attain this objective came through the inclusion of a ready-to-eat, flexibly packaged, heat-processed turkey and gravy in the special Christmas meal during Apollo 8.

This meal contained the first nondehydrated food to be approved for Apollo flight consumption. Termed a "wet pack" food by NASA, the turkey and gravy was designed for consumption with a spoon, an innovation that revolutionized the concepts of space feeding.

Credit for the actual formulation and production of the Apollo 8 turkey and gravy as well as the eight additional heat-processed and flexibly packaged wet-meat items used on subsequent Apollo flights goes to food technologist Gendron (Pat) Legris of NLABS.

This NLABS' researcher was able to respond quickly to NASA's needs because he could draw from 10 years of R&D effort, particularly by NLABS' packaging technologists, directed towards attaining flexibly packaged foods for future combat rations.

Incorporation of these foods in Apollo menus preceded their use in military systems. In fact, at present, the techniques for large-scale commercial production of heat-processed meat and cake items in laminated polyolefin-foil-polyester packs are being determined. The work is being done under contract between NLABS' General Equipment and Packaging Laboratory and cooperating industries.

Since the organizations involved in this effort are optimistic regarding the potential of flexibly packaged, heat-processed foods, there is likelihood of additional use in the civilian market.

NASA's cautious start with three pouches of wet-pack turkey and gravy, one for each astronaut on Apollo 8, was extended to a total of 59 pouches encompassing six items (beefsteak, frankfurters, hamburgers, meat balls and sauce, turkey and gravy and beef and gravy) on the Apollo 17 menus. More than 600 pouches of these six products have been prepared for NASA for the Apollo flights and for back-up use.

Not many U.S. Troops who have consumed the Long-Range Patrol Food Packet, the newest of the military special-purpose rations, know that, beginning with Apollo 10, they and the orbiting Apollo astronauts have eaten five of the same entrees.

PROCESSING flexible packaged foods at Natick Laboratories. Inset shows package of turkey and gravy, one of many thermostabilized wet-meat products now in use.

The success of the spoon introduced with the wet-pack meats permitted the consumption of all rehydratable foods, except clear liquids, in a normal manner. NASA has now adopted a special spoon and bowl feeder package. Five Long-Range Patrol entrees were the first rehydratable foods to be packaged in the spoon and bowl feeders.

Constraints of package design limited the NASA serving to about one-fourth the size of the military item. Since NASA's agreements with industry did not cover these entrees, they have been produced at NLABS for each flight.

Richard Helmer, food technologist, merits recognition for this support. He has produced five entrees—beef stew, chicken and rice, chicken stew, pork with scalloped potatoes, and spaghetti and meat sauce—used on Project Apollo.

For the uninitiated, the long-range patrol entrees are all precooked, freeze-dried packs which reconstitute to familiar foods with the addition of either hot or cold water. They are one of the several types of convenience foods now available for Armed Forces' use as a direct result of the Army's pioneering work in the 1950s on freeze drying to attain lightweight, highly acceptable, familiar foods capable of long storage without refrigeration.

Commercial counterparts of some of the items developed for military use are also available in the civilian market.

The design for the spoon and bowl feeder was adapted from an earlier prototype engineered by Gerald Schulz of

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MRS. MARY V. KLICKA is a ration design specialist at the U.S. Army Natick (Mass.) Laboratories with responsibility for the planning and design of operational, survival and special rations for the Armed Forces. In consultation with the National Aeronautics and Space Administration and the U.S. Air Force, she has also been responsible for the development of space and lunar menus for Projects Mercury, Gemini and Apollo.

On a special assignment in 1958, Mrs. Klicka participated in an onsite study of ration problems for the United Nations Emergency Force in Gaza, Egypt. She contributed to development of menus for a unified group of occupying military personnel from various nations and ethnic groups.

The high caliber of her work as an Army scientist for more than 21 years has been recognized by the Department of Defense Distinguished Civilian Service Award, the Department of Army's Meritorious Civilian Service Award, Decoration for Exceptional Civilian Service, and many other awards.

Born in Winnipeg, Canada, Mrs. Klicka received her BS degree in dietetics from the University of Washington (1944) and her MBA degree from the University of Chicago (1947). She has authored more than 25 technical papers in professional journals and is a member of the American Dietetic Association, Institute of Food Technologists, and the Research Society of America.

NLABS' General Equipment and Packaging Laboratory for NASA and the Air Force. As NLABS' consultant to NASA on matters pertaining to packaging, he has also been intimately involved in ascertaining that all heat-processed flexibly packaged foods are tested for compliance with NASA's stringent requirements for packaging and resistance to decompression.

NLABS investigators also have pioneered in the application of ionizing radiation to food preservation. Started in 1953, this research had its first nonmilitary United States application on the Apollo 17 flight. A total of nine pouches of radappertized ham (ham sterilized by ionizing irradiation) were included on the Apollo 17 menus (three per man).

The irradiated ham was produced at NLABS through cooperative efforts of personnel in the Irradiated Food Products Division and the Radiation Sources Divisions. Technical assistance was given by Drs. R. B. Maxcy and T. E. Hartung, University of Nebraska. The irradiation dose for the ham was 3.7 Megarad at $-25° \pm 20°$ C.

A new fruitcake developed and produced by NLABS also made its debut on the Apollo 17 menu. The initial prototype of this fruitcake was developed as a contingency food for use on the Space Shuttle Program. Its nutrient content is being specially engineered so that 700 grams will supply 2,800 calories and meet other dietary standards recommended by the Food and Nutrition Board of the National Academy of Sciences-National Research Council for males 22–35 years old.

Developmental work was initiated by Wayne Swantak, food technologist, and 14 pouches were included aboard the Apollo 17 menu packs. In addition, each astronaut carried in his pocket a pouch of this fruitcake, dubbed "Moon Cake" by NLABS food technologists, at lift-off from Cape Kennedy.

This latter fruitcake replaced the frozen sandwiches provided for the earlier Apollo lift-off snack. Due to the compression from vacuum packaging, this fruitcake is denser than usual.

Cooked in a sealed flexible pouch, it was conceived as a result of R&D on flexibly packaged cake products under development for future combat ration use. Troops of the future won't have to carry a can opener; they'll merely tear a flexible pouch across at its notched end.

Additional military items borrowed directly from current or future military rations, or food packets which have flown on the Apollo menus, include: flexible pouches of peanut butter and cheddar cheese spread, starch jelly bars and enriched sweet chocolate bars with almonds. These items were not produced by NLABS but were obtained from the sources that made them for the military.

No food can be included on any space flight menu without proof of its wholesomeness and assurance of its quality. Consequently, foods produced by NLABS for Apollo menu use required teamwork of many chemists, home economists, food and packaging technologists and microbiologists.

Coordinated efforts of a number of teams assured completion of all necessary chemical, food preference, decompression and microbiological tests. To assure microbiological safety, a special test procedure was prepared by Edmund Powers covering a 20-day incubation and subsequent tests for sterility.

The ultimate civilian use "spin-off" from NLABS R&D to improve military subsistence will not be established for a long time, but results have had far-reaching benefits for NASA space flights.

BG Meyer Details Basic Policies to AFMA

(Continued from page 14)

First, availability of developed components and subsystems is essential and depends on 6.2 exploratory development and 6.3 advanced development effort in progress. Such effort must be the result of accurate prior assessment of the Army's future needs and priorities.

The AMC's FY 74 RDT&E program thrusts are a key factor towards reaching this goal. The next essential factor requires that elapsed time from issue of a request for proposal (ASARC I decision) to development contract award, not exceed six months.

Next, in response to the requirement for test programs to support early decisions, test programs and test plans must be structured so as to provide, within the first six months of testing, data on essential characteristics and interim reports to support major milestone decisions. This will require the concurrent development test II and operational test II prior to ASARC IIa/DSARC IIa (low rate initial production) decision.

For major systems, we will increase the use of competitive prototypes during the validation phase (ASARC I to ASARC II) and, if appropriately justified, in the 6.4 engineering development phase to further offset risks.

Producibility engineering and planning (PEP) and initial production facilities (IPF) will now replace advanced production engineering and are another essential factor to the successful reduction of development time.

In the past, we have experienced difficulty in obtaining funds for advanced production engineering, since Congressional committees associated PEMA (Procurement, Equipment, Missiles, Army) with a production order.

We believe that funding producibility engineering and planning from the RDTE appropriation offers greater assurance of a timely successful transition from an engineering development model to a production item. The hard tooling and long-lead components for the production item, will continue to be funded in the PEMA appropriation.

A final essential factor is that for major systems a shortened development time will require authorization for the contractor to produce the first production quantity.

The Fourth Basic Policy Has to Do With Funding Priorities. This requires that within the Army RDTE appropriation, we must fully fund our top-priority projects so that development time is not lengthened.

Lower priority demands on RDTE funds must be regarded as potential trade-offs for funding support of the Army's designated high priority systems. The highest priority for exploratory and advanced development funding will be accorded to components and subassemblies of future systems that are identified with an approved ROC.

The Fifth Basic Policy is Costs Versus Quantity. The guidelines are that when there is a requirement for sophisticated equipment to provide superiority on the battlefield, this will prove to be expensive and complex.

Therefore, we must, from the outset, explain the costs in terms of required effectiveness for all, or part of the total force, accept the high unit cost, and explain it well in advance to the Office of the Secretary of Defense and then to the Congress. The basic thought here, is do your homework, make your decision, and be prepared to withstand intense scrutiny and challenge from any quarter.

The Sixth and Final Basic Policy is Program Cost Control. The goal is systems development and acquisition within planned budget and a reasonable elapsed time, while meeting technical performance objectives. This requires early use of independent parametric cost estimates and engineering cost estimates during concept formulation.

Toward the end of concept formulation baseline estimates (i.e., acquisition and ownership costs expressed in terms of bands within which the ultimate program cost may fall) are evolved and provide a basis for arriving at "design to" production unit cost goal.

Fundamental to the process is the establishment of constraining cost boundaries for desired levels of performance. This requires the definition of an acceptable region for trade-offs of both cost and performance.

Design to production unit cost reflects a unit cost goal which the Army believes is achievable for the stated levels of performance. It further insures that engineers design and develop an item that will not cost more than the Army can pay for that item.

Design to production unit cost will be included in request for proposals and subsequent contracts for major items and for high-density, non-major items. Offerors/contractors may conduct trade-offs within the acceptable region of cost and performance in submitting responses to the RFP.

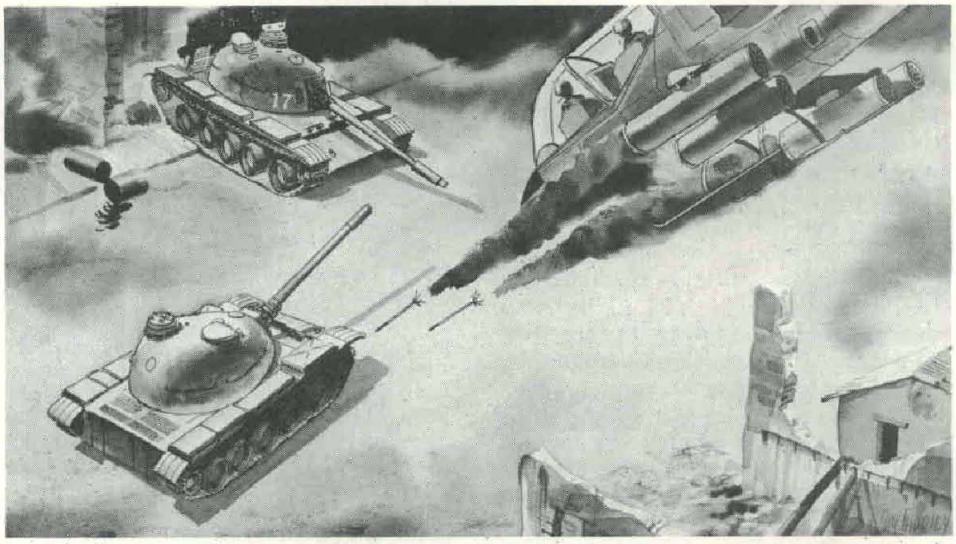
In conclusion let me briefly summarize the objectives of materiel acquisition guidelines.

Reduce development time to six years or less (ASARC I/DSARC I to IOC); Time from request for proposal (RFP) to development contract award not to exceed six months; Full funding for top priority systems; If necessary, buy less of the expensive complex items, pay price, justify actions; Fund producibility engineering and planning (PEP) with RDTE funds; Life cycle costs—parametric cost and engineering cost estimates; Design to production unit cost in RFP and contracts; Conduct development testing and operational testing, with test data on critical characteristics available during first six months of test for major milestone decision.

BEHIND THE SIEGE OF AN LOC . . .

Success Against Tank Invasion Traced Largely to 2.75-Inch Rockets

By Leo Horowitz



AH-1G Cobra helicopter equipped with 2.75-inch antitank rockets

"Army Cobras Blast Tanks Near An Loc," newspaper headlines announced in April 1972. They were referring to the then newly acquired capability of the Army/Bell AH-1G Cobra helicopter equipped with a new 2.75-inch antitank rocket.

Two tanks were hit during that Apr. 15 fighting by a Cobra from Battery F, 79th Aerial Field Artillery, a unit of the third Brigade, 1st Cavalry Division. From Apr. 1 through May 11, which included the fighting around An Loc, the unit claimed 10 Soviet-built tanks destroyed and another six damaged in the all-out Viet Cong effort to capture Saigon.

The rocket capability was provided from a project which was initiated at Picatinny Arsenal, Dover, N.J. only 12 months earlier. At that time a project team was established, based upon a requirement for a helicopter tank killer approved by BG William J. Maddox Jr., Director of Army Aviation in the Office of the Deputy Chief of Staff for Force Development.

Upon approval of the project manager for the 2.75-inch rocket system, the Picatinny team, led by the author and consisting of personnel from the Warhead and Special Projects Laboratory, Fuze Development and Engineering Laboratory, Product Assurance Directorate, and Arsenal shops, was established. The helicopter-delivered antitank capability was achieved by the development of the XM247 dual-purpose warhead and the XM438 fuze, in combination with the MK.40 rocket motor of the existing 2.75-inch rocket.

To reduce lead time in the availability of the warhead and fuze, the design was based on utilizing components from other items being produced for other weapons.

The warhead casing from the 17-pound M229 high-explosive warhead of the 2.75-inch rocket was used to provide the fragmentation antipersonnel effects. The liner and ogive from the M72 LAW was used for the armor-penetration capability. Fuzing utilized the impact crystal of the LAW, and the safety and arming device and the battery and the impact switch from the M429 Proximity Fuze. The only new component developed with the aid of CAD-E (computer aided design engineering) was the fuze control circuit.

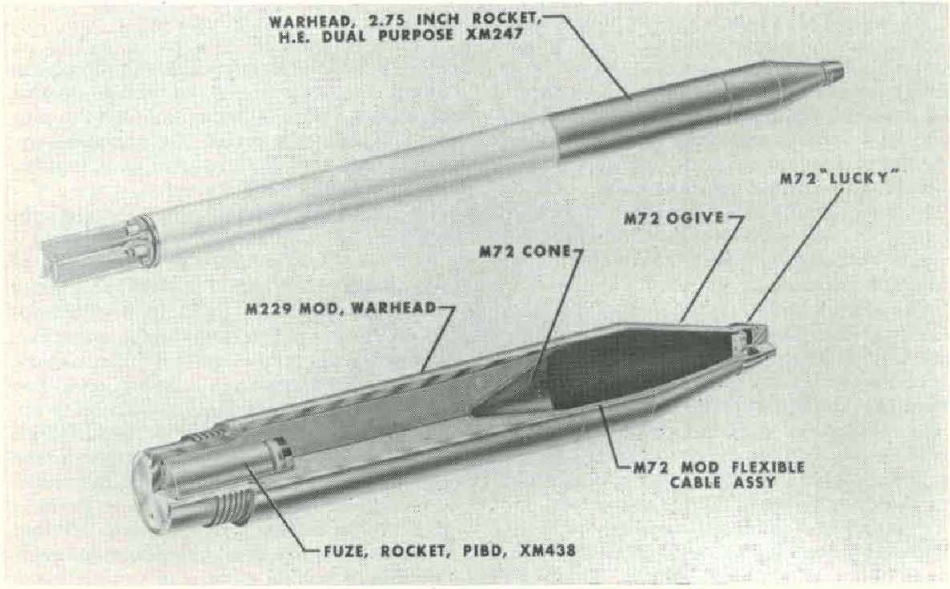


Fig. 1. 2.75-inch Dual Purpose Rocket

The design that evolved from this program was basically the same as originally proposed when the program was approved. See Figure 1. It consists of the M72 "Lucky" used on LAW, the M72 ogive and the M72 precision copper liner from LAW, the M229 warhead body modified on the front and rear end, a 2-pound composition B4HE fill, a new fuze (XM438), which will be discussed later, and a base plug.

The ogive is magneformed onto the loaded warhead body. The warhead is completed after the cable is assembled to the fuze, inserted into the fuze cavity and the closure disc is assembled. The assembly to the rocket motor is similar to the M151 warhead. The complete round is packed in the standard 2.75-inch rocket fiber container.

Warhead characteristics were

verified in a series of static tests. Average penetrations were similar to those of the LAW missile in each of five standoffs. Additional static tests established fragmentation characteristics used in the computerized effectiveness calculations, showing distribution of fragments similar to the M151 high-explosive warhead for the 2.75-inch rocket. Dynamic tests verified that results are the same as the static tests.

In June 1971 track test results at Aberdeen Proving Ground further verified the static tests results, and were followed in July by ground-to-ground firings against two steel-plate targets 1,200 feet from the launcher with satisfactory results.

The Point Impact Base Detonating (PIBD) XM438 rocket fuze is a mechanical arming and electrical firing device (Figure 2). It consists of the Safing and Arming device (S&A), battery and impact switch from an M429 fuze, a fuze firing circuit (FFC) to provide logic and controlled firing, an ogive, nose-cap assembly and an elongated wire harness from the M72 LAW weapon.

The arming function is accomplished initially by acceleration forces characteristic of the 2.75-inch rocket, causing the springloaded weight in the S&A device to move rearward. When the weight has moved to the setback position, the unbalanced rotor is released, causing it to rotate under control of the time-delay gear train. After approximately 0.25 seconds, the rotor releases a firing pin to initiate the thermal power supply for the FFC and the detonator. Under sustained acceleration of 1.03 and 1.35 seconds, the rotor locks in the armed position, aligning the M84 electric detonator with the explosive train and closing switches to the detonator circuit and FFC.

Initiation occurs via the FFC by one of two modes (Figure 3). The primary mode functions on target impact when the piezo crystal sends a signal to the FFC, triggering a Silicon Controlled Rectifier (SCR) which allows the battery-capacitor system to fire the detonator. The secondary mode functions on graze impacts and piezo crystal malfunction.

LEO HOROWITZ has 22 years of ordnance experience in research, development and production. He spent 10 years with industry in ordnance program management, in addition to his current position as chief of the Fuze Development Branch, and formerly as chief of the Atomic Ammunition Development Laboratory at Picatinny Arsenal, Dover, N.J. Horowitz is a graduate of The City University of New York and holds a Master's degree in science and applied mechanics from Stevens Institute of Technology.

The system will fail safe on preshorted impact switches. If the system is pre-armed, the battery will maintain power for approximately 30 seconds. When on-board power is dissipated, neither the back-up impact switch nor piezo crystal impact will function the round.

The mechanical arming component of the fuze is a Harry Diamond Laboratory-developed unmodified M429 S&A device which has been safety certified and has an excellent record to date.

Since this fuze is completely surrounded by the warhead's explosive fill, the out-of-line detonator safety test had to be performed, not only to assure explosive train safety but, to a greater extent, assure safety of the explosive fill. Steps have been taken in the design to insure confinement of the detonation within the fuze housing.

Military Standard tests of 296 fuzes were performed with satisfactory results at Yuma Proving Ground, Ariz. The only problem encountered was that of the warhead separating from the motor during unpackaged transportation vibrations. This deficiency was corrected by specifying a locktight adhesive on the threads between the warhead and motor.

Based upon the results of these tests, TECOM issued a safety statement in late 1971 that the warhead is considered safe for handling, transportation and aircraft flight provided the warheads are positively locked into position.

Subsequently, the Aviation Systems Command issued a safety of flight release statement that a full load of 19 rockets XM247/XM438/MK40 can be utilized with the XM159C or M200 rocket launcher pods on the UH-1 series and AG-1G helicopters.

Based upon these approvals, the drawings were finalized. Engineering test and service test quantities were approved for manufacture, and the Test and Evaluation Command was authorized to conduct their evaluation program.

In April, when the first ET/EST rockets were completed at Picatinny Arsenal, the project manager for the 2.75-inch rocket system directed their diversion to Vietnam to meet the tank threat, resulting in devastating proof of their lethality in combat.

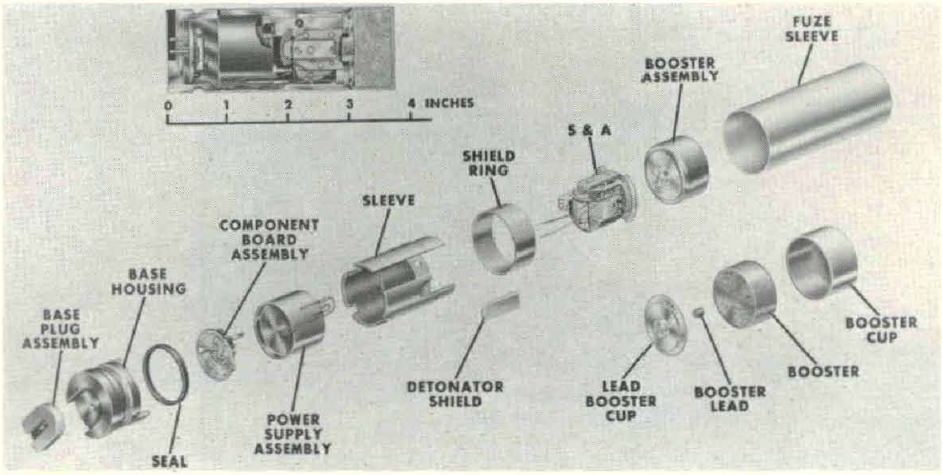


Fig. 2. Rocket Fuze PIBD XM438

The 'Black Box' Battlefield

By David K. Wilburn

Concept & Technology Division
U.S. Army Tank-Automotive Command

DEGREE OF VEHICLE SURVIVABILITY in a hostile environment is highly dependent upon the vehicle's inherent detection "signature," as fixed by operational factors.

The degree of a vehicle's survivability in a hostile environment of "black-box" threats may well have been decided when its design was fixed, since susceptibility to successful attack by a passive sensory-directed weapon is highly dependent upon the target's inherent detection "signature."

In operation, a vehicle's engine and power train are sources of infrared (heat), acoustic (sound) and seismic (vibration) energies. Passive sensory devices require such stimuli as directing and driving inputs in order to perform successfully.

Deprive a passive sensory "smart" system of its stimuli and the weapon may be defeated in seeking its target for lack of a suitable "lock-on" signal. Such preventive measures reduce tactical requirements for locating and attacking the threat weapon at its source position.

At HQ U.S. Army Tank-Automotive Command, Warren, Mich., research is being directed toward improving the posture of combat vehicles in a battlefield situation where passive sensory-directed weaponry is present. Signature suppression programs for the "Army 85" family of vehicles is a technically challenging endeavor.

Future power plants such as the turbine, hybrid-piston engine, and rotary combustion engine will require unique suppression innovations to provide secure vehicles. Power packages of higher output will be necessary to meet requirements of improved vehicle performance.

Historically, engine useage in the medium assault tank has risen from 375 horsepower in the post World War II M-3A5 tank to the current 750 to 810-horsepower versions of the 1790 series engine now in use in the M-48 and M-60 series of tanks.

Correspondingly, vehicle weights have increased from 62,240 combat-loaded pounds for the M-3A5 to 102,000 pounds gross weight for the current M-60 main battle tank (MBT).

EXPERIMENTAL installation of infrared countermeasure device on M113 carrier.

INFRARED surface temperature survey of M113 personnel carrier.

All these factors tend to influence the self-emission signature characteristics of a vehicle. Improvements in vehicle performance, unfortunately, do not necessarily produce a vehicle with improved "sensory survivability" without special emphasis on the countermeasure aspect.

To meet the battlefield challenge of current and future sensory-directed weapons and remote sensing systems, advanced planning on new and prototype vehicles must equate potential threats to requirements for specific countermeasure activities.

Long-range technical forecasts on threat weapon trends and an up-to-date cognizance of weapon system trends form the basis for predicting countermeasure requirements for vehicle concealment or signature-suppression programs.

Standard fielded vehicles can also be configured to meet any existing threat or newly deployed weapon by addition of suppression kits which would address themselves to specific threats on an individual basis.

THE THREAT. The primary objective of the vehicles signature suppression effort is to negate by countermeasures the effectiveness of electronic or human sensory threats which have potential to locate, identify and direct weapon devices to the source of energy.

Human perceptory modes of sight, sound and smell comprise critical links in the over-all remote detection and sensing scheme. Unaided, the eye and ear are excellent discriminatory devices, capable of "hearing" noisy vehicles at extended ranges or "seeing" unsecured on-board vehicle light sources at night.

Aided by ancillary electronic-optical

systems, the eye and ear become formidable sensory weapons. An example of an ancillary-aided eye system is the family of image-intensifier, light-amplification devices. The image intensifier allows enhanced detection of weak light sources at night so that conventional weaponery can be directed at the source of light.

Future sophisticated weaponery will reduce the dependence on human perception as ancillary sensors in the sequence of target location and identification. Sensor-pointed conventional weapons will be replaced by automatic target cueing devices, which will search the battlefield environment, identify the target and launch or direct weapons that will track to the source of stimuli without need of the human link.

The Redeye ground-to-air defensive missile performs functions of automatically tracking and delivering a weapon payload to an aircraft target based on the infrared signature characteristics of aircraft engines. Initial target acquisition, identification and weapon pointing are performed by the human link.

Multi-mode sensory activated systems are also a possibility which will employ dual functions of, for example, sound and infrared in acquiring the target and delivering the weapon.

The basic technology of any passive sensory device is to take advantage of some peculiarity or trait in the signature of the target which makes it detectable or identifiable in the presence of its natural background or environment. Unfortunately, vehicles are the source of a variety of common energies including:

- *Electromagnetic*—Infrared radiations originating from hot exhaust components, suspension systems and engine compartment metal; on-board visible light sources observed at night.
- *Acoustics*—Audible and inaudible sounds developed by engine operation or power train functions.
- *Magnetics*—Magnetic influences generated by electromagnetic on-board vehicle sources; vehicle mass disturbance of earth's magnetic field.
- *Seismics*—Earth-transmitted seismic energy imparted by vehicle weight and motion.

Sensory weapons take advantage of such emission characteristics to perform functions ranging from simple detection, to identification, discrimination and ranging. Passive imagery systems such as LLLT (low light level television) or FLIR (forward looking infrared) devices also are reliant on the availability of source energy contrast above background to produce recognizable imagery.

Although, on initial analysis it appears the target is at a disadvantage in a battlefield environment of unrestrained passive sensors, the combat vehicle's viability need not be compromised.

REMOTE LOCATION sensors placed in the field for detection of target vehicles.

MEETING THE THREAT. As passive sensory-activated systems evolve into sophisticated weapons through continuing R&D activities, it is apparent that combat vehicles will require a greater degree of built-in suppression protection.

One method under consideration is to impose a survivability specification on new vehicle design criteria. This would limit the amount of radiated infrared, acoustic, or other self-emitted energy under a given operational condition. The procedure could easily be adopted during the initial establishment of the Required Operational Capability (ROC) for the vehicle and subsequently introduced into the hardware fabrication phase for actual evaluation.

Both the Armored Reconnaissance Scout Vehicle and Mechanized Infantry Combat Vehicle now have specification requirements that will provide better security within the presence of passive sensory activated weapons. Basic design principles must, however, evolve from laboratory research efforts in support of meeting the survivability requirement.

Existing interdisciplinary suppression programs address themselves to a broad range of threats. The ultimate goal is to provide a suppression device that will reduce, for example, both infrared emissions and engine noise in a single design without penalizing vehicle performance or payload.

Another phase of the over-all survivability effort is the signature measuring program. Routines have been established for measuring and plotting absolute levels of infrared, acoustic, seismic, magnetic and photometric emission.

Vehicles selected for analysis are run through a prescribed operational plan in appropriate backgrounds and atmospheric environments, during which signature observations are made. On-board telemetry equipment transmits vehicle operational parameters to a mobile laboratory where the data is time-related to specific signature observations.

Similarly, various signature suppression concepts or hardware can be evaluated in terms of their countermeasure effect on specific threats, or described generally in absolute levels of emission. In addition to the routine measurements, investigative studies are probing for unique or obscure signature traits which could in future time frames form the basis of a new threat idea.

Experience has indicated that very simple procedures or additive measures on the target can deny an attack weapon its claimed superority in the battlefield scenario. Tactics also dictate that the combat tank is employed most suitably as an assault weapon. In such a role, it should be provided with built-in protective signature-suppression hardware and materials, allowing it to perform its assigned function without the burden of providing active defense mechanisms against sensor-directed weapons.

TACOM field laboratory used in signature measurement programs

SPEAKING ON . . .

The Automobile as a Social Machine

(Continued from inside front cover)

rise to as much as $26 to $39 billion annually by 1985. This adverse balance of payments impact would be aggravated even further by the projected increase in the importation of natural gas.

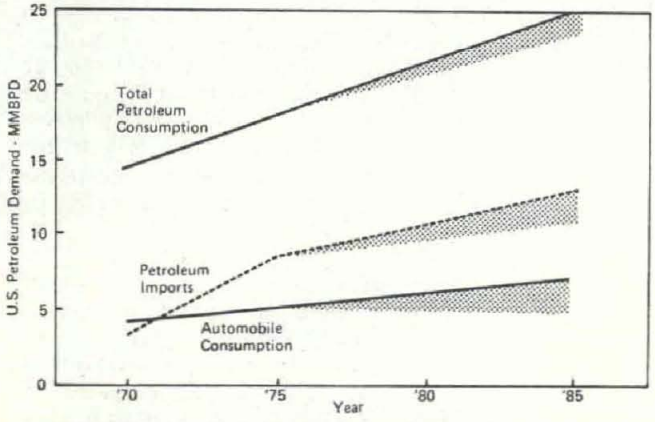
Fuel Consumption Pollution. The consumption of these large quantities of fuel has made the automobile and other vehicles a significant source of pollution in the United States. Nationally, motor vehicles contribute 66 percent of the total man-made carbon monoxide emissions, 48 percent of the hydrocarbons emissions, 40 percent of the emissions of oxides of nitrogen and 90 percent of all atmospheric emissions of lead.

The total of these four pollutants is in excess of 120 million tons per year. The importance of this is compounded by the close proximity of the emissions to the population and the high density of emissions in urban areas. Recent census data indicate that 75 percent of the people in the United States live on 1.5 percent of the land area, thereby creating a situation where a large segment of the population is exposed to high automotive pollution concentrations.

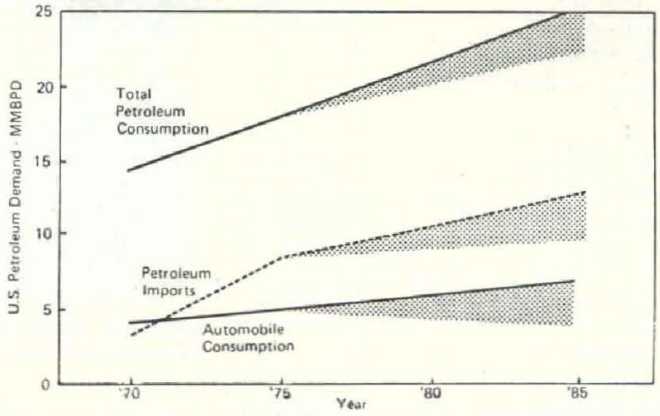
In addition to air pollutants emitted by the motor vehicle, the refinement, transportation and disposal of the petroleum products used in powering and maintaining motor vehicles produce secondary pollution effects that, in a social accounting sense, must be attributed to these machines.

These secondary effects include the spillage of 7.5 million gallons of oil per year, the emissions of 3.4 million tons of air pollutants from petroleum refineries annually and the improper disposal of 600 million gallons of spent crankcase oil.

Determinants of the Problem. For many reasons then, we simply cannot afford to consume our petroleum resources as wastefully as we have in the past. Cheap and easily accessible petroleum resources are becoming scarce. The environmental consequences of being forced to utilize the less accessible and more expensive petroleum resources, such as oil shale, should convince us of the need to slow down the excessive 4 percent growth rate in total energy consumption.



Graph 2. Impact of reduction in vehicle weight



Graph 3. Impact of alternative technology

It is clear that a combination of significant public policies will have to be implemented to (a) bring about a more efficient use of the energy consumed by our automobiles and (b) reduce directly the demand for petroleum products independent of the efficiency of the automobile, for example, with transportation controls and mass transit.

Before discussing these policies, however, it is helpful to discuss in more detail the major determinants of energy consumption in today's automobiles.

The publicity being given to the fuel penalty associated with emissions control devices might lead one to believe that this is the determining factor in the fuel economy of today's cars, but weight is the single most important parameter affecting urban fuel economy. A 5,000-pound vehicle consumes 100 percent more fuel per mile than a 2,500-pound vehicle.

Other increasingly important determinants of fuel economy include:

- *Air conditioning.* In 1971 over 60 percent of all new cars were sold with factory-equipped air conditioning with its $300–$400 sticker price and an average fuel penalty of 9 percent.
- *Automatic transmissions.* Over 90 percent of our automobiles are sold with automatic transmissions, which have been estimated to have 5–6 percent fuel penalty.
- *Rotary engine.* The introduction of the rotary engine with its estimated 35 percent loss in fuel economy could have a substantial impact on total gasoline consumption when it begins to be mass

produced in the United States.

One of the few positive trends in fuel economy has been the increased use of radial tires on American-made cars. It has been estimated that a 10 percent increase in fuel economy can be realized from the use of steel-belted radials.

The introduction of American-made compacts is also a positive step, but it is not clear that the resulting improvement in fuel economy has been great enough to offset the loss due to the increased curb weight of standard and full-sized cars.

Policy Impact. Our fuel economy data on vehicle weight can be used to make an interesting projection of the potential impact of a policy requiring the reduction in the average weight of all new vehicles sold after 1974 from the present weight level to that of a 2,500-pound vehicle.

Using the graph showing projected petroleum consumption under current trends, we see that a mandatory weight reduction would reduce total gasoline consumption in 1985 to a level approximately equal to that projected for 1975. This would reduce total crude oil imports by 2.1 million barrels per day in 1985 and initially reduce the projected annual balance of payments deficit by $2.3 billion at current prices.

Even greater fuel savings can be achieved with alternative engine technologies. If, in 1975, diesel engines were used in all cars—the particular engine I have in mind has demonstrated the ability to meet 1975 emissions standards with a 75 percent increase in fuel economy—the equivalent crude oil consumption of automobiles in 1985 would fall below the level of consumption of 1970. As you can see in Graph 3, this would reduce projected oil imports by nearly one quarter in 1985.

If the fuel economy effects of a reduction in vehicle weight and diesel technology can be assumed to be additive, such a combination, if introduced in 1975, could potentially reduce automotive fuel consumption in 1985 to the lowest level since 1964.

Other technological changes, such as the stratified charge, would also substantially reduce the total petroleum consumption of the automobile.

Impact of Regulations. Our analysis of the impact of emissions-control techniques shows that vehicle modifications made to meet environmental regulations have reduced fuel economy by an average of 7.8 percent over the period 1968–1973.

The data available to EPA on prototype 1975 vehicles do not indicate a trend in either direction from the average of 1973 models. This conclusion is further supported by recent reports from several large manufacturers that they have witnessed no difference in fuel economy between their 1975 prototype and a 1973 vehicle of similar weight.

Our analysis ranks the fuel penalty of 1975 emissions control systems with that of the air conditioners and automatic transmissions and implies that it can be neutralized by a shift in consumption patterns, as simple as a shift to use of radial tires.

Our data on the fuel penalty associated with the 1976 standards are very sketchy at this point. The data available could be used to support claims of no penalty, or of penalties, ranging up to 25 percent. It is too early to hang our hat on any figures associated with the 1976 standards, in view of the very limited number of prototype vehicles which have so far demonstrated emissions at these levels. We will follow this problem closely however.

Future Trends. Although it is clear that much can be done with existing technology to control fuel consumption, a quick look at future trends does not provide one with much encouragement. The September issue of *Automotive Engineering* reports that prototype safety vehicles have weights from 700 to 1,600 pounds over the target weight of the DOT (U.S. Department of Transportation) Experimental Safety Vehicle.

The continued use of the conventional internal-combusion engine in combination with add-on pollution control devices and the introduction of the rotary engine will likely add to the inefficient use of automotive fuels. The trend toward the increased use of automotive air conditioning is also certain to continue in spite of the added cost.

What Can We Do? It is clear that steps must be taken to discourage the inefficient use of our scarce petroleum resources. History offers little hope that either the consumer or the automobile manufacturer will shift to less energy-intensive forms of travel without incentives provided directly by the federal government.

The question then becomes one of the nature of the government action. Should we approach the problem directly through mandatory changes in engine design, aerodynamic and roll resistance, power matching and vehicle weight or should the approach be in the form of incentives, that is taxes?

Recent studies have shown that the demand for gasoline is indeed price sensitive. Over the life of his vehicle, the average car owner spends nearly 60 percent of the original price of his car on gasoline. A substantial increase in gasoline taxes would serve to reduce the total demand for gasoline by shifting travelers to mass transit; reducing vehicle weight and making other energy-saving technological changes would make them more cost-effective.

It is reasonable to assume that the high cost of gasoline in Europe (2 to 3 times that of the United States) has contributed significantly to their more intensive use of mass transit and their deliberate application of energy-saving options, such as radial tires and low-weight vehicles.

A gasoline tax which is paid over the life of the car may prove to be less effective than some form of "energy tax" which is added to the initial price of the car. A tax on vehicle weight or on energy-intensive power options could be designed to make the consumer pay the discounted value of a gasoline tax in the initial price of his car. This would serve to more clearly define for the consumer the real cost to himself and society of the type of vehicle he buys.

With over 55 percent of our automotive energy being consumed in the urban area, it could also be argued that traffic controls such as parking taxes, car pools, vehicle free zones and others, which are designed primarily to reduce excessive concentrations of air pollutants, would also be effective in reducing total gasoline demand.

In summary, the inefficiency of today's automobile is cutting deeply into the available supplies of oil and costing us dearly in foreign exchange. Steps must be taken, and taken soon, to reduce the amount of gasoline consumed by the automobile. I would hope that such steps would be taken freely by the marketplace, but some form of action may well be required by the federal government.

People in Perspective . . .

Army Selects Inselmann 1972 Handicapped Employe

Unyielding determination to surmount formidable obstacles that appear to block attainment of high objectives is well exemplified by Dr. Edmund H. Inselmann, selected as Department of the Army Handicapped Employe for 1972.

Chosen from among 22 outstanding nominees for this honor—and consequently a contender for the U.S. Civil Service Commission's Federal Handicapped Employe for 1972—Dr. Inselmann will be presented the Decoration for Meritorious Civilian Service, with a citation signed by the Secretary of the Army. The presentation will take place at a Pentagon ceremony (date unannounced at press time).

Employed since May 1969 at HQ U.S. Army Materiel Command, Alexandria, Va., Dr. Inselmann has been concerned with developing sound statistical procedures in Army test programs. Assigned to the Office of the Chief Mathematician, he is credited with providing outstanding guidance to subordinate commands.

Afflicted with cerebral palsy since birth, Dr. Inselmann decided in 1946, when he enrolled at Temple University, that a disease affecting the body's entire muscular system was not going to deter him from making the most of his life. Cerebral palsy, which impairs the victim's ability to speak clearly and write legibly at times, often misleads prospective employers in recognizing intelligence and potential capabilities.

That happened early to Dr. Inselmann. Shortly before he entered Temple University, he was advised to settle for a career as a newsstand attendant. He earned a BA degree in mathematics from Temple and received an MA in mathematical statistics at Columbia University in 1951, preparing his thesis on "The Weak Law of Large Numbers."

While employed as a mathematician at the U.S. Army's Frankford Arsenal in Philadelphia, Pa., he enrolled at the University of Pennsylvania to complete work for a PhD in mathematics, which he received in 1962. His work at the arsenal included development of a modern inventory system for spare parts, error analysis of fire control for major weapon systems, statistical hypothesis testing, and design of experiments in test programs for small arms ammunition.

Dr. Inselmann is the author of numerous professional papers on mathematical statistics and is founder and past president of the Philadelphia Youth for Cerebral Palsy Association. He has been honored by the United Cerebral Society in Philadelphia with the organization's Outstanding Achievement Award.

Dr. Edmund H. Inselmann

MERDC Man's Models Invited to Paris Air Show

When the famed International Air Show is held in Paris, France, May 25-June 3, one of the featured United States' exhibits will be the handiwork of Robert M. Mussey, a U.S. Army R&D employe.

Assigned to the model shop of the Developmental Fabrication Division, U.S. Army Mobility Equipment Research and Development Center, Fort Belvoir, Va., Mussey devotes much of his spare time to building working models of historic airplanes. Eight of his prized miniatures of World War I aircraft will be exhibited in the Paris show.

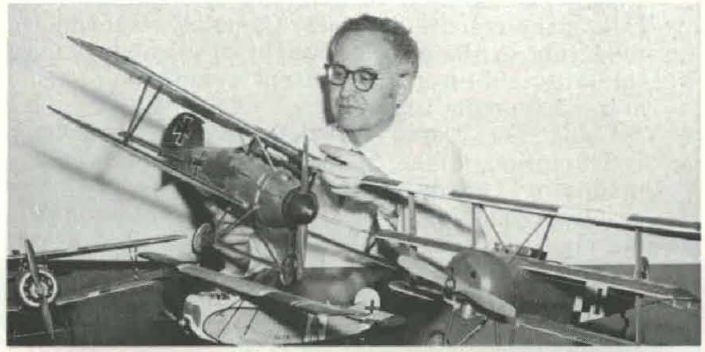
Currently he has about 30 planes, most of which are World War I or 1930s vintage. All of the models will fly, using either gasoline or diesel fuel. They are constructed of balsa wood, silk and metal. Mussey even adds an extra touch by using wire wheels and molding the tires.

One of his favorite models is a triplane Fokker DR-1 patterned after the one flown by LT Everhard von Stapenhorst of Baron von Richthofen's Jagdstaffel-2. Also in the collection is a silver model of the plane flown by Nungesser, who was lost at sea while attempting to cross the Atlantic prior to COL Lindbergh's famous flight.

Mussey's latest venture is a model of the plane in which Quentin Roosevelt met his death when it crashed into a swamp. It takes about 100 hours to construct one of these models, not including the time spent on drawing the scale plans.

A tank driver during his Army service, Mussey has been interested in model building all of his life, but didn't actually get started until 1956. He was inspired after learning the machinist trade and later studying watchmaking.

Wishing to further the interest of others in this fine art, Mussey founded the Fairfax, Va., Modelers Association in 1960. Today, it is one of the largest of its kind in the Washington, D.C., area.



Robert M. Mussey shows four model airplanes he will display at the Paris International Air Show at the invitation of the U.S. Department of Commerce. The triplane is a model of the DR-1 Fokker flown by German World War I ace, Baron von Richthofen.

MICOM Engineer Enjoys Violin Maker Avocation

Life is full of music for C. A. "Doc" Lyles, an electronics project engineer, Targets Special Items Management Office, HQ U.S. Army Missile Command, Redstone Arsenal, Ala.

Lyles is an accomplished musician and a skilled violin maker. His hobby began at age nine with an apprenticeship to a violin maker in Jackson, Miss. This rather rare art was a family tradition with the Lyles. His grandfather, a traveling fiddler in the Tennessee mountains, carried his fiddle around in an old tow sack.

Bequeathed a 1659 Steiner violin that had been in the family for six generations, Lyles expressed his desire to make a career of music. His father had second thoughts and insisted his son learn a trade. Although music took a backseat to electrical engineering, Lyles remained an avid devotee of the "strings."

While his ancestors have been country fiddlers, Lyles has nourished his talents as a concert violinist. In 1946 he sat in as guest violinist with Arthur Fiedler's Boston Symphony Orchestra. He is also a former member of the Jackson (Miss.) Symphony Orchestra and has performed with the Huntsville Symphony.

Lyles constructs his violins just as the old masters did. He insists on using wood that is at least 25 years old. It takes 180 hours of carving and fitting; he never carves to dimensions but rather to tone, using a pitch pipe. Once fabrication is completed it takes him two to three months perfecting the desired finish.

In addition to the violin, Lyles also plays the mandolin, viola, piano and tenor saxophone. His first love, however, still remains the violin. He recently commented, "The violin is the king of all instruments."

C. A. "Doc" Lyles

Conferences & Symposia . . .

STRATCOM Reviews Nontactical Communications-Electronics Program

Seventy-nine nontactical U.S. Army airfields and heliports need improvement in communications-electronics (C-E) equipment, COL Robert G. Chamberlin stated at a recent HQ Strategic Communications Command (STRATCOM) conference.

Some 50 communications experts listened as the chief of the Systems and Networks Division, Office of the Deputy Chief of Staff for Plans, Operations and Automation, explained STRATCOM's mission to conduct studies and install C-E equipment at Army facilities.

Five such facilities in the Continental U.S., Europe and the Pacific have already been upgraded, he said, and the program should be completed by 1976. The purpose is to improve aviation safety with standardized C-E support to assure better air traffic control.

Conferees included representatives from the Department of Army Office of the Assistant Chief of Staff for Communications-Electronics; the Army Materiel Command; the Continental Army Command; the Military District of Washington; the U.S. Army, Europe; and the Army Aeronautical Systems Office.

Represented also were such STRATCOM elements as the Army Communications Agency, the Army Communications Electronics Engineering Installation Agency (CEEIA), CEEIA Western Hemisphere, CEEIA Continental U.S., STRATCOM Europe, STRATCOM Pacific, and STRATCOM Alaska.

Government, Industry Representatives Discuss Ballistic Protective Equipment Developments

Representatives of the nation's law enforcement agencies, industry and federal and state agencies met recently at Edgewood (Md.) Arsenal to discuss progress in ballistic protective clothing and equipment.

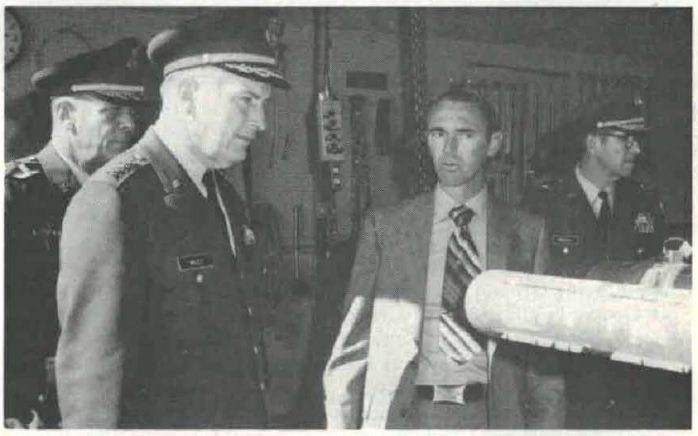
Following a suggestion in 1971 by the Law Enforcement Assistance Administration (LEAA), U.S. Department of Justice, Edgewood Arsenal initiated research directed to an external garment capable of withstanding the impact of a .38-caliber bullet.

The purpose of the recent meeting was to examine possibilities of expanding the arsenal's present program to include protective garments that would withstand bullets of various other calibers. Clarence E. Hawkins, coordinator of the arsenal program, said the meeting was intended to coordinate numerous requests by government and industry for expansion of R&D efforts.

Participants in the discussions included representatives of the Federal Bureau of Investigation, LEAA, New York City Police Department, National Bureau of Standards, U.S. Army Land Warfare Laboratory, and U.S. Army Biomedical Laboratory, and industrial organizations.

DIRECTOR of the Edgewood (Md.) Arsenal Biomedical Laboratory, COL Joseph R. Blair, discusses protective features of a new police antiriot helmet with Lt. Lief Reinerston of the New York City Police Department, during conference attended by the nation's leading law enforcement agencies.

"THE BULLET STOPPED HERE," Clarence E. Hawkins points out during discussion on bullet-proof vests at conference of law enforcement officials and industrial engineers at Edgewood (Md.) Arsenal. Modeling the vest is Robert Kennell of Aerospace Corp. Looking on are (left) Nick Montanarelli, U.S. Army Land Warfare Laboratory, Aberdeen (Md.) Proving Ground, and Dr. Thomas Gage (right), E. I. dupont de Nemours Co. researcher.

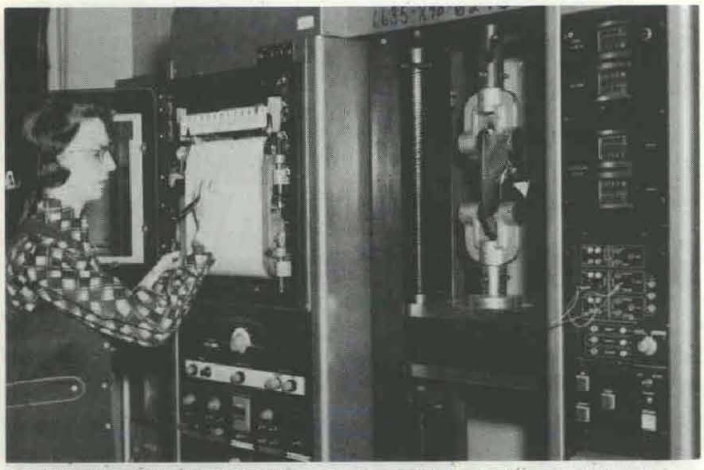


GEN HENRY A. MILEY JR. watches as components of a Chaparral missile undergo a vibration test in one of the White Sands (N. Mex.) Missile Range laboratories. The AMC commander making his first official visit to WSMR since he assumed office Nov. 1, 1970, also watched a Chaparral firing and static test, an Air Force Athena missile launch computer playback, and received detailed briefings on WSMR test and evaluation programs. Chaparral project engineer John T. Sween (center) explains the test. At left is COL Benjamin B. Safar, director, Army Missile Test and Evaluation; right, MG Arthur H. Sweeney Jr., CG of WSMR.

AMC RDT&E Director MG Stewart C. Meyer (second from right) and COL Joseph E. Fix III (right) were among 50 representatives of AMC agencies who attended the recent Quarterly Program Review at the U.S. Army Training Device Agency (USATDA), Orlando, Fla. COL Myles H. Mierswa Sr. is CO, USATDA. LTC Earle L. Denton (l.) is USATDA chief of Army requirements.

Women in Army Science . . .

Physical Scientist Conducts Soft Goods Tests
To Provide Adequate Logistics for Field Soldiers



PHYSICAL SCIENTIST Mrs. Nancy Hill tests the stretch of material from an air mattress at APG Soft Goods Testing Laboratory.

Soldiers serving in the field may unknowingly have a special regard for Nancy S. Hill, a U.S. Army career scientist who is continuingly concerned with equipment linked to their comfort and well being.

Assigned to the Materiel Testing Directorate (MTD) at Aberdeen (Md.) Proving Ground, Mrs. Hill is a physical scientist in charge of the Soft Goods Testing Laboratory, the only one of its kind in the U.S. Army Test and Evaluation Command. She is responsible for testing all items a soldier uses to set up housekeeping in the field—everything from ponchos to dehydrated food.

Test operations include chemical, spectroscopic and physical techniques, environmental simulation, and X-rays. A great deal of her laboratory work involves testing of various types of fibers, fabrics, plastics, containers, liquids such as oil, and food items.

When packaging techniques for dehydrated food were being developed, her laboratory was given the unusual task of determining the compression strength of packaged strawberries. During shipping and storage, packaged foods must be able to withstand pressure. Prior to acceptance for standard Army use, an item must be shown to have practical value in a military environment.

In an interview Mrs. Hill pointed out that the Army determines wear, use and content for each new product that industry proposes for general military use.

One of the purposes in establishing the physical properties of new materials is to assess their safety for soldier use. Factors involved in this assessment include flammability and the amount of static electricity produced when an item of clothing is worn.

Spectroscopic techniques are often used to discover the composition of material from which a new product is to be made. Through a mechanical process a graph is developed which shows the composition of a new item. These spectral patterns, as they are termed, are very much like fingerprints pointing to the quality of an item.

A member of the American Society of Testing and Materials, Mrs. Hill has bachelor's and master's degrees in textiles and clothing from the University of Tennessee.

Reader's Guide . . .

NAS-NRC Report Examines Physics Activities

Physics in Perspective, Volume 1, is a 1,065-page recently published report compiled by the Physics Survey Committee of the National Academy of Sciences-National Research Council.

Offering a comprehensive examination of the progress, opportunities, and problems of physics in the United States, the report relates the contribution of physics to other scientific disciplines. Detailed also are numerous illustrations of how advances in physics have been utilized for the welfare of the nation.

Further, the report suggests the future course of activities in the various subfields of physics, and the extent to which these efforts will require resources of manpower, facilities and funding. Rationalized also are the responses of the total research effort in physics to alternative funding levels.

Chapters in the report are: Origin, Objectives and Organization; Recommendations; The Nature of Physics; The Subfields of Physics; Priorities and Program Emphasis in Physics; The Consequences of Deteriorating Support; Physics and U.S. Society; and

International Aspects of Physics; The Institution of Physics; The Support of U.S. Physics; Physics in Education and Education in Physics; Manpower in Physics: Patterns of Supply and Use; Dissemination and Use of the Information of Physics; Policy Considerations: Conclusions and Findings.

Copies are available from the Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Ave., Washington, D.C.

Russian Electron Devices Information Published

"Tabulation of Published Data on Electron Devices of the U.S.S.R. Through December 1971," the seventh revision and expansion of a compilation of data on Russian electron devices, was recently published by the U.S. Department of Commerce.

Documenting the growth of the U.S.S.R. electron device industry since about 1960, this 108-page publication gives information on all active devices—ranging from receiving to microwave, semiconductor, and miscellaneous devices such as photographic flash tubes and thermistors.

Sources for the tabulation are books published by the institutes, export brochures, and data contained in magazines and journals. The Russians have no equivalent of the complete data sheet, with characteristic curves, as published by western European, United States, and Japanese electronics manufacturers.

Identified as National Bureau of Standards Technical Note 715, the publication may be ordered prepaid from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, or from local U.S. Department of Commerce Field Offices as SD Catalog No. C13.46:715; Stock Number 0303-0969.

Microfiche copy may be ordered prepaid for 95 cents a copy from the National Technical Information Service (NTIS), Springfield, Va. 22151, as NBS Tech. Note 715.

HumRRO Publication Stresses Peer Training

Development and Implementation of a Quality-Assured, Peer-Instructional Model is the title of a recent publication issued by the Human Resources Research Organization (HumRRO).

Identified as Technical Report 72-35, it formulates a new Army training system that utilizes peer contact as the sole medium of instruction. Students perform the role of both learner and instructor.

Conventional teaching methods, which emphasize the lecture-demonstration approach, it is contended, fail to cope with the problem of student aptitude variations. Conclusions of the report suggest that peer instruction more effectively covers the aptitudinal spectrum, improves trainee attitudes, increases motivation, self-reliance and group morale.

Researchers also found a basis for cost savings with this system as a result of reductions in training time and trainee attrition. Copies of this report may be obtained from: HumRRO, 300 North Washington St., Alexandria, Va. 22314.

NBS Provides Information on Biased SQUIDs

Superconducting Quantum Interference Devices (SQUID): *An Operational Guide for rf-Biased Systems* has been issued by the National Bureau of Standards, U.S. Department of Commerce.

Identified as Technical Note 629, it is intended to fill a void in literature concerning practical operational information on rf-biased SQUIDs. Emphasis is given to the SQUID itself, the resonant circuit coupled to it, and its application in measuring.

Discussed also are readout circuitry, operation of the rf input, SQUID shielding and SQUID utilization to control currents in external circuits or to drive bidirectional digital flux counters.

Among the measurement problems in which SQUID has been applied are magnetometry and magnetocardiography, dc measurements, noise thermometry, high-sensitivity low-frequency ac measurements, and susceptibility and moment measurements.

Personnel Actions . . .

Army Names Taylor Deputy Surgeon General

MG Richard R. Taylor

MG Richard R. Taylor, MC, has been named to succeed MG Spurgeon Neel as Deputy Surgeon General of the Army, after serving since 1970 as CG, U.S. Army Medical Research and Development Command (USAMRDC) and as special assistant for R&D to the Surgeon General. MG Neel is now commander of the newly organized U.S. Army Health Services Command at Fort Sam Houston, Tex.

MG Taylor was deputy commander, USAMRDC (1959–64) and later headed the Biomedical Science Division, Office of the Director of Defense Research and Engineering, Office of the Secretary of Defense.

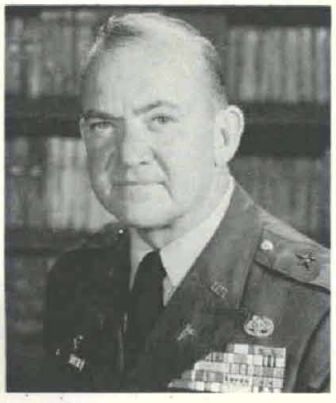
Other key assignments have included: commander, 7th Medical Battalion, 7th Infantry Division, Korea; deputy commander, U.S. Army Medical Research and Nutrition Laboratory, Denver, Colo.; and command surgeon, U.S. Military Assistance Command, Vietnam (1969–70).

A 1946 graduate of the University of Chicago School of Medicine, he entered the Army in 1947. MG Taylor served his residency in internal medicine and cardiology at Letterman General Hospital, San Francisco, and in pulmonary diseases at Fitzsimons General Hospital, Denver, Colo. He has American Board of Internal Medicine certification.

MG Taylor has completed the Army Command and General Staff College and the Army War College. In 1963 he received the John Shaw Billings Award from the Association of Military Surgeons of the U.S. He is a Fellow of the American College of Physicians and the American College of Chest Physicians.

Included among his military decorations are the Distinguished Service Medal, Legion of Merit, Bronze Star Medal, Joint Service Commendation Medal with Oak Leaf Cluster (OLC), and ARCOM w/OLC.

Bernstein Assigned as AMRDC Commander



BG Robert Bernstein

BG Robert Bernstein, MC, has been named CG of the U.S. Army Medical Research and Development Command (USA MRDC), succeeding MG Richard R. Taylor.

Commissioned in the Army Medical Corps in 1947, BG Bernstein holds a BA degree from Vanderbilt University and an MD from the University of Louisville. He is also a graduate of the Army Command and General Staff College and the Army War College.

He served as chief of Medical Service (1955–58) and later as CO, U.S. Army Hospital, Aberdeen Proving Ground, Md. Other key assignments include: chief of Plans and Operations and later deputy surgeon, Office of The Army Surgeon General (OTSG); director of Plans, Supply and Operations, OTSG; Surgeon, U.S. Military Assistance Command, Vietnam; and recently as deputy commander of Walter Reed Army Medical Center.

Included among his military honors are the Distinguished Service Medal, Legion of Merit with two OLC, Bronze Star Medal with "V" device and OLC, Meritorious Service Medal, Joint Service Commendation Medal, Army Commendation Medal and Purple Heart.

Redman Commands STRATCOM-CONUS

BG Albert Redman Jr. has succeeded COL John N. Medinger as commander of the U.S. Army Strategic Communications Command-Continental U.S. (STRATCOM-CONUS), Fort Ritchie, Md. BG Redman was formerly CG, White House Communications Agency.

BG Redman has two master's degrees—in military science from the University of Maryland and in business administration from George Washington University. His military schooling includes the Army Command and General Staff College, Armed Forces Staff College, and the Industrial College of the Armed Forces.

He participated in the invasion at Normandy, France, during World War II and later served in the European Theater. Other assignments have included project officer, Signal Corps Engineering Labs, Fort Monmouth, N.J.; CO, U.S. Army Communications Agency, Taiwan; director of operations, STRATCOM; plans officer, Office of the Army Chief of Staff; and chief, Def Com, Southeast Asia, Mainland.

Among his military decorations are the Legion of Merit with OLC, Army Commendation Medal with OLC and the Joint Services Commendation Medal.

Proudfoot Joins Installations and Logistics Office

Deputy for Materiel Acquisition, Office of the Assistant Secretary of the Army for Installations and Logistics, is the new title of BG Robert J. Proudfoot as successor to MG Vincent Ellis.

BG Proudfoot served six years at Redstone Arsenal, Ala., most recently as Lance project manager, following duty as head of the Lance and Shillelagh missile programs, and a brief tenure as chief of staff, U.S. Army Missile Command and deputy for Land Combat Systems.

As a captain in 1953, he attended one of the first missile courses taught at the Army Missile and Munitions Center and School, Redstone Arsenal. One of his first missile assignments was the emplacement of Nike air defense sites near Baltimore, Md., and Washington.

BG Proudfoot has a 1958 bachelor's degree from the University of Maryland and a master's degree in business administration from Babson Institute. He has also completed the Army Command and General Staff College and the Industrial College of the Armed Forces.

Included among his military honors are the Legion of Merit, Bronze Star Medal, Air Medal with OLC, and ARCOM w/OLC.

Agnor Assumes Command of Rock Island Arsenal

COL Thomas J. Agnor Jr. has succeeded COL Paul E. Martin as commander of Rock Island Arsenal, Ill. COL Martin retired after 26 years of Army service.

COL Agnor had served as chief of staff, U.S. Army Weapons Command, Rock Island Arsenal since 1970, following duty as senior adviser to the Third Area Logistics Command in Vietnam. During 1961–63 he was chief of electronics data processing and then executive officer, Rock Island Arsenal. A 1946 graduate of the U.S. Military Academy, he graduated in 1950 with an MSME degree from Massachusetts Insitute of Technology.

MICOM Picks Morrison as Laser Director

COL Robert C. Morrison, until recently CO, Division Artillery, 1st Cavalry Division, Fort Hood, Tex., is now director of the newly established High Energy Laser Program Office, U.S. Army Missile Command, Redstone Arsenal, Ala.

A graduate of the U.S. Military Academy, he has a master's degree in electrical engineering from the Georgia Institute of Technology. He has also completed the Army Command and General Staff College, Armed Forces Staff College, and the Army War College.

He has served with the Wolfhounds of the 27th Infantry Regiment, 25th Division in Korea, as CO, 5th Battalion, 77th Artillery, Germany, and CO, 2d Battalion, 19th Artillery, 1st Cavalry Division, Vietnam.

TECOM Assigns Lynch as Logistics Director

COL Camille L. Lynch has been named director of Logistics, HQ U.S. Army Test and Evaluation Command (TECOM), Aberdeen Proving Ground, Md. He had served since 1969 as CO, U.S. Theater Army Support Command, Europe.

COL Lynch received a commission in the Quartermaster Corps in 1942 after graduating from Officer Candidate School. Assignments in the U.S. and abroad have included duty with the Military Assistance Advisory Group (MAAG) in Vietnam and with the Office of Personnel Operations in Washington, D.C., and with MAAG in Taiwan.

WECOM Appoints Sherman as RD&E Director

COL Lee M. Sherman recently was named director of the Research, Development and Engineering Directorate, HQ, U.S. Army Weapons Command, Rock Island, Ill., succeeding COL Charles P. Alter (ret.).

During 26 years of Army service, COL Sherman has had duty tours in Korea, Japan, Vietnam and in 1969–70 was stationed in Thailand.

His academic credentials include a BS degree in procurement from the University of Maryland and a master's degree in research and development and financial management from American University. He is currently completing work for his doctoral dissertation.

AWARDS . . .

MERITORIOUS CIVILIAN SERVICE. *James P. Jordan,* director of the Personnel, Training and Force Development Directorate, U.S. Army Test and Evaluation Command, recently received the Meritorious Civilian Service Award (MCSA), the Army's second highest honor for civilian employes.

Jordan was cited for dedication and exemplary staff direction (1962–72) of TECOM's personnel, training and management programs.

Dr. Chandrakant S. Desai, research civil engineer in the Soil and Rock Mechanics Branch, Soils and Pavements Laboratory, U.S. Army Waterways Experiment Station, Vicksburg, Miss., received the MCSA for his work in the development and application of finite element techniques which helped solve complex engineering problems.

C. D. Burns and A. H. Joseph, U.S. Army Waterways Experiment Station employes, were presented the MCSA for work which resulted in the development of a revolutionary means of constructing military roads without the use of aggregate. The technique is known as the membrane-enveloped soil-layer method.

DISTINGUISHED SERVICE MEDAL. *LTG Charles W. Eifler,* former CG of the U.S. Army Missile Command, Redstone (Ala.) Arsenal, was presented the second Oak Leaf Cluster (OLC) to the Distinguished Service Medal prior to his retirement as CG of the U.S. Theater Army Support Command (TASCOM), Europe.

He was cited for meritorious service as deputy commander-in-chief, U.S. Army, Europe (1969–70) and CO of TASCOM (1970–73).

MICOM Engineers Named to IEEE For Electronics Achievements

Bernard Reich and Sol Schneider, engineers with the Electronics Technology and Devices Laboratory, U.S. Army Electronics Command, have been named Fellows of the Institute of Electrical aand Electronics Engineers. Both men have international reputations in their fields.

Reich was recognized for his contributions to the reliability improvement, standardization and design of semiconductor devices and integrated circuits. He has authored or coauthored more than 50 technical papers and holds five patents.

Schneider was honored for his contributions to high-energy, gaseous electron devices.

MERITORIOUS SERVICE MEDAL. *COL Donald A. Seibert,* formerly with the U.S. Army Test and Evaluation Command (TECOM), was a recent recipient of the Meritorious Service Medal.

Presented by MG Charles P. Brown, CG of TECOM, the award recognized COL Seibert for outstanding meritorious service in 1971–72 as TECOM deputy chief of staff for Support.

LEGION OF MERIT. Director of Army Research *BG Charles D. Daniel Jr.* was recently presented the second OLC to the Legion of Merit (LM) by LTG William C. Gribble Jr., Army Chief of Research and Development. BG Daniel was cited for exceptionally meritorious service in 1971–72 as CG, I Corps (ROK/US) Artillery Group, and DCG, Korea Support Command, Eighth U.S. Army.

COL Garrison Rapmund, MC, chief of the Office of Life Sciences, Office of the Chief of R&D, is a recent recipient of the first OLC to the LM. He was cited for exceptionally meritorious achievements during 1969–73 in consecutive assignments as director of Medical Research, chief of the Research Planning Office, and deputy commander, HQ U.S. Army Medical R&D Command. He was cited for significant contributions to research in tropical diseases and for innovative foresight in planning for the new Western Institute of Research, San Francisco, Calif.

COL Raffaele Suriano, DC, director of Personnel and Training, Office of The Army Surgeon General, was recently awarded the LM for 37 months prior service as chief of the Dental Corps Career Activities Office.

COL Francis A. Richter, chief of the Plans and Study Programs Office, U.S. Army Test and Evaluation Command (TECOM), received the LM for 1968–72 service as chief, Surface Systems Division, Directorate of Research, Development and Engineering, U.S. Army Materiel Command. MG Charles P. Brown, CG of TECOM, made the presentation.

COL Bennett L. Lewis, Office of Personnel Operations, Washington, D.C., was recently awarded the first OLC to the LM. He was cited for exceptionally meritorious services as CO, U.S. Army Mobility Equipment R&D Center, Fort Belvoir, Va., and as director of Research, Development and Engineering, U.S. Army Mobility Equipment Command (MECOM), St. Louis, Mo. MG Hugh R. Higgins, CG of MECOM, presented the award.

LTC E. Podurgal received the LM at his recent retirement ceremonies following 25 years of Army service. MG John C. Raaen Jr., CG, U.S. Army Weapons Command, Rock Island Arsenal, Ill., presented the award. LTC Podurgal was recognized for outstanding service at the arsenal since 1971.

LTC Henry G. Skeen, chief of the Functional Software Division, Combat Service Support System, Project Directorate, U.S. Army Computer Systems Command, recently received the LM. The citation praised his exceptional meritorious services as commander of the 88th Supply and Service Battalion and the Regional Support Activity, Military Region II.

ARMY COMMENDATION MEDAL. *CPT William G. Thomas,* Frankford Arsenal, Philadelphia, Pa., received the Army Commendation Medal for 1970–73 service. He was cited for acquiring new data on methlnitrate and nitroglycerine, important to Army programs involving ignition and combustion of high-energy materials. COL J. L. Wallace, Frankford Arsenal CO, presented the award.

Hughes Receives BRL's 1972 Zornig Award

The 1972 Zornig Award, one of the two highest civilian awards made annually at the Army Ballistic Research Laboratories (BRL), Aberdeen (Md.) R&D Center, was presented recently to Richard L. Hughes.

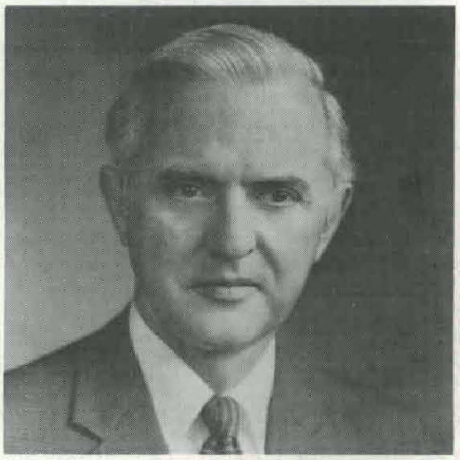
Hughes was cited for achievements as chief of the Budget and Programs Office, specifically for his planning, programing, execution and coordination of the entire BRL budget totaling $31.1 million.

BRL Director Dr. Robert J. Eichelberger presented the award, a gold lapel pin and a plaque listing the names of former recipients.

Established in 1959, the Zornig Award honors COL H. H. Zornig, who was responsible for the organization of BRL in 1938, and who served as director until 1941. The award recognizes outstanding individual achievement in technical, administrative, mechanical and other related fields.

Richard L. Hughes

Dr. McFann Elected President Of Military Psychology in APA



Dr. Howard H. McFann

Dr. Howard H. McFann, director of Division No. 3, Human Resources Research Organization (HumRRO), a major U.S. Army contract agency, recently became the third HumRRO staff member honored as president-elect of the Division of Military Psychology, American Psychological Association.

Dr. Meredith P. Crawford, president, and Dr. William A. McClelland, executive vice president, are the other HumRRO leaders who have served in this capacity. Dr. J. E. Uhlaner, technical director of the recently established U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), was selected for the honor in 1968. Dr. Arthur Drucker, chief of the ARI Plans and Operations Office, is serving a 3-year term as secretary-treasurer of the APA Division of Military Psychology.

Dr. McFann joined the HumRRO staff in the Motivation, Morale and Leadership Division, Washington, D.C. Following other assignments with various units, he became deputy director of HumRRO in 1962 and assumed his present duties in 1964.

Dr. McFann received a BA degree from Indiana University in 1948, an MA degree from Oberlin College in 1950, and a PhD from the State University of Iowa in 1952.

Initially, Dr. McFann's psychological research and publications were involved with animal and human learning. Recent work has dealt specifically with human performance in military and organizational settings such as training methods, small-group effectiveness, and behavior under conditions of stress.

Modified Mapping-Collocation

AMMRC Develops Analysis Technique For Isotropic, Orthotropic Materials

By Oscar L. Bowie

An effective analytical-computational technique has been devised recently for the analysis of cracks, notches and cutouts in 2-dimensional problems in either isotropic or orthotropic elasticity.

The technique and its applications are the results of a team consisting of Oscar L. Bowie, Donald M. Neal, Colin E. Freese and Kanu R. Gandhi, all employes at the Army Materials and Mechanics Research Center (AMMRC), Watertown, Mass.

With this technique, it has been possible to analyze several technically important configurations and loading systems to determine the effects of the orientation of material properties on the redistribution of stress, particularly in regions of high concentration.

The solution technique, the method of "modified mapping-collocation," was originally invented by Bowie and Neal for the 2-dimensional analysis of isotropic materials. This technique depends on combining the more attractive features of conformal mapping methods in complex variable theory and the method of boundary collocation of a stress function.

Each of the two latter methods is considerably modified in the sense of conventional application. The modified approaches, when combined, lead to an extremely effective tool for solving a large class of previously intractable problems. Furthermore, reliability of accuracy to within two percent is generally assured with computer runs of several seconds each.

Among several applications of the technique to isotropic materials, a particularly important investigation from the Army's needs was made by Bowie and Freese when they considered the problem of bore cracks in internally pressurized cylinders with finite wall-thickness. Numerical value of the stress intensity factors as a function of crack depth and tube wall ratios will aid the gun tube designer in applying fracture mechanics concepts.

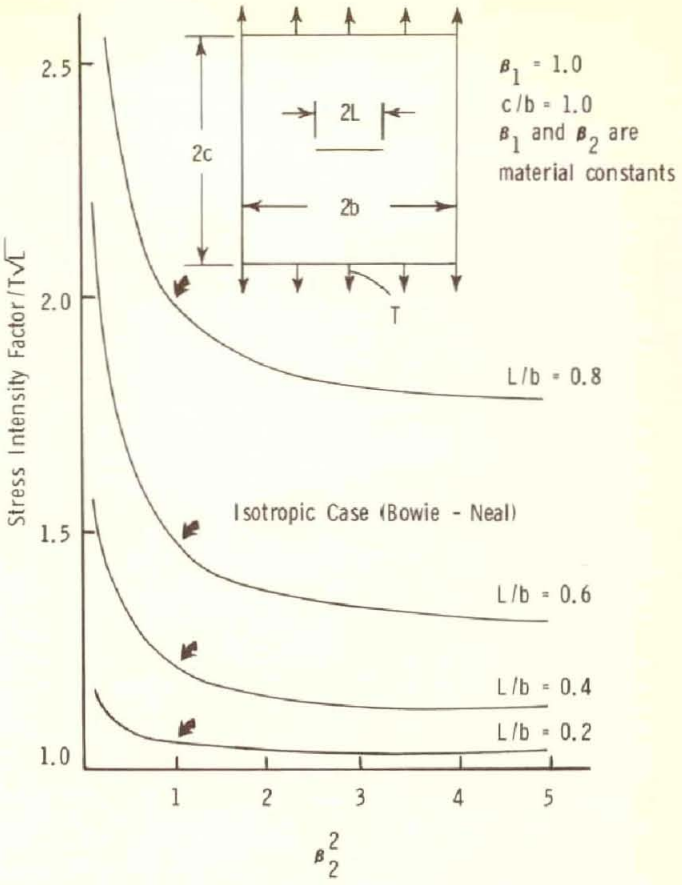
It was found that the approach was also effective for orthotropic materials. Historically, the mathematical formulation of the 2-dimensional problem of orthotropic elasticity has been well-defined for several years. On the other hand, very few solutions to practical design problems have been found.

Until recently, available solutions have consisted of a few classical methods for such relatively simple problems as holes or cracks in regions of infinite extent. Interest in this area has become increasingly intensified because of the possible applications of the model of homogeneous anisotropy to the overall behavior of composite materials.

The method for orthotropic materials was presented by Bowie and Freese in a paper, "Central Crack in Rectangular Sheet with Rectilinear Anisotropy," at the Army Symposium on Solid Mechanics, October 1970, at AMMRC. A variety of configurations have since been considered, including an investigation by Gandhi of the effects of material orientation on an arbitrarily oriented crack angle.

The most significant result found thus far relates to the stress intensity factors for cracks in orthotropic panels. The conventional stress intensity factor for orthotropic materials is defined to be consistent with the corresponding definition for isotropic materials.

On the basis of previous classical solutions, it has been stated frequently that the orthotropic and isotropic stress intensity factors coincide for self-equilibrating load systems. However, numerical results found in the investigations above



Stress Intensity Solution for Orthotropic Materials

for cracks in finite panels show that this widespread extrapolation is not valid.

Indeed, the conventional orthotropic stress intensity factor is often considerably influenced by the material's properties. This matter should be quite significant in the application of fracture mechanics concepts to 2-dimensional orthotropic materials.

A computer code, dubbed "ORTHO," has been written by Freese to handle a variety of configurations of orthotropic materials in a routine manner. It was found that isotropic results can be found with sufficient accuracy from the ORTHO code by choosing the orthotropic material constants as nearly the limiting case of isotropy. This eliminates for all practical purposes the need for considering two separate codes.

OSCAR L. BOWIE graduated from American International College in Springfield, Mass., in 1942 with a BA degree in mathematics. He then attended the Graduate Division of Applied Mechanics at Brown University before joining Watertown Arsenal in 1944. During his 27-year career at the arsenal (and AMMRC), he frequently has taken graduate courses at Massachusetts Institute of Technology.

Bowie remained in the applied mechanics group during his career and specialized in mathematical stress analysis. During the last several years his chief interest has been in the stress analysis of cracks with relation to fracture mechanics. He has authored approximately 60 technical reports and published numerous papers on academic and industrial research.