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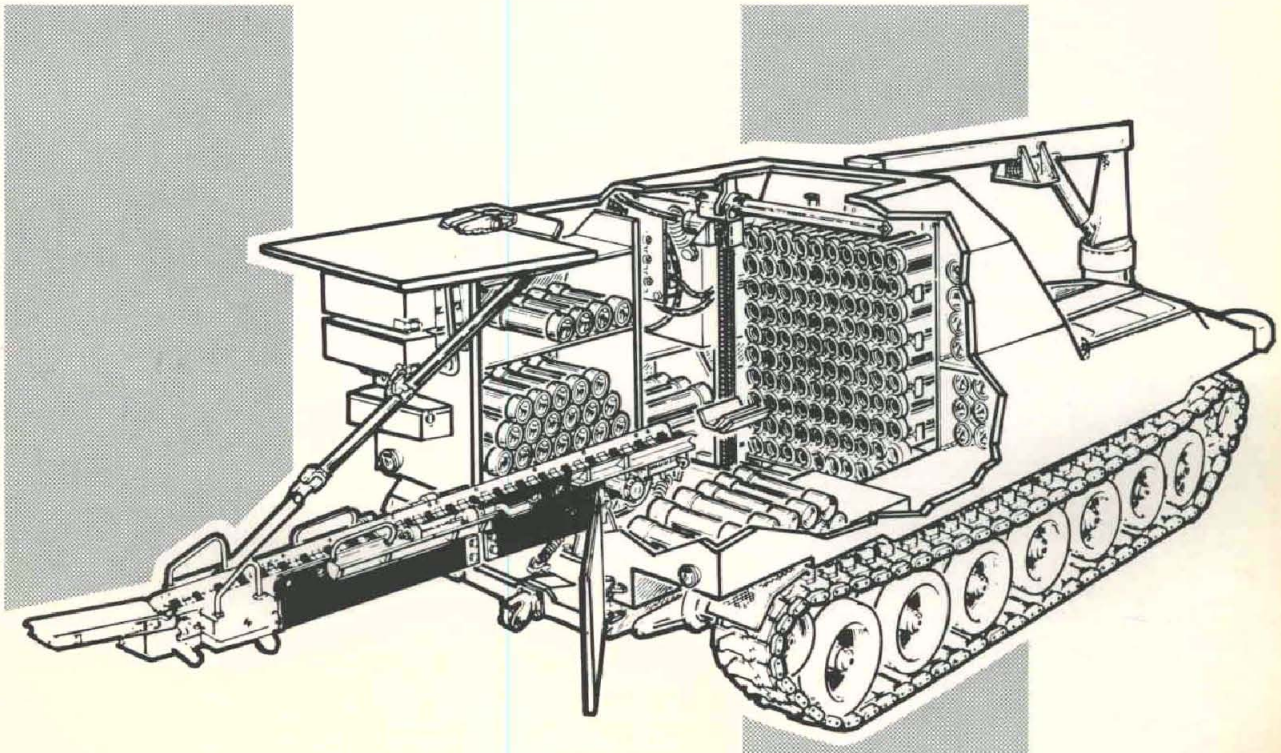

NEW ARTILLERY AMMUNITION SUPPORT VEHICLE

SEE PAGE ONE

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ABOUT THE COVER:

Shown on the front cover is a cutaway view of the new Field Artillery Ammunition Support Vehicle (FAASV). A full exterior view of the vehicle is shown on the back cover.

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FEATURES

DEPARTMENTS

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

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Field Artillery Ammunition Support Vehicle

By MAJ Arthur S. Remson and George Taylor III

A new Field Artillery ammunition carrier, under development for the Army's M109- and M110-series self-propelled howitzers, will provide improved ammunition handling, increased armor protection for the crew and cargo, and better mobility over that of the M548 resupply vehicle.

This new carrier, known as the Field Artillery Ammunition Support Vehicle (FAASV), is scheduled for fielding in May 1984.

The new vehicle consists of components which constitute an automated ammunition loading/unloading system enclosed in an armor shell mounted on an M109A2 chassis. It is designed to provide mobility equal to that of the M109A2, as well as small-arms and fragmentation ballistic protection for both the crew and ammunition.

Unlike the light-armored M548 carrier, which has an overhead crane that provides only a limited self-loading capability, the FAASV features a highly mechanized ammunition-handling system. This system includes an externally front-mounted, 1,500-pound-capacity crane, which will assist in loading ammunition aboard the vehicle and a mechanical stacker and conveyor belt to feed the ammunition into the howitzer.

The hydraulically operated crane, which rotates 350-degrees to aid in the ammo-loading process, has an extendable boom with a maximum lift capacity of 1,500-pounds.

In operation, the crane will pick up special honeycomb storage racks previously loaded at an ammunition supply area, and lower them through the top door of the FAASV where they are secured.

Propellent canisters and fuzes are loaded and stored in special compartments within the cargo area of the vehicle.

Not until the FAASV arrives at the forward combat area will the crew actually handle the projectiles. With the vehicle backed up to a howitzer, a crew member will slide a fuzed projectile from one of the honeycomb rack tubes onto the stacker. He will then slide the projectile from the staker onto the conveyor.

After he has the fuzed projectile on the conveyor, he then loads on a propellent charge. A complete round is delivered to the supported howitzer for firing before the next complete round is loaded onto the conveyor for transfer into the howitzer.

The FAASV, with the capability to deliver ammunition at a rate faster than the howitzer can fire, will be a vast improvement over the M548 ammunition carrier.

With the M548, the carrier and howitzer crewmen have to do almost all the work by hand. At the supply area, the crewman use the onboard crane to load pallets of ammunition onto the bed of the vehicle. However, from that point on everything has to be done manually.

At the battle site, a crew member cuts the bands that secure the ammunition to the pallet. It is then necessary to physically lift each round and hand it to personnel on the ground, who then must carry it to the howitzer.

This work is strenuous. The 155mm (6.1-inch) round used in the M109A2/A3 weighs about 109 pounds, and the 8-inch M110A2 projectile weighs about 207 pounds.

One FAASV will support either howitzer without making changes to the vehicle or ammunition-handling equipment. When supporting an M109A2/A3, the FAASV will carry 9 honeycomb storage racks, each containing 10 155mm rounds. For M110A2 support, the vehicle will carry 48 of the 8-inch projectiles in eight 6-round racks.

In addition to providing improved armor protection and ammunition handling, the new vehicle will be highly beneficial from a logistics standpoint. Since the FAASV and the M109A2/A3 use the same chassis, roughly 50 percent of the components are the same for both vehicles.

With so much component commonality, some important advantages are gained. For one thing, storage and stockage of spare parts will be simplified.

Another benefit is that the FAASV and M109A2/A3 howitzer automotive maintenance and operating procedures are virtually the same. Therefore, personnel training will be greatly simplified, and FAASV and M109A2/A3 howitzer crews will be partly interchangeable.

The new vehicle incorporates several advanced systems not present in the M109 vehicle family but which are planned for adoption in a product improvement program. These include an automatic fire suppression system, a nuclear, biological and chemical protection system, and the Army's Simplified Test Equipment for Internal Combustion Engines.

In addition, a high capacity auxillary power unit (APU) will be incorporated. The APU's generator will provide power to charge the vehicle batteries to supply electricity for the vehicle lighting, NBC equipment, and communication equipment. An integral hydraulic pump will provide the means to operate the front-mounted crane, the conveyor, and the X-Y stacker.

Also featured is an improved communications system consisting of an AN/VIC-1 intercommunication unit and an AN/VRC-68 small unit transceiver.

The program to develop the FAASV began in 1979 following a comparative evaluation of various chassis; a stretched version of the M548 chassis, an XM993 Fighting Vehicle System chassis and an M109A2 chassis. This evaluation led to the conclusion that the M109A2 chassis was the most suitable for use in a FAASV concept, and on March 19, 1980, the Army approved a program for development of a vehicle that would use the M109A2 chassis.

On August 27 of that year, TACOM released a request for proposal for the design, fabrication, test support, and integrated logistics support for the system. On March 25, TACOM awarded a contract to Bowen-McLaughlin-York Co., of York, PA, for fabrication of five FAASV prototypes by first quarter 1982.

The vehicles will undergo a series of tests at Yuma Proving Grounds and Fort Sill which are scheduled for completion in April 1982. If successful, as expected, type classification of the FAASV could come as early as September 1982, with a production contract awarded the following month.

MAJ ARTHUR S. REMSON is assigned as the Weapons System Manager (WSM), 10-Ton M.A.N. Tractor Transporter in support of the Ground Launched Cruise and Pershing II Missile Systems. He received a BSA degree from the University of Georgia and a MS degree from Alfred University.

GEORGE TAYLOR III is a technical writer and editor at the U.S. Army Tank Automotive Command. He holds a bachelor's degree in journalism and a master's degree in communications from Michigan State University.

Interview . . .

Human Engineering Laboratory Director Dr. John D. Weisz

Director of the U.S. Army Human Engineering Laboratory Dr. John D. Weisz reflected on past, present and future human factors requirements during a recent interview at Aberdeen Proving Ground, MD. His candid responses follow.

Q. Human engineering is so often referred to as an attempt to provide "man-machine" compatability. What is your definition?

A. I have been involved in the human factors engineering field for about 28 years and during this period there have been tremendous changes. Originally, it was thought of as an attempt to change the design of knobs and dials. Although these items are still essential, they are considered minor aspects. We are now much more involved in trying to attain, despite today's high technology, greater simplicity for both the operator and the maintainer. Therefore, we are constantly working with all of the DARCOM project managers and designers to assure that the average soldier can operate and maintain today's equipment. This is especially important because of the current high percentage of category-IV soldiers.

Q. Weapon system efficiency depends largely on the human user. Although weapons are becoming increasingly more complex, the human being is not. What, specifically, is HEL doing to deal with this growing complexity so as to assure optimum weapon efficiency?

A. First of all, I would like to differentiate between the words *complexity* and *sophistication*. A lot of people use these terms synonymously and this is incorrect. A *"sophisticated"* piece of equipment can be a high technology item yet it can still be relatively simple to operate and maintain. The example I use to stress this point is the Global Positioning System. This is a backpack system which interacts with space satellites. A computer in the backpack locates you very accurately on the ground within three or four meters. This is a very highly sophisticated piece of equipment. However, I learned to operate it in about 30 minutes. Maintenance, however, would not be done by the operator.

Complexity is when a system is so complicated that the average soldier, and even those who are highly trained, would have a difficult time with it. This is particularly true relative to maintenance. They may be able to understand the operational aspects but they would have a problem maintaining it, especially under certain environmental conditions. Now that I have differentiated between complexity and sophistication I will give a brief review of what we are doing here at HEL.

We try to work daily with designers and contractors in the development of U.S. Army materiel. We have also worked with the other three Services to develop and update two important documents relative to human factors engineering. One document is the *Human Factors Engineering Design For Army Materiel Handbook.* The other publication is a tri-service one entitled *Human Engineering Design Criteria For Military Systems Equipment and Facilities.* This second document lists such things as the anthropometric measurements for both male and female soldiers.

We try to get designers to design from the 5th to the 95th percentile person. This includes individuals ranging from about 5 feet 2 inches to 6+ feet. Height, of course, is only one of the many human dimensions we study. We include measurement of all aspects of the body. These measurements are listed in our human factors handbook. This handbook also contains guidelines relative to seat adjustments, lighting, and labeling of display controls, etc.

These are examples of the types of research results that are available here at HEL and at Universities and other Service laboratories. We can insist that these guidelines be incorporated in all Army materiel development contracts. As far as the Army is concerned, the tri-Service publication I discussed earlier becomes a requirement document that goes into every major materiel system contract.

Q. During the recent past, HEL conducted a pilot study to determine why some soldiers react better under stress than others. Has this study been completed and, if so, have any conclusions been reached?

A. We have not done anything recently pertaining to stress. Stress in humans is a very difficult subject to study. However, we have done one study that had a spinoff for training. We wanted to find out what effect a stressful situation had on rifle fire accuracy, and the number of rounds fired. Therefore, we conceived and developed a range in which the targets were arranged in a half circle about 30 yards in front of the soldier. The soldier was then told that if he did not hit the pop-up target with an M16 within three seconds then a BB gun, located in front of him, would start shooting back at him. The results were that the firing rate went up fantastically and the accuracy rate decreased. This training technique, using BB guns, was also adopted at Fort Benning.

Q. What are some of the more noteworthy contributions that HEL has made in the man-machine compatibility field during the past decade?

A. I am very proud of HEL's achievements. During the past year we developed a human factors engineering management model which begins when an initial requirements document is written. We then follow the entire development cycle and we delineate how each phase must address human factors design. Subsequently, when the system enters production, we can be sure we have the appropriate design and the right type of individuals available to operate and maintain the equipment when it is fielded.

The availability of skills is very important. My own personal opinion is that if skills are not going to be available, under a non-draft situation, we may have to stop development of some systems. I must stress that this is *my own opinion,* not the Army's. Two key factors which are becoming more important are *manpower* and *affordability*. There is no sense in developing a piece of materiel that we can't man and maintain in the field under combat conditions.

About 1½-years ago we developed a concept for the first artillery ammunition resupply vehicle. Basically, we took the top off an M109 and rebuilt an uparmored cab with a crane in it. This concept was so successful that it went directly into advanced development at TACOM. This was one of our more recent major achievements.

We also redesigned and successfully tested, in conjunction with Natick, a new female soldiers uniform. We have also successfully completed more than 2,500 field trials at a simulated ammunition supply point. I believe that HEL is the only facility doing R & D in support of the readiness side of DARCOM. In fact, I have established a new Combat Support Directorate which specifically deals with today's readiness problems. Additionally, we have redesigned the forklift so that it can be operated at night. There is only about a 10 percent decrease in loading and unloading ammunition at night versus daytime using this modified forklift.

We have also initiated new ammunition packaging concepts. Ultimately, this involves an attempt to develop a universal packaging system. Hopefully, this type of system will eventually replace the one we now have.

HEL, incidentally, is the lead agency for Military Operations in Built-Up Areas (MOBA). We have reviewed all of our present generation weapons and radios to determine how good or bad they are in cities and villages. We have conducted studies in Philadelphia, Boston, and in other cities. Based on these studies, we have made a series of recommendations relative to communications equipment requirements. We are also involved in coordinating the development of a potentially new MOBA weapon system. We have done a series of tests with the Ballistic Research Laboratory and others to analyze our current weapons for their effectiveness in a MOBA situation.

"Two key factors, which are becoming more important, are manpower and affordability. There is no sense in developing a piece of materiel that we can't man and maintain in the field under combat conditions."

Additionally, HEL holds the patent rights to the viscous damped principle which was involved in the design of the TOW tripod mount. An antitank weapon system must have a tracking accuracy of about a 10th of a mil in order to hit a target at 1,000 meters or 3,000 meters (the range of today's TOW). The viscous damped principle provides TOW with this accuracy. This same principle has been used by us in developing a concept which is presently adopted in Europe. The concept involves putting the Dragon on the M113 vehicle so we can hit moving tanks with a hit probability of about 92 percent. The viscous damped principle, therefore, gave us a very significant increase in hit probability.

One general comment I would like to make is that HEL is the world's leader in human factors engineering. I know of no other country or Service in the United States that has a similar type of laboratory that is as comprehensive as HEL.

Q. HEL has reportedly done some work with robotics. Do you envision a role for robots on the future battle fields?

A. I love to answer this question. I think that robotics is just emerging as an important factor, both with U.S. industry and the Services. HEL has been given the lead role in DARCOM for robotics. We currently have one project underway and we are forming a DARCOM executive steering committee on robotics which we will chair.

I see robotics as a field in which we can apply technology which is available today. Robotics isn't something that requires a lot of research. The Japanese, for example, have adopted robotics in their production lines for automobile design. Robotics technology is already available, it only needs to be implemented. The first demonstrator we are putting together will be a caisson vehicle which will be pulled by an 8-inch M110 artillery piece. This will be a wheeled vehicle with ammunition stacked on both sides of the flatbed with the robot in the center. The robot will be able to extract the rounds from the cases, be able to fuze it, and hand it into the back of the firing piece. The only problem we must solve is how to cut the charges. The charges come in bags and we need to overcome this.

Other possible near-term applications for robotics are for ammunition inventory control, spare parts handling, fueling of helicopters, and fueling of tanks, etc. I feel very enthusiastic about the use of robots. I think, in the long-term, it may be possible to use them for mineclearing and reconnaissance work, and use them as a vehicle to gather information. I believe that a great deal of R & D work will be done with robots during the next 5 or 10 years by DARCOM.

Q. How would you compare Soviet man-machine problems with those of the U.S.?

A. There is no doubt that the Soviets have similar problems. We do know that they do not put emphasis on human factors engineering as we do in the U.S. One advantage they have is that they are physically smaller than we are. Also, since they have such a large population, they can be very selective in choosing crewmen for various jobs such as tank operators. This permits them to design a vehicle for a smaller individual. We cannot do this because we have a smaller population to choose from and we have a non-draft situation. Consequently, our designers have a tougher job than theirs do.

I also believe that the Soviets don't pay as much attention to the comfort aspects as we do. I am not saying that we go overboard, but we are more sensitive to comfort than they are. *War is hell,* but we do try to make the individual as comfortable and efficient as possible.

Several years ago I had an interesting conversation with a Soviet colonel. I asked him how Soviet tank interiors were heated in order to keep their soldiers inside warm. He jokingly said, although I think he was serious, that they don't worry about their tank crewmen because they give them minimum clothing and tell them if they want to stay alive then they should keep active. I think this shows the difference in Soviet and U.S. attitudes toward the individual soldier.

Overall, I think that Soviet equipment is much easier to operate and maintain than ours. I don't believe that their systems are as complex as ours. One of our key problems is to make equipment as simple as possible to operate and maintain. My own opinion is that sometimes we create operational and maintenance problems by incorporating too much complexity into our equipment.

Q. What suggestions might you offer to bring greater attention to the importance of human factors in the design of weapon systems?

A. We have been trying to bring greater attention to the importance of human factors engineering for 30 years. I feel we have made tremendous progress in this area. During the past year there have been some dramatic changes. One of these changes was

"I always stress that the human being must be taken into full consideration when designing a system. A soldier's physical and mental assets and limitations are key factors if we want to develop effective combat equipment."

the approval of our "management model" by the Chief of Staff and its application by DARCOM.

We have made a special effort to stay in contact with all the designers in the Army and we try to insure that their contractors follow our design guides. We also operate a DOD-wide human factors data bank. During FY 1980 we responded to more than 8,000 inquiries on technical matters. Our data bank was an enormous asset in answering these inquiries. The data bank is used daily and we try to get our responses out within 24 hours.

There is really no single solution for bringing greater awareness to the importance of human factors. We use every available media for this purpose. I do know that we have been successful in gaining support because Army Chief of Staff GEN Edward Meyer is personally involved. He has requested that a special group be established to study the man-machine interface.

Q. Some critics contend that human design engineering efforts are often unnecessary and add substantial costs to the development of a weapon system. How do you respond to these charges?

A. There are a number of ways I respond. First, there is the analogy of safety. Contractors do not get paid extra for designing a safe system. Therefore, why should that be any different than designing a system that is properly engineered for human factors. Although there are some extra costs involved, it would not make sense to design a system that can't be properly utilized.

Man must be considered a "component" of the system. Machines do not operate themselves. Criticism of the financial costs of human factors used to be much more prevalent. Although it still occurs, it is very rare today. I always stress that the human being must be taken into full consideration when designing a system. A soldier's physical and mental assets and limitations are key factors if we want to develop effective combat equipment.

Q. There is currently a TRADOC/DARCOM study underway on the "man-machine interface." Do you envision any change to the Army's acquisition process as a result of this study?

A. I can be both pessimistic and optimistic in answering this question. I can be pessimistic because of my past participation in a number of these studies. For example, I was involved in a 1967 DOD-wide study on the exact same subject. Eight persons, including myself, devoted a year to this study. We formulated a series of recommendations on how to improve things and, to the best of my knowledge, nothing has ever been done regarding those recommendations. I have a famous old Indian phrase that I apply to these kinds of studies if the results are not properly implemented . . . *"Big wind, loud noise, no rain!"*

Relative to the current study, I must say that I am more optimistic. This is because it is being guided by high-level people such as GEN Meyer. I have hope that this time the results will be properly implemented. The study is still ongoing, TRADOC is chairing it, and we are participants in it.

Five systems will be studied to determine what human factors were originally recommended and what ones were adopted and utilized. We know that we do have some success stories. For example, approximately 67 percent of our recommendations were utilized in the design of the Pershing missile system. However, I could also give you examples where systems did not get fielded because our recommendations were ignored. These systems were never produced, specifically because of human factors engineering deficiencies.

I just want to emphasize that I do have high hopes that the current study will result in major contributions and, along with our management model, we will be able to do a better job in designing Army materiel.

Q. If the Army returned to the draft do you believe it would simplify the man-machine interface problem?

A. This question is very difficult to answer. It obviously has ramifications as far as our society is concerned. I think it is rather doubtful that the U.S. public would support the draft. If the U.S. were attacked then perhaps opposition to the draft would cease. I should stress that these comments are my own opinion.

A return to the draft would obviously increase the potential population from which we could draw to operate our complex equipment. Hopefully, we would then have the skills, both in quantity and quality, to operate and maintain our materiel items. This is a very controversial issue that must be resolved at the highest levels. It must also be accepted by the American public.

The Vietnam War didn't really help the public's attitude toward the draft. This wasn't the case in World War II because we were attacked. Whether we can turn this country around to accept the draft is a serious question that must be resolved very soon. I do not believe we can continue on our present path. The critical point will be around 1983 when the Army will be fielding more than 30 major systems. The real dilemma is whether we can man this new materiel with the limited manpower that we now have.

Let me make myself clear because I don't want to be misunderstood. I have complete faith in the individuals we now have in the Army. We use about 5,000 of our soldiers annually, both male and female, in laboratory and field experiments and I am constantly amazed at their devotion and motivation. However, I won't deny that we do have problems. Drug and alcohol use have created some problems, but I think they can be solved through counselling and separation of some individuals.

I would like to stress also that the Army has devised new maintenance manuals which are better adapted to the intellectual capacities of today's soldiers. For example, the reading capabilities of the average U.S. high school graduates is only equivalent to the sixth-grade level. Under these circumstances, I think there is a serious question whether the draft would even help us. I think this is a very sad situation. I believe that our school system must get involved if improvements are to occur. Dr. Fischer, one of my principal investigators in reading behavior, has come up with some fantastic results. If these results were to be implemented in our school system, then I think we could improve reading skills very dramatically. Incidentally, Dr. Fisher has published his results and they have received wide acclaim and he has become an internationally renowned researcher.

Basically, I think we have to work at solving our problems in this area, both from within the Service and with our educators. Perhaps our educators need to go back to the older methods of teaching people how to read, write, and do arithmetic.

Army R & D Achievement Awards . . .

49 In-House Army Scientists, Engineers Recognized

U. S. Army R & D Achievement Awards will be presented to 49 Army in-house laboratory scientists and engineers for achievements that have advanced capabilities of the U.S. Army and contributed to the national welfare during Calendar Year 1980.

The awards, consisting of a wall plaque and a 2-inch cast-bronze medallion, will be shared by 39 personnel attached to activities of the U.S. Army Materiel Development and Readiness Command (DARCOM), 8 with the U.S. Army Corps of Engineers, and 2 with the Office of The Surgeon General.

Recipients of the awards will be honored by Army R & D leaders, during the next few months, at the activities where they are employed.

Listed within their major commands, subcommands and/or installations, the award winners and excerpts from their nominations and citations follow.

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

• **U.S. Army Armament R & D Command (ARRADCOM) HQ, Dover, NJ.** Four members of the Large Caliber Weapon Systems Laboratory (LCWSL) will receive the Army R & D Achievement Award for developing and producing an improved warhead section (M207E1) for the TOW missile system, in an extremely short time.

"This accomplishment provides the Army with a capability to defeat enemy armor targets that may be found on the battlefields of the future."

Team members are *Messrs. Theodore Stevens, Edward Naiman, Michael Esposito* and *James Pearson.*

A 2-man team from ARRADCOM's LCWSL will receive an award for contributions to the science and technology of amorphous metals which, because they have a non—crystalline liquid-like structure, exhibit unique properties when compared to normal crystalline metals. The absence of a grain structure results in exceptional corrosion resistance, strength and ductility.

Through the efforts of *Drs. Paul Cote* and *Lawrence Meisel,* high crystallation temperature amorphous metals have been synthesized for the first time, using a low-cost and efficient electrodeposition technique, and important insight was gained into understanding the relationship between the electronic structure and properties of these materials.

A 3-man team of scientists and engineers from ARRADCOM's Ballistic Research Laboratory (BRL), Aberdeen Proving Ground (APG), MD, was commended for development of a new SADARM munition millimetre-wave sensor that employs novel techniques to render it less sensitive to electronic countermeasures and more effective under conditions of severe battlefield obscuration than the sensor it is designed to replace.

The team includes *Messrs. Donald G. Bauerle, Joseph E. Knox* and *Harry B. Wallace,* all employed within BRL's Ballistic Modeling Division.

Four more R & D Achievement Awards will go to BRL scientists and engineers for individual accomplishments.

Dr. Albert E. Rainis was cited for his research and display in development of a new armor concept that increases survivability of personnel and equipment exposed to combined effects of conventional and nuclear weapons.

It is anticipated that his efforts in armor research will have a significant impact on the future design and development of armored combat vehicles.

Stanley K. Golaski will be honored for conducting and directing research on new methods of bonding previously incompatible materials into dynamically stable laminates. This work is considered of great value to armor designers and far beyond, since the laminates permit precise tailoring of materials to fit almost any task.

Walter O. Egerland will receive an award for his fundamental research in the applied mathematics of dynamical games of conflict with randomized strategies.

According to his citation, his work will find immediate application in conventional combat situations used for weapon effectiveness studies, and may ultimately lead to new techniques for artillery fire control using "smart" munitions.

Dr. Robert B. Frey was selected for exceptional performance of duty resulting in significant advances in the understanding of the mechanisms of initiation of violent reactions in explosive-containing munitions. The results of his research provide the basis for developing munitions that will survive severe impact environments without detonating.

ARRADCOM researchers employed at the Chemical Systems Laboratory (CSL), APG, MD, account for a 2-man team award and an individual award.

Drs. Robert H. Frickel and *Janon F. Embury* will be commended for their development of a theoretical approach and mathematical model for predicting the optimal extinction per unit mass of an aerosal of any shape, size or homogenous composition. "Their selection of candidate smokes, based on their prediction, has greatly speeded-up the development of new IR screening smokes."

Joseph W. Hovanec is recognized for his technical contributions that have led to significant advances in the U.S. Army chemical munitions demilitarization program.

"He has shown diligence and imagination in applying basic chemical research techniques to the problem of VX solubilization and decontamination. The decontaminant formulated through his efforts will permit the facile adaptation of the Chemical Agent Munitions Disposal System to VX operations at a considerable savings of time and cost to the Government.

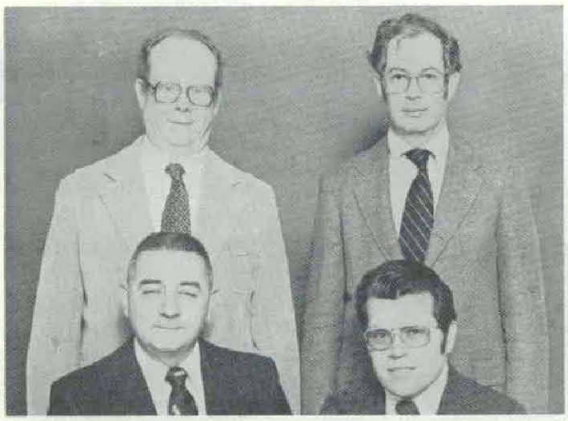
• **U.S. Army Electronics R & D Command (ERADCOM), Fort Monmouth, NJ.** Three R & D Achievement Awards will go to ERADCOM personnel; a 3-man team award for research at the Electronics Technology & Devices Laboratory (ET&DL), Fort Monmouth, NJ, and 3-man and 2-man awards for accomplishments at the Harry Diamond Laboratories (HDL), Adelphi, MD.

Messrs. John L. Carter, Maurice Weiner and *William C. Beattie* will be commended for major contributions to the development of nanosecond pulsers for millimeter crossed-field amplifier tubes.

"The development has resulted in a practical design of a pulser module capable of providing nanosecond pulses at the voltage levels required to drive high-power transmitting tubes that operate in the millimeter wavelength of the electromagnetic spectrum. The application of millimeter-wavelength target acquisition and advanced fire control radar system will result in a significant improvement in system high-resolution capabilities."

R & D Awards will be presented to *Dr. Norman J. Berg,* and *Messrs. Michael W. Casseday* and *Irwin J. Abramovitz* at HDL in recognition of the discovery, development and application of innovative acousto-optic signal processing techniques to critical Army problem areas.

"Their work has led to development of



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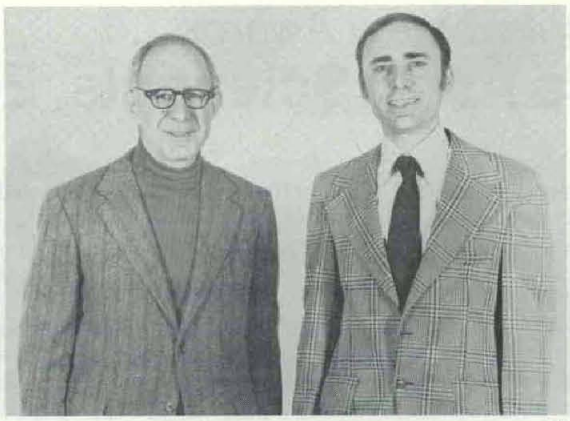

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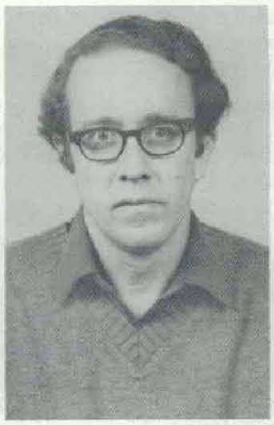

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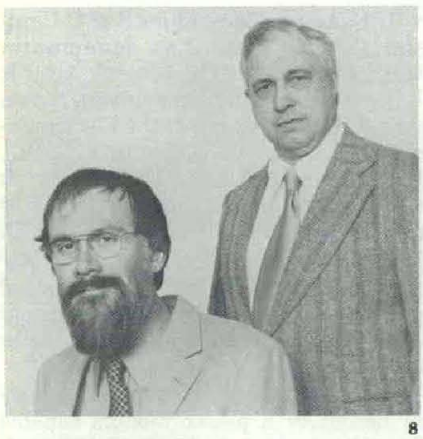

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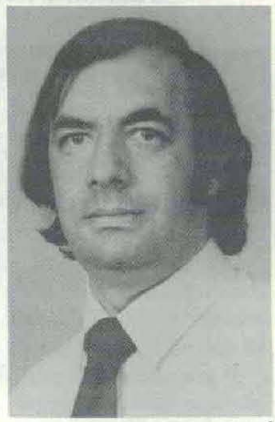
R & D Achievement Award Winners

U.S. Army Armament R & D Command (ARRADCOM), HQ, Dover, NJ — (1) Top (l. to r.) are Theodore Stevens and James Pearson; below, Edward Naiman and Michael Esposito. (2) Dr. Lawrence Meisel and Dr. Paul Cote. (3) Dr. Albert E. Rainis. (4) Donald G. Bauerle, Harry B. Wallace and Joseph E. Knox. (5) Dr. Robert B. Frey. (6) Walter O. Egerland. (7) Stanley K. Golaski. (8) Dr. Janon F. Embury and Dr. Robert H. Frickel. (9) Joseph W. Hovanec. **U.S. Army Mobility Equipment R & D Command (MERADCOM), Fort Belvoir, VA** — (10) David C. Heberlein. (11) Peter M. Pecori. **U.S. Army Missile Command (MICOM), Redstone Arsenal, AL** — (12) Walter E. Jordan and Paul L. Jacobs (13) Thomas A. Barley.



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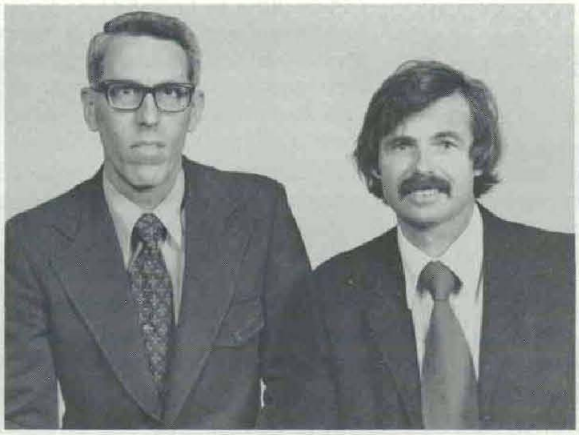

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signal processing architectures that utilize the extremely large time-bandwidth products and other high-performance characteristics of acousto-optic devices to analyze complex signals in real and almost real time."

These signal processing techniques are now being used in new systems that are of great interest to the Army and which were not feasible with previously available technology.

HDL physicists *Dr. Donald E. Wortman* and *Mr. Herbert A. Dropkin* will receive awards in recognition of the successful research effort to develop a tunable, lightweight, intermediate power, narrow-linewidth source of near-millimeter wave radiation referred to as an Orotron for Open Resonator Oscillator.

Their citation states, in part, "The meticulous patience, ingenuity and tenacity of these individuals resulted in their overcoming numerous difficult problems in an exceptionally short period of time to construct the Western world's first operating Orotron. This oscillator has application as a near-millimeter wave source of radiation for tactical battlefield scenarios in the prescence of obscurants."

• **U.S. Army Mobility Equipment R & D Command (MERADCOM), Fort Belvoir, VA.** *Dr. David C. Heberlein,* a supervisory physical scientist with the Countermine Laboratory, was selected as a recipient of the R & D award for formulating and developing the theoretical and experimental scientific basis for exploiting CANETIP, binary enhanced explosives and for application towards significantly increasing countermine capability over that now available from fuel-air explosives.

"The military importance of this achievement is profound and portends the potential for new applications in diverse military systems."

Mr. Peter M. Pecori, electronic engineer with the Countermine Laboratory, is commended for development of a new design for the AN/PRS-7 metallic/non-metallic mine detector that corrects an operational deficiency in desert environments.

"This accomplishment will significantly enhance the Army's operational readiness and combat effectiveness by improving the current ability to perform countermine missions in desert environments.

• **U.S. Army Missile Command (MICOM), Redstone Arsenal, AL.** Aerospace engineers *Messrs. Walter E. Jordon* and *Paul L. Jacobs,* with the U.S. Army Missile Laboratory, are recognized for advancing the Army's technical capability in the analysis, design and development of new technology for strapdown inertial guidance systems for present and future Army missile systems.

It is reported that the technology developed during the program has the flexibility and growth potential to adapt to many missile systems, both in the true fire-and-forget mode, the midcourse guidance mode or the guidance with update mode.

Mr. Thomas A. Barley, U.S. Army Missile Laboratory, was selected to receive an R & D award for concepting a millimeter wave differential guidance technique; developing an implementation plan for experimentally validating the guidance technique; directing the general design of the experimental validation hardware; and conducting the validation experiments through guided flight testing.

"The work is particularly significant in demonstrating precise radar guidance in the presence of clutter, multipath, and totally obscuring smoke, which is characteristic of the realistic battlefield."

• **Ballistic Missile Defense Advanced Technology Center (BMDATC), Huntsville, AL.** *Dr. Carl G. Davis* was nominated and selected in recognition of his pioneering work in designing and developing the Software Development System, a collection of advanced software development tools that have had a significant impact upon the software development community.

"The system has demonstrated that it can develop the high-quality software required for ballistic missile defense and other Army weapons systems, and its techniques have become the foundation for the industry standard."

• **U.S. Army Aviation R & D Command (AVRADCOM), St. Louis, MO.** AVRADCOM nominated a 5-man team from the U.S. Army Research and Technology Laboratories (USARTL), NASA--Ames Research Center, Moffett Field, CA, to receive Army R & D Achievement Awards.

Mr. Henry E. Jones, aerospace engineer with the USARTL Advanced Systems Research Office; *CPT John D. Berry, Henry L. Kelley, John C. Wilson, Gene J. Bingham,* of the USARTL Structures Laboratory, were selected for developing, demonstrating and verifying a design technique for improving performance potential of helicopter rotors.

"The method involves treating definition of airfoil requirements for a specific application, airfoil development and blade geometric parameters as an integrated system."

"This technique represents a significant advance in the technology of helicopter performance, since the changes can be incorporated as a part of reblade product improvement programs (PIP) without any additional helicopter modifications."

• **U.S. Army Materials and Mechanics Research Center (AMMRC), Watertown, MA.** *Dr. James W. McCauley* and *Mr. Normand D. Corbin,* both with the Ceramics Research Division of the Metals and Ceramics Laboratory, are officially recognized for their contributions to the Army's Science and Technology base in developing nitrogen-stabilized cubic alumnia (ALON), and devising a method for its fabrication by a sintering process.

"This material provides the Army with significant new potential capabilities in the area of missile guidance transparancies and other key technologies."

Dr. Janet S. Perkins, Composites Development Division, Organic Materials Laboratory, AMMRC, is recognized for her work in elucidating, the mechanism by which tungsten-bearing resins provide superior laser protection. "Her work will have a significant impact on the design of future laser barriers."

• **U.S. Army Research Office (ARO), Research Triangle Park, NC.** *Dr. James W. Mink,* with the Electronics Division, will be commended for contributions to printed and conformal microwave antenna technology.

The results of his work will provide the Army with "improved design methods for more reliable, high-performance antennas for radar arrays, fuzes and missile telemetry systems."

U.S. ARMY CORPS OF ENGINEERS

• **U.S. Army Engineer Topographic Laboratories (USAETL), Fort Belvoir, VA.** Assigned to the Equipment Development and Test Group of the Special Projects Division, *Mr. Anthony W. Stoll* was selected for successfully guiding development of the Pershing II Reference Scene System (PRESS) and the Reference Scene Generation System (RSGF), which generate simulated target references that guide the Pershing II missile to its target.

"Mr. Stoll's effort has enhanced the capabilities of the Pershing II and it is expected that other weapons systems will borrow technology developed under the direction of Mr. Stoll."

Mr. George E. Lukes, a physical scientist with the Research Institute, USAETL, will receive the Army R & D Achievement Award for planning, designing and implementing a research laboratory and program in computer-assisted photo interpretation research that is expected to have a significant impact on USAETL's research program and further developments for the Defense Mapping Agency.

"This achievement contributes directly to the high-priority goal of developing more efficient and accurate techniques for extracting information from mapping and


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R & D Achievement Award Winners

U.S. Army Aviation R & D Command (AVRADCOM), St. Louis, MO — (1) Henry E. Jones. (2) Gene J. Bingham. (3) John C. Wilson. (4) Henry L. Kelley. (5) CPT John D. Berry. U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL — (6) Frank W. Kearney. U.S. Army Engineer Topographic Laboratories (USAETL), Fort Belvoir, VA — (7) George E. Lukes. Ballistic Missile Defense Advanced Technology Center (BMDATC), Huntsville, AL — Dr. Carl G. Davis.

reconnaissance aerial photography."

• **U.S. Army Waterways Experiment Station (WES), Vicksburg, MS.** *Dr. Phillip G. Malone,* geologist, and *Mr. Douglas W. Thompson,* environmental engineer, have been selected for their contributions to the development and application of the ultraviolet-ozone treatment process technology to a wide variety of military toxic and hazardous waste-treatment problems.

According to their citation, "this technology has the potential for widespread application in the future for the removal of chemical and biological contaminants, including some potentially carciogenic compounds, from water supply sources for troops in the field in the theater of operations, military installations, municipalities, and selected industries."

Dr. James R. Houston, a research hydraulic engineer, will receive an R & D award for conducting research activities leading to new and significantly improved methods for numerically simulating tsunami propagation and interaction with nearshore regions. He used these methods to determine tsunami inundation levels for the entire west coast of the continental United States, the Hawaiian Islands, and American Samoa.

"The systematic and technically sophisticated approach he developed to delineate tsunami hazards allows rational development of coastal areas threatened by tsunamis and proper design of coastal structures to withstand predicted forces."

• **U.S. Army Construction Engineering Research Laboratory (CERL), Champaign, IL.** *Dr. Edgar Samuel Neely* has been selected as a recipient of the Army R & D Achievement Award for his effort in development of a new computer-aided construction specification preparation system known as EDITSPEC.

The system, according to his nomination submission, will result in an estimated 335 manyears of effort and more than $10 million over the next five years.

Mr. Frank W. Kearney, an electronics engineer with CERL, is commended for his work in developing a real-time Weld Quality Monitor (WQM) capable of establishing the quality of a weld while it is being made.

"The development means that it will be possible to minimize or eliminate costly post-weld inspection and still assure a quality weld. Interest in the WQM has been shown in both Government and private industry who see the device as a major cost-cutting item."

• **U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NH.** The award will be presented to *Dr. Wilford F. Weeks* for establishing a scientific basis for engineering problems dealing with floating ice.

His achievements have included furthering the understanding of the strength and electromagnetic properties of sea ice, and organization of major remote sensing experiments that have developed an increased knowledge of the movement, occurrence, distribution, and behavior of sea ice.

OFFICE OF THE SURGEON GENERAL

• **Walter Reed Army Institute of Research (WRAIR), Walter Reed Army Medical Center, Washington, DC.** *Dr. H. Kenneth Sleeman* and *Mr. Nesbitt D. Brown* have made a significant contribution to the U.S. Army's program on medical defense against chemical agents by isolating, purifying, identifying and characterizing toxic substances which develop in the antidote formulations in Atropen injectors.

"These toxic components generated during storage and aging of Atropen obviated the use of the injectors by U.S. Army Forces in the event of nerve agent attack. The solution to this problem was achieved in a short period of time, due to their systematic approach, organizational talents and innovativeness in development of required analytical methodology."

Toward New Combat Vehicle Armament

A popular military topic in the media for the past six months has been the RDF - Rapid Deployment Forces. Closely related to this topic has been that of a new lightweight tank and combat vehicle of some type to be used by RDF ground forces. The sought-after vehicle has been referred to under a variety of terms, depending upon to whom one talked, when, and in what context.

The terms one has heard include HIMAG for High Mobility and Agility Vehicle, HSTVL - High Survivability Test Vehicle-Light, Light Tank, APAS for Air Transportable Protected Anti-Armor/Assault Capable System, HMMWV - High Mobility Multiple wheeled vehicle, LAWCV for Lightly Armored Wheeled Combat Vehicle, MPG or Mobile Protected Gun, Mobile Protected Weapons System (MPWS), and finally, LAV for Light Armored Vehicle-the name that now is in general use.

Both the Army and the Marine Corps have stated interest in some sort of a light armored combat vehicle that will meet the weight restrictions of rapid deployability, yet be able to carry out its successful combat mission at its destination.

With the maturing of the RDF concept the need for such a lightweight armored vehicle began to emerge in more specific terms. What has finally jelled is a two part effort - a quick interim near-term solution and a long-term one. The near-term requirement is being driven by the Marine Corps who have set a goal of 1983 to field such a system, using off-the-shelf components. This program, recently formally established, will be a joint Army-Marine Corps effort. (See July-August 1981 issue, inside back cover).

Additionally, technology efforts began some years ago by the Army and closely monitored by the Marine Corps, will continue with the goal of satisfying the long-term requirement of both services.

In the months that preceded the establishment of this new LAV program there were some problem areas between the two services. One of these was the resolution of what the term "light" meant. It was accepted by all that mobility-strategic as well as tactical-would be the dominant characteristic of the needed new vehicle. It had to have the capability to be carried in Air Force C-141s and C-5As as well as by Marine CH-53 and helicopters. But there was a difference of opinion then between the Army and Marines over how light was light. The Army thought in terms of a 20-25 ton vehicle, but the Corps contended that the lift capability of their CH-53s restricted the vehicle to one of hopefully 14 tons, certainly no more than 16 tons.

Part of the weight problem naturally, hinges on the armament to be placed on the vehicle, and this in turn is governed by the mission to be assigned the vehicle. While the trend of tank armament over the past two decades has been to upgun from 76mm to 105mm and now to go to 120mm, the weight and dynamics of the latter makes its use on a very lightweight armored vehicle virtually impossible. Consideration initially was given to both a new 75mm and a 90mm cannon utilizing new technology. The Marines recently, have expressed interest in a new 105mm gun approach for an assault gun version of the LAV.

The Marine Corps philosophy caused it to lean originally toward the 75mm, not forseeing the vehicle's primary role as a tank killer. The Army thought more toward the larger 90mm, forseeing its vehicle in an antitank role.

However, as the program has solidified, the vehicle to answer the near-term requirement will carry the Army's newly developed M242 Bushmaster 25mm Automatic cannon. For the long term solution development of the heavier caliber weapons will be pursued.

A recent newspaper article on the subject of cannons to be used on the new light vehicle stated that developments on the 75mm and 90mm guns went back to 1974. Actually the idea of a new cannon of medium bore, capable of defeating most armored targets, was begun some years before. It was an idea or concept fostered and pushed by a physicist then on the Army staff, Dr. Vitali Garber.

Dr. Garber, now a senior official in OSD and NATO, came to the Army's Office Chief of Research and Development in 1971 to serve as technical director to the director of developments. Garber, a former tank officer himself, brought with him the idea of a radically new cannon, and he spent considerable time doing theoretical design and testing of the concept.

It so happened that at this same time the Army was getting ready to terminate its MBT-70 program on the grounds that the tank had become too costly to procure. Congressional interest was intensely high, and the evidence at hand said that the Army would be mandated by the Congress to come up with a less costly tank, but one that would represent a considerable technological improvement over the M60 series. And equally important, the Army was being told that it would have to complete its development in six years.

Independently but concurrently, Garber told the RDA Magazine, he had been directed, in his capacity of scientific advisor, to provide LTG William C. Gribble, Jr., the Army's then Chief of Research and Development, with an evaluation of what would be needed to materially upgrade a future tank. His investigations were to include all areas - mobility, firepower, fire control, armor, etc. He was to look at the goals in terms of near-in improvements or product improvements, those attainable in the next three to four years, and last, those applicable for the generation beyond.

While payoffs existed in all areas, there was one in particular, said Garber, which beyond all others his study efforts said appeared to offer a far greater enhancement, and that was in the firepower category. Specifically, it was in the rate of fire deliverable on a moving target. The payoff seemed comparable Garber believed, to that of the machinegun on horse cavalry.

The data were derived from studies and computer evaluations in which an array of the Army's finest labs participated. The driving force became those things attainable within the current or foreseeable states of the technological art.

The emerging concept was that of a high rate of fire gun, a gun of a caliber in the 60mm - 75mm range, firing a high length to diameter (L/D) armor piercing fin stabilized discarding sabot (APFSDS) using a heavy metal penetrator of depleted uranium or tungsten alloy. Such a gun would require advances in metallurgy to withstand greatly increased stresses, but these advances were believed attainable. Contemporary data provided by the French government corroborated this belief, said Garber.

The pay-off seemed to be tremendous. Size and weight of main armament could be reduced, yet hit and kill probability went up, particularly at the longer ranges against moving targets - the point where the effectiveness of conventional cannon gunnery falls sharply. The rapid rate of fire, utilizing the long rod penetrator was

the solution. It seemed to offer, said Garber, equally advantageous capabilities when adopted to the air defense role and to the attacking of soft ground targets using high explosive warheads.

The concept appealed to LTG Gribble, and the idea was outlined in detail to then Chief of Staff GEN William C. Westmoreland, in 1972. But the climate, Garber noted, was awkward for introducing a new concept. The Army was terminating MBT-70, and Congress impatient with the Army's slow progress in fielding a tank, would not be in a receptive mood for a new start involving unproven technology.

The decision by GEN Westmoreland then, was to follow the more conventional route capitalizing on the breakthrough in new armor, the route which has led to the development of what most believe is the finest tank of its generation - the new M1 Abrams.

But LTG Gribble was determined, Garber said, that the new idea not be allowed to die. Rather, he found a way to continue it at Aberdeen's Ballistic Research Laboratory on a relatively low level, but with the objective of pushing the technology for an automatic cannon, from the 60mm caliber up to and including 90mm.

"But it was very hard keeping the project alive," said Garber, since the Army had made the decision to put its eggs in the XM1 basket. "We decided then, in 1973 to ask DARPA, (DOD's Advanced Research Projects Agency) for help." In approaching DARPA, the Army promised to support that agency by making available the resources of the Ballistic Research Laboratory if DARPA agreed to do the work. Enthusiastic support by Dr. Charles Church and Mr. Charles Lehner resulted in DARPA's soliciting industry views later in 1973. The guidelines or system parameters provided industry were relaxed a bit to allow closer-in technology to be utilized, one element thereof being to allow consideration of a 75mm approach, vis-a-vis Dr. Garber's 60mm high pressure gun approach.

It was DARPA's conclusion after some initial investigations, that the single most productive area would be an automatic cannon, something on the order of one round-per-second rate of fire, with the propellant means - liquid or conventional-left unspecified.

Within DARPA the effort was in two parts - one that looked at the new gun technology, and a second that looked at new vehicle approaches.

The gun program progressed to a paper competition conducted by DARPA for the gun and for the round. The gun winner was ARES, Inc., while AAI of Cockeysville, MD - a firm known to many because of its work on the Army Special Purpose Individual Weapon (SPIW) in the 1960's, was the selectee for the ammunition development.

In March 1976, DARPA awarded a contract to the National Water Lift Co. to build a prototype test vehicle called the High Mobility-Agility Test Bed Vehicle (HIMAG), a program that was taken over in January 1980 by Teledyne Continental Motors.

Concurrently with this action, and in anticipation of the transfer of the program along with the separate DARPA high velocity automatic gun effort, the Army established an Armored Combat Vehicle Technology Program Office at HQ, TARADCOM.

However, Army Chief of Staff, GEN Bernard L. Rogers, decided to keep direction of the Army effort in his own immediate office to ensure adequacy of effort. To carry out this function, then MAJ Terrel G. Covington was transferred from DARPA to the Army staff, designated as system manager, and his office was physically located in the Office of the Chief of Staff. But since the Headquarters Department of the Army is not normally a contracting and operating agency, a small project manager's office was established in July 1977 at HQ TARADCOM to handle these functions. The charter stated that the PM was responsible for discharging Army/DARCOM responsibilities in support of the system manager's office. Currently assigned as PM is LTC (P) James B. Welsh.

In November 1977, DARPA turned all of its work on the gun and the HIMAG vehicle over to the Army and the Marine Corps by means of a Memorandum of Understanding between that agency and the two Services. The Services were to fabricate test bed vehicles to carry the previously done theoretical work into a more realistic test framework - reduce uncertainties and lessen technological risks.

Under the MOU, test versions of both the 30-40 ton HIMAG and a lighter 16-20 ton High Survivability Test Vehicle - Lightweight (HSTV-L) would be built; accelerated development of a 75mm automatic cannon and ammunition would be undertaken along with its integration into the HSTV-L; and parallel analysis would be done by the two services to determine experimental employment concepts of the several systems.

Shortly thereafter, a contract was awarded to the AAI Corp. to build the High Survivability Test Vehicle (HSTV-L), which contract was definitized in March 1978.

The responsibility then, for the integration of the 75mm gun and ammunition project with the two test vehicles was assigned to the PM-ACTV, with technical and administrative control of the gun/ammo contracts provided by an ACTV program office at ARRADCOM.

The concept of the new cannon has now taken form of a high rate of fire, burst or single shot, rotating breech gun, capable of using telescoped (cylindrical) ammunition.

Army testing of HIMAG began in 1977 at Yuma Proving Ground and continued at Fort Knox, with a full-up system test conducted there in March 1981.

The HIMAG exceeded the goals assigned in speed and acceleration - 72 mph and 0 to 30 mph in 7.2 seconds. Current HIMAG weapon data reflect a burst rate of one round in less than one second, also in excess of performance goals, Initial data from contractor tests reflect the weapon accuracy goals against moving and stationary targets by both a moving and stationary HIMAG, have been attained. The HIMAG contract effort has been essentially completed.

Progress with the HSTV-L has been behind its companion program due to a later start and initial technical difficulties experienced during contractor tests. Noise and toxic fumes testing were completed at Fort Knox in October 1980, and shoot-on-the-move tests began in mid-April 1981.

Some goals have been difficult to meet to date. The weight has risen to 19 tons combat loaded without special armor and 22 with it. During the contactor testing at Aberdeen Proving Ground, the HSTV-L attained a top speed of slightly over 51 mph at a gross vehicle weight of 35,660 pounds, while acceleration to 30 mph required 11.8 seconds.

During the government's full-up system testing, scheduled for completion in June 1981, 129 rounds have been fired with

both vehicle and target stationary. All were fired with the fire control system in either the automatic target track mode or manual. However, the evidence indicates that system accuracy goals from both stationary and moving vehicles versus stationary target will be met.

The burst fire rate of HSTV-L is currently at 1.5 seconds per round. As of the time of writing this article there are no significant problems in the HIMAG/HSTV-L programs.

In the spring of 1980 a new dimension was added when HQDA saw potentially significant technological advances in gun state-of-the-art to direct a new 90mm gun program to be undertaken. Begun as a 6.3A effort, the idea was to establish the merits of initiating a 6.3B or 6.4 90mm MC-AAAC system development program in FY82. What is hoped will emerge will be the best gun design and caliber for deployment with a vehicle of some 22 tons. Supported by Congress, in July 1980 ammunition and gun contractor efforts were begun to attain this goal.

Work to date indicates that a 90mm gun using the 75mm HSTV-L feeder design will meet the desired cyclic rate, dispersion goal, and kinetic energy penetrations. Trunnion reactions however, remain a problem.

The HIMAG and HSTV-L programs were begun as technology efforts, and while there may well be applications for the longer term requirement the impact of these programs on any near-term light armored vehicle for RDF use will be minimal, if any.

While both the Army and the Marine Corps indicated to Congress in '81 budget hearings a need for a light armored vehicle, it was the Marine Corps which went on record that it had an urgent need for such a vehicle, and given the resources the Corps could have a near-term vehicle IOC date in 1983. The Senate Armed Services Committee, noting differences in approach to the concept between the Army and the Marines directed the two services to resolve their differences and come in with a common requirement when appearing for their FY82 budget hearings.

Subsequent to this, the Marine Corps firmly established their near-term requirement. The Corps also felt it had made a commitment to Congress for a 1983 IOC date and became the program's driving force. The result was the establishment of the joint program described in the July-August 1981 issue of this magazine, wherein the Army is basically an actively participating observer. All the up-front RDTE funding is USMC. The Army has both RDTE and procurement funds programmed for LAV in FY82-FY87.

The weapon to be used on this near-term vehicle will be the Army's new 25mm M242 automatic cannon, sometimes called the Bushmaster or the Chain Gun, the latter being the name it went under by its developer - Hughes Aircraft. The M242 was the winner in a competition with Ford Aeronautics for the main armament of the M2 Infantry Fighting Vehicle.

Some Army R & D-types express concern however, at the feasibility of adapting this system to an off-the-shelf vehicle within the very short time available on the schedule. These persons see potential difficulties by recalling the 1960's horror of the Army's retrofit program that called for replacing the .50 caliber machine gun on the M114 Reconnaissance Vehicle with the HS 820-20mm cannon. They say the lesson is clear that one type weapon is not always readily retrofitted to a vehicle for which it is not originally designed. There can be a great many problems - not necessarily easily overcome. Among these are space required, overall weight versus power plant and drivetrain, balance, turret ring bearing wear, ammunition storage and feed, and fumes and hearing effects on crewmen, to mention some. So, the time required to integrate a 25mm turret into an existing vehicle may not in some peoples' views, be a relatively simple effort.

But despite the attention and effort now being given to the near-term LAV effort, the Army intends to continue its armored combat vehicle technology effort. Results from this effort will then be available for use on both the near-term and long-term light armored vehicle programs.

Army To Establish New Communications Command

The Department of Army has announced it will commence planning for the establishment of a new Automation and Communications Command.

The new command, when the planning and implementation are approved and completed, will be responsible for functions currently performed by the U.S. Army Communications Command, headquartered at Fort Huachuca, AZ, the U.S. Army Computer Systems Command headquartered at Fort Belvoir, VA, and other selected automation and communications functions.

The ACC commander, MG Gerd S. Grombacher, will be directed to develop a plan to establish the new command and integrate the Army's automation and communications activities below Headquarters, Department of the Army. Automation and communications have been integrated at DA level since 1978.

Grombacher said he will create a special planning team of functional area experts headed by BG John T. Myers, ACC deputy commander, to accomplish the planning for the establishment of the new command. The team will work fulltime on developing the plan and will work closely with the Computer System Command and other elements involved.

Grombacher said the planning team will be tasked to find ways to integrate benefits into the new command similar to those ACC has accomplished since 1973 through its centralized management of post, camp and station communications. He emphasized that the planners will have to insure that the structure they recommend will provide more effective management and control of the Army's command and control system; realize economies of scale in command overhead and automation and communications at the installation level; and increase standardization and interoperability.

The need for this new command and the integration of the two functions below HQDA level is occurring because the technologies involved in operating automation and communications are very similar, and because they are dependent on each other in supporting the worldwide mission of the Army.

In communications, it is now common practice to use automated or computerized switching for both printed and voice messages. In a like manner, the electronic movement of information over communications lines is necessary to provide data processing support throughout the Army. The new command will provide the management and planning organization needed for the Army to operate more efficiently.

In developing the plan, ACC will consider giving the new command the responsibility for operating and maintaining the data processing activities that support management of stateside installations. Consideration will also be given to eventually giving the new command the same responsibility for overseas installations.

Resources Optimization Via Training Devices

By COL Donald M. Campbell

"Training, the Army's principle activity in peacetime, is intended to raise individual and unit proficiency to levels necessary for mission accomplishment." - *GEN Edward C. Meyer*

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". . . we must recognize the importance of training in the fielding of a system and take the cuts in the number of XM1 tanks and not in the training device program." - *MG Richard D. Lawrence.*

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I have taken the liberty of quoting the Chief of Staff of the Army and the Commander of the 1st Cavalry Division in order to illustrate the importance being placed on training at the very highest levels of the Army. In this article I will relate to you in broad terms who PM TRADE is, what we're doing now and where we're going in the future.

PM TRADE is charged by the Secretary of the Army and by the commander of DARCOM with project management of the following: non-systems training devices; synthetic flight training systems; system training devices as assigned by HQ DARCOM; acting as the DARCOM focal point for *all* training devices; establishing and maintaining the training device technology base; acting as the principal DARCOM advisor - independent assessor of training device requirements; and life cycle support of assigned non-type classified training devices.

PM TRADE responsibilities are discharged by the 117 authorized civilians and military personnel plus some 80 professional man-years of reimbursed support from the Naval Training Equipment Center which is collocated with us in Orlando, FL.

The magnitude of our total program from 1976 through 1985 is shown in Fig. 1. We recognize that we do not have the resources to develop and field training devices for all system project managers. However, in order to effectively exploit our technology base, we plan to provide system PM's a concept formulation package which they can use to acquire their own training devices.

We use our technology base to generate

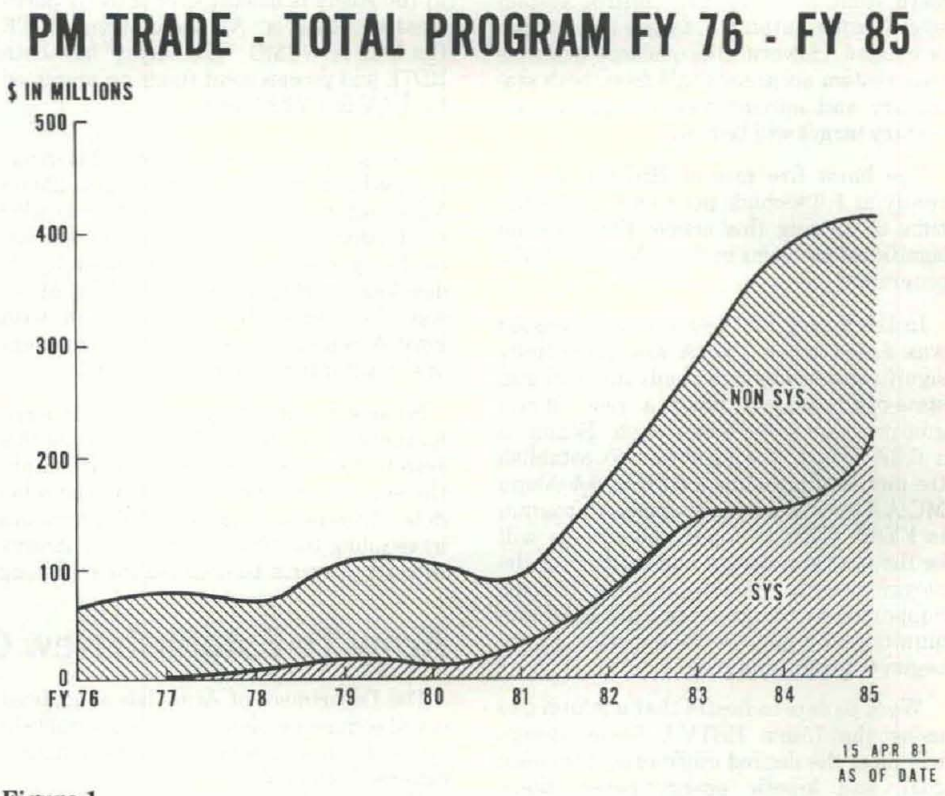


Figure 1

a training device trade-off analysis, best technical approach, cost, and lead time estimate. Combine this with the cost and training effectiveness analysis from TRADOC and the system project manager has a road map which he can follow in acquiring his training devices.

Principle organizations comprising the training device development and acquisition community are the Army staff, TRADOC, the Army Training Support Center (ATSC), DARCOM, and my office. AR 350-XX, Training Device Policies and Management, was completed in final draft by ODCSOPS in March, and when published, will direct the integration of all activities in the life cycle of training devices.

Some of the more familiar devices which have been or are close to being fielded are discussed below.

• The *Multiple Integrated Laser Engagement System* (MILES) is a program for the coordinated development and integration of a family of direct fire simulators, consisting of a laser transmitter (weapon) and receiver (target). MILES permits combat units to conduct two sided engagements, delivering simulated destruction while providing real time hit and near miss (suppression) assessment to achieve realism.

MILES disciplines the combatants into using techniques which reduce vulnerabilities while maximizing target detection, engagement and fire distribution. Exploratory development programs are in progress that will add area weapons effects, indirect fire, electronic welfare, mines & NBC to the MILES engagement simulation capability.

• Another effort is the *Army Training Battle Simulation System* (ARTBASS). It is a high fidelity, computer driven battle simulator which trains maneuver battalion commanders and staffs in the control and coordination of combined arms warfare, enabling them to attain, sustain and even exceed ARTEP standards. This is accomplished by providing an unclassified environment in which current and potential threat organizations, flexible force ratios, tactics, command, control and weapons effects are realistically simulated.

Recent agreements have been made with HEL to study training implications arising from HELBAT findings and the Artillery Control Experiment (ACE). One of the results of this study will likely be the definition of an ARTBASS type simu-

lator for training the artillery closed loop decision process.

• The *Infantry Remoted Target System* (IRETS) will provide the Army with a system of threat oriented two and three dimensional moving and stationary targets that provides the appearance of threat soldiers. IRETS embodies automoted control, built in hit sensing and scoring while simulating enemy weapon sounds and muzzle flashes.

• *Synthetic Flight Training Simulators* (SFTS) programs currently being managed by PM TRADE are UH-60, CH-47, AH-1, and AH-64. Synthetic flight systems enjoy widespread publicity and do not require a lengthy discussion of their capabilities. However, the requirements for a Combat Mission Simulator (CMS) for the AH-64 are placing new demands on visual simulative technology.

The need for integrating visual cues for nap of the earth (NOE) flight and weapons delivery using a sophisticated combination of sensors and enhanced visual capabilities is a problem that goes beyond the state of proven visual simulation capabilities of industry today. An aggressive advanced development program is underway to arrive at an affordable, training effective CMS which incorporates the best mix of technology in the industrial base with the needs of the user.

• The *Remote Electronic Equipment Simulator* (REES) simulates selected components of the Army's communication system, providing the capability of representing a communications node or intrasystem communications configuration. Monitoring of student performance and insertion of malfunctions to train organizational maintenance is accomplished from the instructor's console. There are two instructor stations and 32 student stations.

• The *FIREFINDER* simulator trains operator and organizational maintenance tasks for the AN/TPQ-36 mortar locating radar system. At the operator station, the trainer interfaces with the simulated radar systems via a modified weapons locator unit, a line printer and a CRT which reproduces the B-scope display. The organizational maintenance trainer consists of the same computer complex plus six maintenance stations for students.

These devices have proven the cost and training effectiveness of simulators, and illustrate the need for additional devices to help offset the effects of reduced resources. Training devices and simulation in training are coming into prominence none too soon.

Traditional hands-on training is becoming less and less affordable, in fact, the resource pinch may very well prove to be the Army's "boll weevil" because we are now investigating alternate approaches to training and discovering more effective approaches to training than hands-on training.

• The *Air-Ground Engagement Systems/ Air Defense* (AGES/AD) is a family of laser engagement systems compatible with MILES. It will provide a realistic means of simulating helicopter operations during tactical exercises; will provide a realistic means of simulating ground to air defense measures against low flying aircraft during tactical training; and will provide realism in training by the introduction of suppressive fire and a real-time casuality assessment in combined arms exercises incorporating air-to-ground and ground-to-air weapons systems.

• *M1 and M60 Conduct of Fire Trainers* (COFT) will consist of several configurations for use in basic and advanced gunnery skills training at institutional level and additional configurations designed to sustain gunnery proficiency of tank unit gunners and tank commanders.

These devices will negate the need for significant quantities of costly main gun ammunition and yet provide the capability to maintain proficiency. This will eliminate the typical proficiency loss between tank gunnery cycles. Fighting Vehicle System (FVS) COFT will consist of institutional and unit versions providing the exact training discussed above for the M1 and M60 COFT.

• *M1 Driver Trainer* (DT) will consist of five individual trainee stations and an instructor station. Each trainee station will represent a fully enclosed full-size mockup of the M1 driver's compartment. Each trainee station will have an independent visual driving and audio system.

The visual driving system will feature a programmed, color, daytime and nighttime dynamic visual scene inter-linked to the trainee's driving compartment. The audio system will feature vehicle and track noise corresponding to both the terrain surface, and the engine speed being simulated.

Each trainee station will feature an auxiliary control panel to permit limited control by an auxiliary instructor. The instructor station will have two instructor positions. Each instructor position shall be capable of selecting a visual scene, viewing the visual scene, monitoring each trainee's procedural performance by means of control consoles, and introducing typical malfunctions and emergency driving conditions.

• *M1 and M60 Maintenance Trainers* (MT) are also important efforts. The M60 MT is a programmable, computer driven panel trainer used to teach the hydraulic and electrical system troubleshooting procedures to the organizational and DS/GS maintenance personnel.

The M1-MT will consist of a full size turret simulator to train organizational maintenance troubleshooting procedures on the turret hydraulic and electrical systems; and five programmable, computer driven panel trainers designed to teach troubleshooting to DS/GS maintenance personnel.

• *Fighting Vehicle System* (FVS) *Turret Maintenance Trainer* (TMT) will be used to train organizational and DS/GS maintenance personnel. Each trainer system will consist of one turret mock-up and two interchangeable, programmable, computer driven panel trainers.

• The *ROLAND Institutional Trainer* (RIT) and *ROLAND Maintenance Institutional Trainers* (RMIT) are also key programs. The RIT is a classroom procedures and tactics simulator which will simultaneously train six gunners and squad leaders. It will generate targets, provide the necessary inputs to simulate engagements, perform all weapon system operational functions and kill assessments. The RMIT will provide a system consisting of three dimensional mock-ups and human factors enhanced panel trainers designed to train organizational and DS/GS maintenance personnel at the institutional level.

• *The Automatic Weapons Effects Signature Simulator* (AWESS) will provide aural and visual effects simulation for vehicular mounted automatic weapons, thereby reducing the need for blank ammunition. It is anticipated that the cost for simulating the firing of one round of ammunition will be approximately 1/10 of one cent using AWESS, thereby providing a significant cost reduction over conventional blank ammunition.

PM TRADE has recently become the acquisition focal point for commercially available training devices which are identified for use by more than one MACOM. These training devices range from the medium Girder Bridge Model to the DRAGON launch Effects Simulator. No attempt will be made to discuss these devices in this article. However, additional information can be obtained from the U.S. Army Training Support Center or from my office.

This appears to be an opportune time to discuss the magnitude of the cost avoidance the Army will enjoy within the first 10 years of fielding several devices. Figure 2 portrays cost avoidance data for various training devices and systems which were derived from field reports, as in the Cost Training Effectiveness Analyses (CTEAs).

As you review the data provided, it is necessary to provide some clarification with regard to the basis for the data. The savings which are portrayed for SFTS are based solely on fuel savings derived from

data provided by the U.S. Army Aviation Center and calculated at $0.55 per gallon of JP4.

Savings for the M1 Tank, M60 Tank, M2 and M3 Fighting Vehicles are based on fuel, maintenance and ammunition cost estimates from the respective CTEAs. I hasten to point out, however, that the effectiveness of all training devices must not be couched in terms of dollars alone.

While the devices listed in Figure 2 provide the targeted training results at reduced costs, the value of certain other training devices and systems (such as MILES) can only be measured in terms of increased training effectiveness and the resultant increase in combat readiness compared to conventionally trained forces.

Faced with the realities of the current development cycle, we are forced to employ all the clairvoyance and fiscal wizardry at our disposal to anticipate and meet future needs.

In this regard, General Meyers has undertaken the first step in this herculean effort by charging the DAIG to review the present system for fielding training devices and to report findings and recommendations.

Senator Nunn has also grappled with the problem and has indicated the need to replace our 200-year-old budget process by one which will fully fund systems throughout the life cycle. These efforts, in my opinion, represent rays of hope for the Army's ability to field equipment in a timely and cost effective manner.

Many of the future Army simulators and training devices spring from the Army Simulation and Training Device (SATD) Technology Base Program managed by PM TRADE. The SATD Technology Base Program is focusing its attention on the development of simulators and training devices for a ground-based force.

A 5-Year Simulation and Training Device Technology Development Plan structured along the lines of the DARCOM Long Range R & D Plan, highlights significant technological products which may be expected to evolve from the technology base (6.2-6.3a) and to become, or be integrated into, future material development. This 5-Year Plan has been circulated widely within DARCOM and TRADOC for review and is expected to become a primary means for improving communication and coordination in this area within the Army.

The Army Simulator and Training Device Technology Base Programs combines all scientific disciplines into a comprehensive technology base from which promising technological opportunities are breadboarded and user tested for applicability to provide training support systems for operational and maintenance personnel.

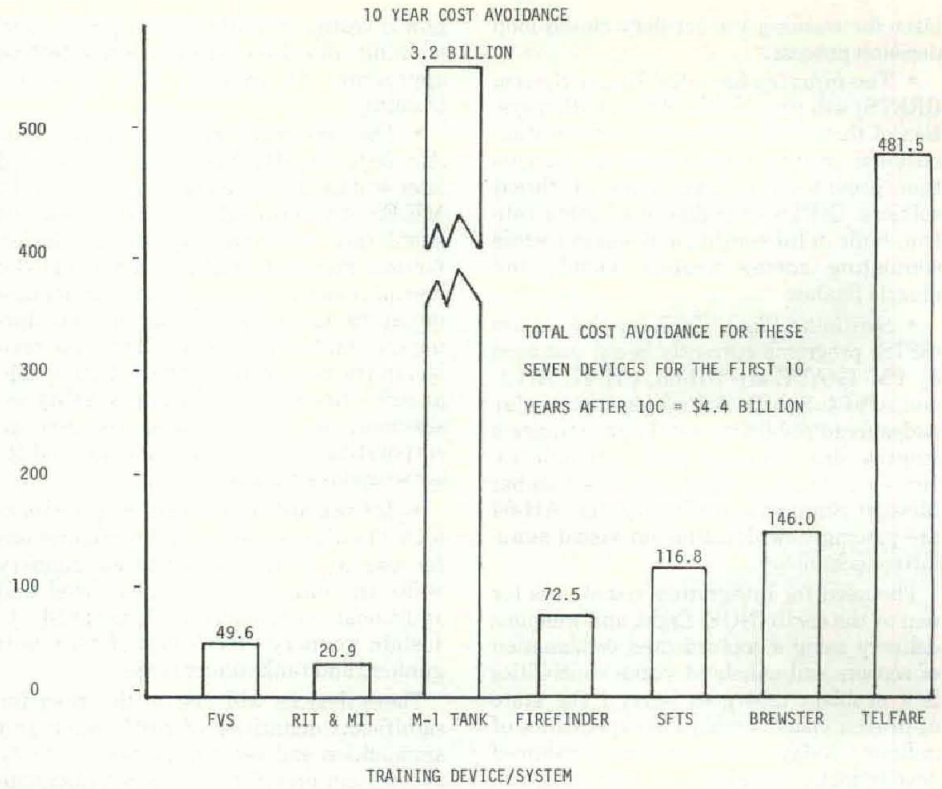


Figure 2

Such support systems include force on force engagement, maintenance training evaluation and simulation, visual simulation and operational equipment simulation. Technology product lines for this area are: engagement simulation; maintenance simulation; visual simulation; simulated environments; electronic technology applications; computer aided learning; aviator training research simulator; and flight simulator components.

There are presently 41 technology initiatives in these 8 product lines. Funding for these initiatives during the POM period is $90M.

To extend the technology base and to preclude duplication of research efforts, PM TRADE actively seeks opportunities to capitalize on research conducted not only within the DARCOM Laboratories, but also the other Services.

Joint experimentation and cooperative programs are managed under MOA's negotiated with the responsible service laboratory. Currently, PM TRADE has agreements and joint programs with the Naval Training Equipment Center, Air Force Human Resources Laboratory, and Army Research Institute.

I hope that I have been successful in conveying to you the past, present, and future of PM TRADE. To my mind the United States has wherewithal to solve its training problems from a technical standpoint. It stands to be proven, however, whether the defense community can provide the needed training in a timely and cost effective manner. Part of the solution will require action by the Congress. This accomplished, we will have to provide the foresighted, disciplined management to insure that the Nation receives maximum returns on its investment in defense.

COL DONALD M. CAMPBELL is the U.S. Army project manager for Training Devices. He graduated from Davidson College, and holds a master of business administration degree with a major in operations research/systems analysis from Tulane University. He has also completed the Army Command and General Staff College and the Army War College.

New Ammunition Devices May Ease Huge Training Costs

A new family of training ammunition devices may soon help make the huge costs associated with training soldiers a thing of the past.

The new ammunitions are primarily made of plastic, or are sub-caliber devices for larger weapons. All are aimed at providing realistic training in less space than is required for firing "real" ammunition, according to Mr. Marvin Maule, senior test engineer of the .50 caliber plastic ammunition test project at Aberdeen Proving Ground's Materiel Testing Directorate.

Maule said the rationale behind the new ammunition is that training is an expensive business, but that the big costs are not for ammunition itself, but for transportation of soldiers and equipment to suitable training areas. This is especially true for soldiers assigned overseas, where training areas are scarce.

Plastic and sub-caliber ammunition now being tested at MTD generally is supplied by foreign manufacturers as part of the International Materiel Evaluation Program (IMEP).

"In a sense this (development) has been on-going almost forever. Army planners have always looked for less expensive, more realistic ways to train soldiers," Maule said.

"The Europeans, who have real space problems, and not much acreage to devote to training areas have put a lot of effort into these training devices. The U.S. Army is now looking at them for training purposes. They make a lot of sense," he said.

The advantage of plastic and sub-caliber munitions, Maule notes, is that they can be fired in relatively small areas. The new 5.56mm round for the M16A1 rifle, for example, has a maximum range of less than 200 yards at any elevation, and the .50 caliber round will travel only about 600 yards.

While many U.S. installations have adequate acreage for conventional real-bullet firing ranges, National Guard, Reserve and overseas-based units don't. "This means that if troops want to fire their rifles or tank guns they have to transport them to one of the few ranges available. But with these short-range bullets, simulated or scaled-distance ranges can be built and soldiers can train in their own areas," Maule said.

Besides allowing firing operations in smaller areas, the new rounds have other advantages. These rounds allow training activities that are not possible with live ammunition. Currently, we have ball ammunition and blanks. Ball ammunition has some inherent dangers, such as ricochets and long distances needed for safe firing, and blanks aren't realistic.

With plastic bullets, troops actually get to fire their weapons and handle them just the way they would with ball ammunition. Soldiers will probably get to fire more often with these because transportation costs are reduced.

Also, some kinds of training, such as an urban warfare, are very difficult to do with ball ammunition because of ricochets, and other problems. Plastic bullets can't ricochet, but splatter or evaporate on impact with hard surfaces.

At close ranges, possibly up to 25 feet for the 5.56, or out to about 100 feet with .50 caliber, they can be dangerous. They have enough energy behind them to put a hole in a person or cause injury. That means that soldiers must learn weapons safety with them just as they would with ball ammunition.

Another aspect of realism with the new plastic ammunition is the ability to make "pop-up" targets work. "They have enough energy to knock a pop-up down. That lets the soldier know he has hit something when he fires. At close ranges, the plastic bullets are accurate enough to zero a weapon or fire at simulated, long-range targets. At short ranges they simulate ball ammunition trajectories very well," Maule said.

"One of the critical design criteria factors for these rounds is safety. It was decided that there should be no way that a soldier could mix the two kinds of rounds in his weapon. Modifications to the weapon itself were judged to be the best safety method.

The M16 will not fire the plastic bullet except as a single-shot, hand-load-and-ejected round. In order to use the plastic bullet on semi or full automatic, a different bolt must be put into the rifle. It takes about 10 seconds to make the change. And, with the other bolt in place, ball ammunition cannot be fired in the rifle.

The .50 caliber plastic bullet cannot be fired in the machine gun at all without making some modifications. The barrel must be changed and the bullet guide altered. Both are quick-change items.

The other member of the small arms training ammunition family is a .22 caliber tracer round, which isn't used in small arms at all. The standard .22 bullet has a tracer element added which glows when fired to allow a shooter to follow its flight and see where it impacts.

The bullet is designed for use in a Brewster training adapter on 105mm guns. The Brewster fits on top of the big gun and allows a gunner to fire at simulated targets in almost any kind of surroundings.

The 5.56mm ammunition has already been type-classified and will be purchased in quantity. The .50 caliber ammunition has been type-classified for limited use, with additional testing at MTD. The .22 caliber tracer ammunition is still involved in various stages of testing.

DARCOM Program

Shown on these pages are 53 of the Army's program/project/product managers. This listing is correct as of 1 September 1981. Additional information regarding the Program/Project/Product Manager Program may be obtained from the Office of Project Management, ATTN: DRCPM, HQ, DARCOM, 5001 Eisenhower Ave., Alexandria, VA 22333. Phone Autovon 284-9570, or Commercial (202) 274-9570.

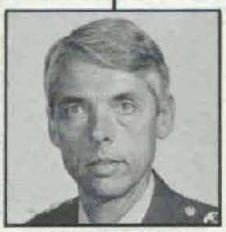
ACRONYMS:

AAH - Advanced Attack Helicopter
TADS/PNVS - Target Acquisition Desig
Pilot Night Vision System
30MM - 30MM Ammunition
ASH - Advanced Scout Helicopter
ADCCS - Air Defense Command and Co
ASE - Aircraft Survivability Equipmen
ACVT - Armored Combat Vehicle Tech
ATACS - Army Tactical Communicatio
CAWS - Cannon Artillery Weapons Sys
Guided Projectiles
CH-47M - CH-47 Modernization Progra
CHAP/FAAR - Chaparral/FAAR
CCE/SMHE - Commercial Construction

AAH

MG Edward M. Browne

TADS/PNVS



COL Donald P. Wray

30MM

LTC David W. Logan

ASE

COL Edward C. Robinson

ACVT

LTC (P) James B. Welch

ATACS

COL Glen L. Rhoades

BLACK HAWK

COL Donald K. Andreson

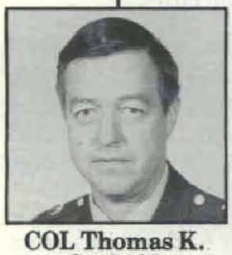
CAWS

COL John Kronkaitis

CH-47M

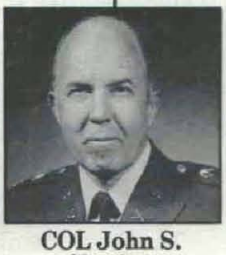
COL Dewitt T. Irby Jr.

FVA



COL Thomas K. Seybold

FIREFINDER/ REMBASS

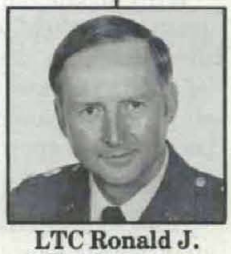


COL John S. Chesbro

HAWK

COL John S. Drosdeck

HET

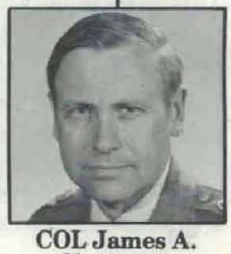


LTC Ronald J. Charbonneau

HELLFIRE/GLD

COL Stanley D. Cass

ITV

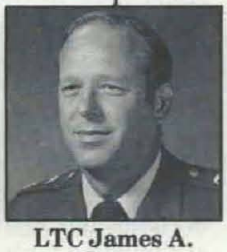


COL James A. Chernault

MEP

COL Michael S. Higgins

MICNS

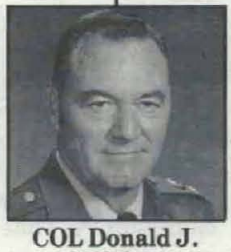


LTC James A. Love

MLRS

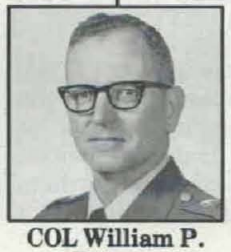
COL Monte J. Hatchett

MSCS



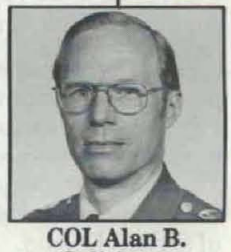
COL Donald J. Callahan

NUCMUN



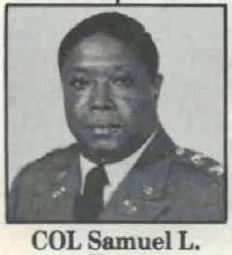
COL William P. Farmer

OPTADS



COL Alan B. Salisbury

SMOKE

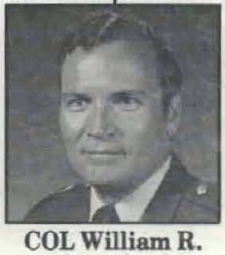


COL Samuel L. Eure

SEMA

COL Sylvester C. Berdux Jr.

SOTAS

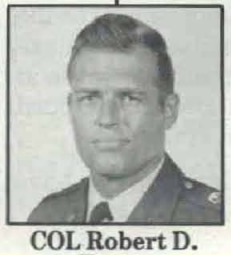


COL William R. Crawford

STINGER

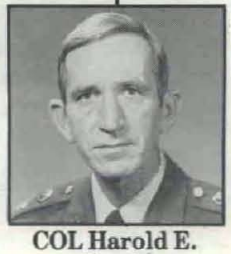
COL James E. Rambo

RPV



COL Robert D. Evans

TACFIRE/FATDS



COL Harold E. Luck

Project/Product Managers

Selected Material Handling Equipment
DCS (Army) - Defense Communications Systems
DIVAD - Division Air Defense Gun
FVS - Fighting Vehicle Systems
FVA - Fighting Vehicle Armament
HET - Heavy Equipment Transporter Systems
ITV - Improved TOW Vehicle
JTFP - Joint Tactical Fusion Program
TMAS - Tank Main Armament System
MEP - Mobile Electric Power
MICNS - Modular Integrated Communication and Navigation System
MLRS - Multiple Launch Rocket System
MSCS - Multi-Service Communications Systems
NUCMUN - Nuclear Munitions
OPTADS - Operations Tactical Data Systems
PLRS/TIDS - Position Location Reporting System/ Tactical Information Distribution Systems
SATCOM - Satellite Communications
SANG - Saudi Arabian National Guard Modernization Program
SINCGARS - Single Channel Ground and Airborne Radio Subsystem
SEMA - Special Electronic Mission Aircraft
SOTAS - Stand-Off Target Acquisition System
RPV - Tactical Airborne Remotely Piloted Vehicle/ Drone System
TACFIRE/FATDS - Tactical Fire Direction System/ Field Artillery Tactical Data Systems
TMDS - Test Measurement and Diagnostic System
TRADE - Training Devices
ARD - Armor Training Devices

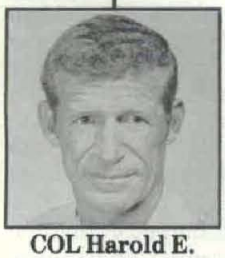
ASH

COL Ivar W. Rundgren Jr.

ADCCS

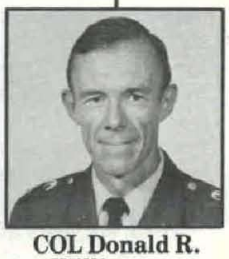
COL David L. Wyatt

CHAP/FAAR



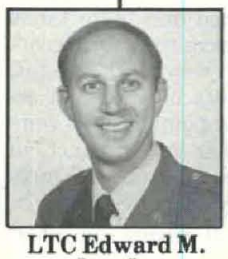
COL Harold E. Stubbs

COBRA



COL Donald R. Williamson

CCE/SMHE

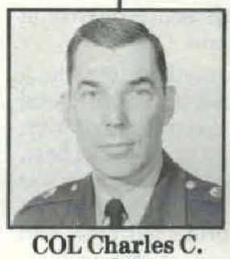


LTC Edward M. Lee Jr.

DCS (Army)

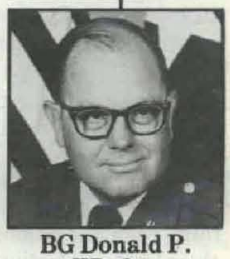
MG V.O. Lang

DIVAD



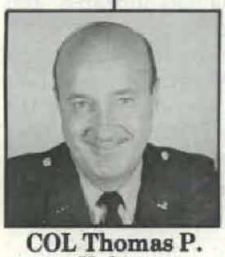
COL Charles C. Adsit

FVS



BG Donald P. Whalen

JTFP

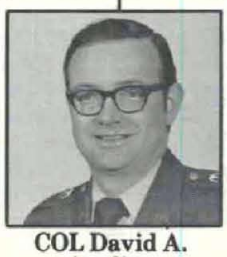


COL Thomas P. Kehoe

M1 ABRAMS TANK

MG Duard D. Ball

TMAS

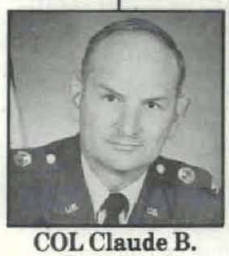


COL David A. Appling

M9/UET

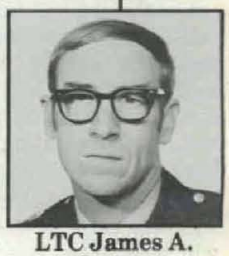
COL Richard H. Benfer

M60 TANKS



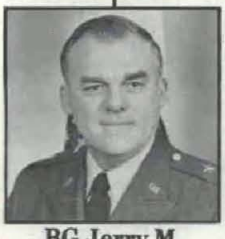
COL Claude B. Donovan

M113



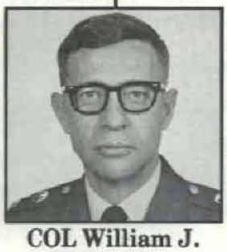
LTC James A. Logan

PATRIOT



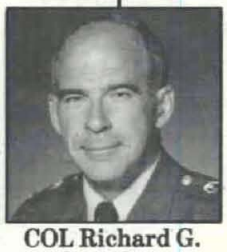
BG Jerry M. Bunyard

PERSHING



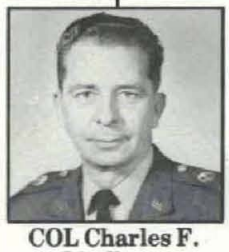
COL William J. Fiorentino

PLRS/TIDS



COL Richard G. Saunders

SATCOM

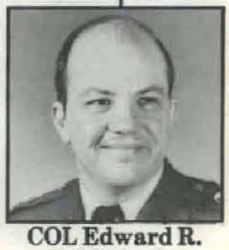


COL Charles F. Lindberg

SANG

BG John J. Yeosock

SINCGARS



COL Edward R. Baldwin Jr.

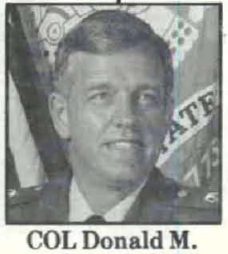
TMDS

LTC Joseph C. Marangola

TOW

COL Byron L. Powers

TRADE



COL Donald M. Campbell

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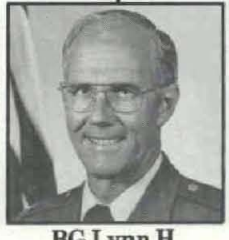
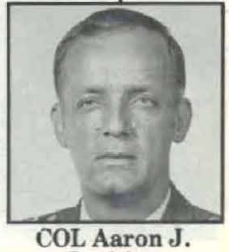
LTC Harry Meeth III

US Roland



BG Lynn H. Stevens

VIPER



COL Aaron J. Larkins

Vision Blocks: A Greenhouse of Armor

C. Douglas Houston

World War I changed the tactics of the infantry foot soldier and led to the eventual demise of the horse cavalry, and some visionary military leaders saw the future need for a mechanized fighting force, based on the crude tanks of that war. One needed improvement was a way to protect the infantry gunner from enemy fire while allowing him to return fire effectively and still provide him with some degree of mobility over most terrain.

The tank provided a method to make a gunner mobile, surround him with metal armor and send him into combat. However, his ability to aim the gun was poor at best, and his ability to see where his tank was going was even worse. The important thing was the armor-protected crew and their gun; effectiveness of the vehicle would have been greatly improved if protected vision was possible.

In early tanks a small hole or slit was cut in the armor, and the occupants of the vehicle could peer out and see enough to steer their tank, or even survey the countryside. They still had some protection because the probability of an enemy bullet hitting the sighting slit was reasonably low.

The armored vehicle of WWI had these sighting slits, as well as a sighting port which could be closed during combat operations. Under combat conditions, the small slits were sufficient. The tank commander frequently did his job in the open with his pedestal-mounted machine gun. Indeed, he was a good target, but if probability was on his side, he had a fair chance of survival.

In the years preceding WWII, U.S. tank production was limited. All such vehicles were built at Rock Island Arsenal, IL, where facilities were quite adequate for the few new tanks were strictly infantry weapons, and with our Army at a low operating level, the supply and development of tanks was at a correspondingly low level.

As WWII approached and more tanks and combat cars (the cavalry's counterpart of the infantry's tank) were being sought. The bulk of the Army's inventory of armored vehicles at that point in time were light tanks and combat cars. In fact, in November 1940, there were only 17 medium tanks in the Army's armored fleet.

When World War II finally exploded, armor was to play a monumental role. For the United States, a generation of new tanks was quickly designed and pressed into production. The great advance in armor was under way.

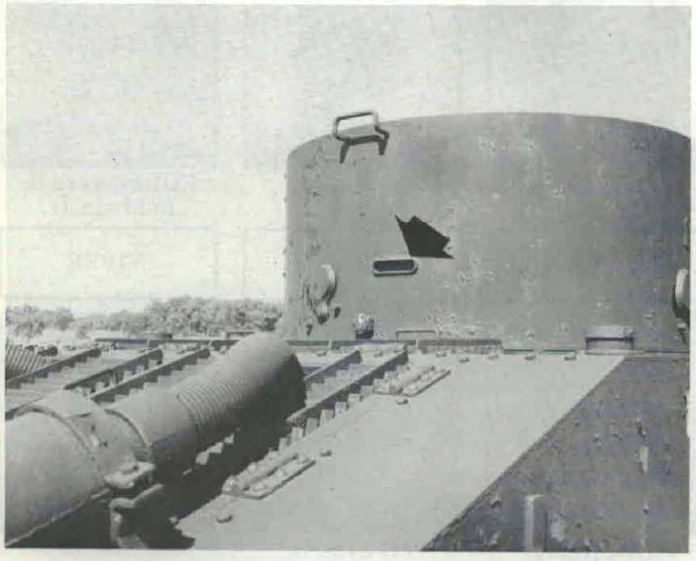
At this time some use of periscopes for viewing outside a tank was understood. This indirect method of viewing offered a great advantage over slits and cutouts because a direct ballistic path into the vehicle did not exist, and still, the occupants could see outside. Since periscopes were replaceable from the inside, their desirability was enhanced. Far better vision was made possible with periscopes, but improvements were yet to come.

During the mid 1930's, safety glass had become commonplace in automobiles. When heavy glass plies were laminated together, the result was bullet-resistant glass. The glass industry came up with a variation on conventional bullet-proof glass in the form of many layers of 1/4-inch glass with a layer of polyvinyl butyral plastic between the plies of glass. This thick glass, encased in a steel frame, mounted in a cavity in the cupola or turret, was the forerunner of our modern vision block and the beginning of truly good visibility from a totally enclosed armored vehicle.

The earliest vision blocks appeared in such vehicles as the M4 Medium Tank and the M24 Light Tanks. While a direct view to the outside with excellent optical quality was then a reality with vision blocks offering ballistic protection, WWII came to an end with only one design of vision block in use.

Then, six years after the end of that war the Korean War showed us a new threat in the product of our enemy's new technology in weapons and the new ballistic threat to our armor. The Soviet 14.5 mm armor piercing rounds had appeared, and U.S. development of new armor materials and configurations went into high gear. New hull and turret designs began to take shape to provide protection against the new high-ballistic threat facing our armored forces. But direct vision was required from within the new, and more powerful armored vehicles.

This was a turning point in armored vehicle design. From our experience during WWII, U.S. designers realized a need for two important things: protection for the tank commander, and vastly improved panorama of vision. High speeds demand



T4 Medium Tank (1936) With Closeable Sighting Ports

MOCKUP of Modern Wide-Angle Cupola

high vision capability.

Major glass manufacturers provided the solution to the problem. It has never been customary to laminate more than 13 or 14 1/4-inch thick plies of glass into a ballistic window, but a 25-ply vision block was designed and built.

The finest color-free polished plate glass was used for high transmission of light. This build-up of glass was made free of flaws such as bubbles, delaminations, or optical distortions. Early ballistic testing proved the worth of this vision block. It was found to measure up to the Army's high expectations for quality of vision and ballistic protection.

The U.S. Army Tank-Automotive Command standard for ballistic protection is simple: When a specified armor piercing round in a worst-case situation is fired at the glass, there must be no trace of broken glass blown from the inboard face of the block as a result of the impact. Should there be even one clip that could injure a crew man, the block is considered unacceptable and some means had to be found for upgrading the design of the block.

The new blocks took the form of a wedge, mounting them in a "ring" arrangement. This permits a continuous panorama of vision, with the tendency of a block to be tightened in its mount on impact.

When the new generation of high-vision designs began to appear, other new vision blocks were designed, based on the 7-inch high-ballistic block. A 4-1/2-inch thick version of this block was released for the M114 Command Reconnaissance Vehicle and gave a commander a panoramic view from his station as well as ballistic protection as good as, or better than, the metal armor in the vehicle. This 4-1/2 inch block was used in other combat vehicles in subsequent years.

As new designs for armored vehicles came off the drawing boards, there was an increasing use of wide-angle vision blocks in turrets and cupolas of tanks, driver's stations, and sighting ports of tanks and armored personnel carriers.

In the Vietnam War, the direct-vision block was used in turrets of Navy riverine warfare craft where its superior ballistic protection was needed from small arms fire.

As with metal armor, TACOM is engaged in a continuing incessant search for stronger, harder, lighter materials to be used for protective transparencies. During TACOM's long path of progress in developing vision blocks, many arrangements of many materials have been tested, and each set of ballistic data has contributed a valuable chapter to the volume of design experience in vision through armor.

The outboard face of a vision block must be able to resist the scratching that is caused by flying stones, low hanging branches, the soles of crewmens boots stepping on them, and even sand blown across them.

Glass, or the new aluminum-oxide plate, are the only materials that answer this need - hence hard transparencies are always found on the outboard face of a vision block. Also, should a monolithic vision block (solid glass or plastic) be hit by a projectile, the facture propagates through the transparency at a velocity many times that of the projectile. Penetration is thus assured but laminating many plies of transparency into a vision block interrupts the breakage process, and aids in "steering" the projectile into the surrounding armor. Thus, vision blocks are always made of laminated materials.

In another special application, a vision block was employed to serve as a protection for a sighting instrument inside a tank. Its faces were carefully held parallel so as not to degrade the instrument's optics, and the block had to protect only from rocks, dirt, etc. Six such vision blocks were made but they were very expensive. This factor, plus the difficulty of maintaining optical accuracy with a replacement block, ruled out the use of fire control optics behind vision blocks.

The weight of a vision block is only part of the weight to be considered. Vision blocks are mounted in a cavity and are surrounded by metal armor, which accounts for considerable weight in the vehicle. If a vision block could be reduced in thickness, the armor surrounding it could be reduced, with an appreciable saving in total weight.

In recent years, the transparent armor program at the U.S. Army Materials and Mechanics Research Center in Watertown, MA, funded the development of a new high-hardness glass by PPG Industries. The performance of this material is such that when used in a vision block, equal protection from impact is provided with far less glass. The resulting thinner block enables a reduction in the surrounding armor "pocket" depth and a weight savings.

Special variations must be incorporated into vision blocks. Defrosting may be accomplished by a deposited electrically conductive surface on the inside face of the outboard ply of glass. A current passed through this conductive surface will produce heat to cause defrosting. Flash protection is possible by incorporating a layer of darkening glass in a vision block. This "shutter" could guard crewmen against optic damage resulting from a nuclear flash.

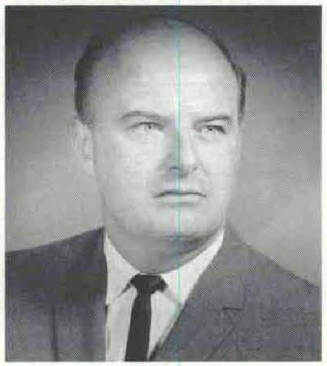
Further developments have contributed to yet another plateau of vision block technology. These are the tough polycarbonate plastics, and the cast interlayers adhesives that bond them to glass and other plastics. These cast interlayers replace the polyvinyl butyral interlayers in some instances.

An important source in transparent armors and indeed, vision blocks, is single crystal aluminum oxide. This is a product of synthetic crystal technology, which permits a clear, cylindrical aluminum oxide crystal to be produced up to 12 inches in diameter. From this, plates may be cut and polished to a transparent plate, like plate glass, but many times harder.

Applying this aluminum oxide plate as the outboard face of the composite transparency, backed by plies of glass and finally, a polycarbonate spall guard, we have a high ballistic transparency of greatly reduced thickness and, of course, weight. This project of applying a new material to known materials, has provided significantly lighter but ballistically superior vision blocks for armored vehicles.

Applications of vision block design are not limited to tanks alone. There is a need for protected vision in law enforcement vehicles, bulletproof bunkers and armored personnel carriers, to name a few. The build-up of transparency plies may be tailored to the application and protection needed.

A high potential is on our shelf now for new transparent viewing systems that offer protection that was unknown just three years ago. Where light weight and high level of protection were previously trade-offs, they are now welcome companions in our new vision block technology.



C. DOUGLAS HOUSTON, Jr. is a project engineer with U.S. Army Tank-Automotive Command, and has been associated with work in vision devices since 1961. He holds a BS degree in electrical engineering from Michigan Technological University. He was also associated with Chrysler Corp. on early projects in guided missiles.

New Blackout Security Lights

By Harry Young

The familiar red color of the interior blackout lamps used on all combat vehicles will soon be changed to a blue-green color. The new lights will provide a significant reduction in the capability of the enemy to "see" our vehicles through his low light level imaging devices.

The change is being made to all production combat vehicles and a minor alteration will be made on vehicles presently in the field. Modification kits will be available and can be installed by vehicle crews or Organizational Maintenance Units.

The M1 Abrams tank shown in Figure 1 was photographed through a first generation image intensifier. The glaring light around the driver's and commander's hatches is emission from the red blackout interior lamps coming out through the open hatches. This light is reduced with the hatches closed, but every viewing port and optical device then becomes visible to IR sensors. This light, however, could not be seen with the unaided eye.

The Soviets and Warsaw Pack nations exploit night vision technology extensively. They are known to use not only active IR, but also passive image intensifiers (starlight scope technology) for individual weapon sights.

Passive sights are used for their anti-tank grenade launchers, anti-tank guided missile systems and night observation devices. It is probable that the gunner's sight in the T-72 tank uses an image intensifier and that night vision goggles are also used.

The use of low light level TV by the Soviets for aiming and tracking has been reported. The use of these devices by the enemy and the visibility of our present blackout lights to them surely justifies a reassessment of our blackout lighting approach.

Figure 2 shows the effectiveness of the new light in reducing the signature of the vehicle to an image intensifier. Two M48 tanks were photographed

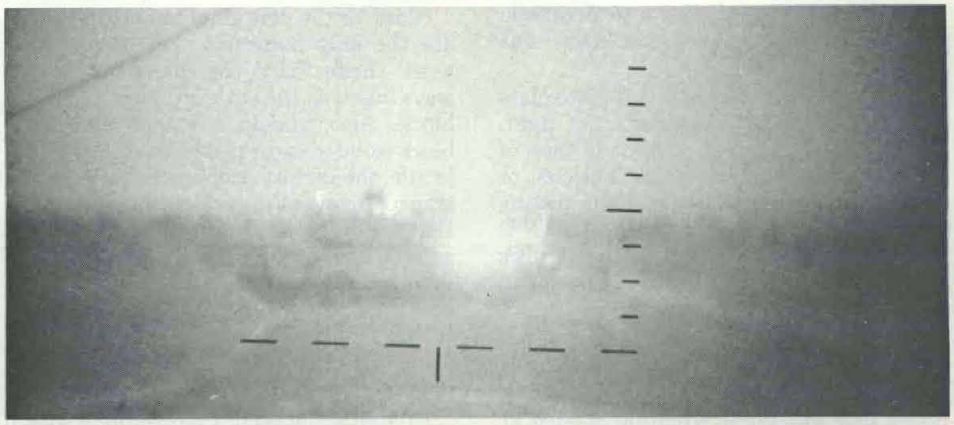


Fig. 1. M1 Abrams tank signature, with red security lights, photographed through a first generator image intensifier.

through a first generation image intensifier from a range of 400 meters. The vehicle on the left (circled) had the new interior lights and the one on the right had the older red lights.

Both vehicles had the interior light adjusted for the same brightness and had the hatches open. The vehicle with the red lights was clearly visible through the intensifier at a range of 1,800 meters while the vehicle with the blue lights virtually disappeared at 400 meters.

Even with the hatches closed, the red lighted vehicle was clearly visible, using the intensifier, by emission through vision blocks and optical devices. However, no light emissions were detectable from the blue-green lighted vehicle. The new blue-green lighting color not only improves security, it improves personnel visual acuity and makes color coded maps easier to read.

Previously, the use of red lighting was dictated by the fact that it had a less detrimental effect on the dark adaptation of the crewmen's eyes when they had to leave the vehicle or look outside.

Tests were performed at USATACOM, with the help of the Human Engineering Laboratory, to measure the detrimental effect of the new light. Comparison of the results showed a change in dark adaptation time from 4.7 seconds for the man exposed to the red light to 7.0 seconds for the man who had been exposed to the blue-green light.

Many other factors, such as light intensity and physical condition of the test subject, appeared to have a greater

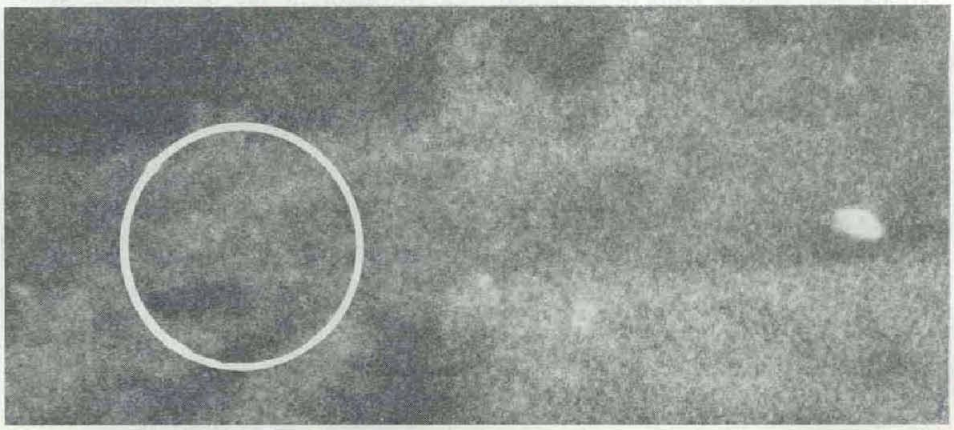


Fig. 2. SIGNATURE comparision of M48 using red interior lights (right) and a similar vehicle with new blue interior lights, at 400 meters.

effect on dark adaptation than the color of the light. Of the subjects used in this test, those who were smokers required approximately 12 seconds to become dark adapted, three times as long as the non-smokers.

Based on the findings of this test, an assessment by USATRADOC and the U.S. Army Armor-Engineer Board considered the improved vision security considerably more important than the small gain in dark adaptation.

To understand the effectiveness of the new light against the low-light level images, one must compare the spectral responses of a third generation low light level imaging device and the human eye to the spectral emission characteristics of an incandescent lamp and that of the red blackout security lamp. We can show how the spectral response of image intensifiers extends far into the infrared region which is invisible to the human eye.

The spectral emission of the incandescent lamp falls largely in the infrared region where it is readily visible to most low-light level imagers but is invisible to the human eye.

The red filter, when applied over the incandescent lamp, significantly reduces the light visible to the human eye, but has little, if any, effect on the invisible infrared emission. The third generation image intensifier and silicon television camera response curves are extremely sensitive to the bulk of the emission.

The spectral transmission characteristics of the new blue-green filter compared to the red filter and the sensitivities of the image intensifier and the human eye are shown in Figure 3. Here it can be seen that only visible light is emitted by the new lamp.

The visible emission from the blue-green filtered lamp is equal to that of the red filtered lamp. However, the emission of the red lamp visible to the image device greatly exceeds that visible to the unaided eye.

While the interior dome lamps are one of the major contributors to the visible signature of the vehicle, they are by no means the only contributors. The typical combat vehicle has about one hundred incandescent lamps which

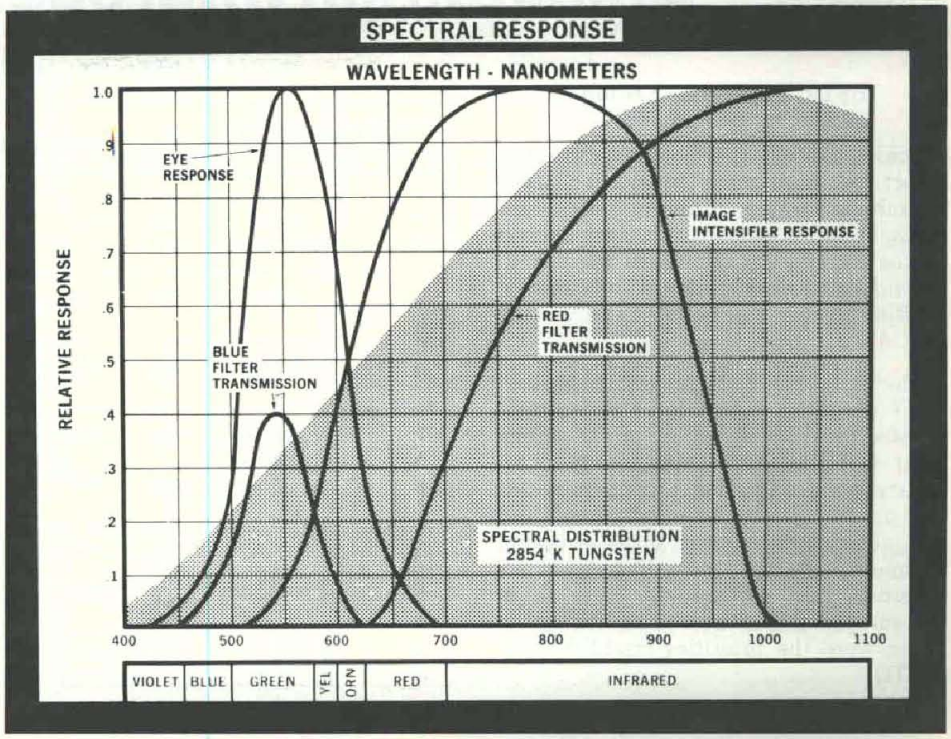
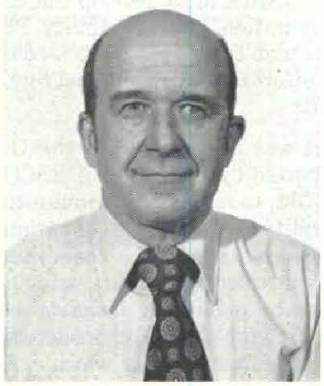


Fig. 3. COMPARISON of spectral transmission characteristics of blue filter to the red filter and to the sensitivity of the eye and image intensifier.

are illuminated during night operation. Some of these lamps are outside the vehicle and some inside.

Red or green light is required for some warning of indicating lamps. Through an ongoing secure lighting program at USATACOM, each of these lamps is being examined to optimize its intensity as well as spectral and spatial distribution.

It is the intent of this program to provide optimum vision in and around U.S. combat vehicles with minimal light. Each lamp will be designed to emit only energy visible to the human eye.



HARRY R. YOUNG is a research mechanical engineer in the Survivability Division at the Tank-Automotive Command's R & D Center. He is presently employed in the development of countermeasures for all military vehicles. He holds a BEE from the University of Detroit.

Ammunition Interoperability

By Dr. Eugene L. O'Brien

During the past several years a concerted effort has been made to achieve interoperability of ammunition in our current stockpile and to assure that it is maintained in the future. The effort has resulted in considerable involvement, bilaterally, multinationally, in NATO, and in the ABCA.

The background for this effort began in 1977 when the Secretary of Defense requested the Joint Chiefs of Staff to outline their priorities for achieving interoperability with NATO. The response provided five priority items: command, control and communications; aircraft cross-servicing; ammunition; target surveillance and acquisition; and replacement parts. It is not surprising that those priorities in that order were the priorities established by NATO.

In that same time period interoperability was emerging as a high priority effort in USAREUR. General Blanchard had set interoperability goals in three component areas: programs and policies (e.g., language training, programs . . .); software (e.g., STANAGs, doctrine, SOPs . . .); and hardware (e.g., equipment, ammunition, weapons . . .).

It was with regard to hardware that the CINCUSAREUR approached DARCOM to take all necessary actions to allow for exchange training firings between the U.S. and other specified NATO armies. This was to be done for the purpose of instilling troop confidence in the ammunition stockpiles in NATO.

What was essentially necessary was a safety certification of the foreign ammunition. Therefore, a team was formed by ARRADCOM in early 1978 and sent to Germany to examine the technical data packages, malfunction reports, safety related incidents and acceptance criteria for artillery and tank ammunition.

On the basis of this analysis of ammunition components, a binational agreement was signed for specific combinations determined to be safe to fire by troops in training. Subsequently, the same procedure was followed with the United Kingdom, Canada, the Netherlands, Belgium, France, Norway and Italy.

Results to date are 30 agreements as described in the table at the top of this page.

PERMISSABLE EXCHANGES WITH U.S. IN TRAINING

Weapon Catagory	Round Catagory	Germany	UK	Canada	Netherlands	Belgium	France	Norway	Italy
ARTILLERY	8-inch (203mm)	Yes	Yes	NA	Yes	Yes	NA	NA	Yes
	155mm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	175mm	Yes	No	NA	**	NA	NA	NA	No
TANK	105mm APDS	Yes	NA	Yes	*	*	NA	Yes	Yes[2]
	105mm HEAT	Yes	NA	NA	*	Yes	NA	Yes	Yes
MORTAR	4.2-inch HE	NA	NA	NA	Yes	No	NA	No	NA
	4.2-inch Illum.	NA	NA	NA	Yes	Yes	NA	Yes	NA
	81mm HE	NA	Yes	Yes	No	No	No	Yes1	Yes1

Legend:

Yes - Interoperable.
NA - Does not have weapon or does not use ammunition.
No - Ammunition and/or weapon not interoperable or being phased out.
*** - Does not use live rounds for training.**
**** - Does not train with this weapon.**
1 - Agreement for Illum. only.
2 - Agreement for TP-T only.

The agreements contain further provisions for the notification of changes to the TDP and for reporting of malfunctions. One exchange firing of 8-inch ammunition has been conducted to date. Legal problems, which inhibited the exchanges, have been resolved and more exchange firings are anticipated.

Concurrent with the negotiation of binational agreements, ARRADCOM was directed by DARCOM to develop the U.S. Army Ammunition Interoperability Plan (AAIP). The plan essentially addressed the binational effort and was approved by DA in July 1979.

An effort was exerted within the U.S. Army, supported by TRADOC, FORSCOM and DARCOM, to implement ammunition interoperability into all phases of training and operations. From the beginning, ARRCOM provided valuable assistance to the effort by publishing technical bulletins describing the physical characteristics of the foreign ammunition for which agreements had been signed.

In cooperation with the USAFAS, Fort Sill, OK, and USSAAS, Fort Knox, KY, simple changes were added to artillery and tank firing tables. These tables listed, by nomenclature, foreign ammunition that could be fired in training and combat. The information also was provided in TACFIRE software. Again, with the USAFAS, appendices were added to the Artillery Field Manuals in the FM6-series to further inform the troops with regard to interoperability.

Standardization Agreements, permitting the exchange of ammunition in war, had existed in NATO for years. They described equivalents of ammunition, e.g., projectiles/cartridges, fuzes, etc., and drew their conclusions based on form, fit, function and safety. They did not address restrictions or accuracy and had, therefore, not really addressed safety.

The initial phase of this effort started with "taking stock" of what the nations had. The STANAGs were used to start and their content verified by each nation through direct contact. Again, this was accomplished on a binational basis.

Eventually the agreement allowed the U.S. to compile a data base of permissible combinations for artillery, tank and mortar ammunition components which were in the inventory of each nation in NATO. This is strictly a data base, but many applications of its content have already been found to provide information to the troops in the field.

Shortly after the approval of the AAIP by DA, it was decided to introduce a similar plan into NATO. The U.S. had made sufficient progress in this areas to be able to present a credible plan in November 1979. A program following the plan was initiated in AC/225 Panel IV (Surface-to-Surface Artillery) through Sub-Panel 2 (Ballistics).

The response was immediate and affirmative. Panel IV forwarded it to the NATO Army Armaments Group (NAAG) supported by endorsements from Panel II (Armor) and Panel III (Infantry).

In January 1980, NAAG recommended endorsement by the Conference of NATO Armaments Directors (CNAD). This was enthusiastically received in April 1980. The process from introduction into Sub-Panel 2 through CNAD took only six months indicating the importance of this effort in NATO.

A parallel path was followed on the Military side of NATO starting with the Army Board, through the Chairman, the Military Agency for Standardization (MAS) to the Military Committee who added their endorsement to that of the CNAD.

By agreement between CNAD and the Military Committee, an *ad hoc* group was established within the Army Board with representation of the International Staff (representing CNAD) to conduct the NATO Ammunition Interoperability Review (NAIR).

The review initially relates to artillery, tank and mortar ammunition interchangeability and involves all ammunition oriented panels and working groups throughout NATO. The objectives follow the same pattern as the AAIP:

- Determine where interchangeability now exists.
- Identify actions required to maintain and to enhance interchangeability in the future.
- Provide NATO land forces the information required to interchange ammunition for peacetime training and during war.

In March 1981, the nations agreed to support the NAIR as a high-priority NATO program. It should be noted that there has been considerable effort within NATO for a long period of time dealing with interoperability. A lot of good work has been done. The NAIR concentrates the focus of NATO into that area, and in essence, it creates awareness.

Agreements have now been signed to allow exchange of ammunition between the NORTHAG nations (Belgium, Germany, Neatherlands, United Kingdom). The agreements follow the same format used by the United States. In fact, NORTHAG is planning a firing demonstration involving those nations previously mentioned and a U.S. Brigade sometime in 1981. It is anticipated that additional agreements will be signed in the future.

Where does NATO stand then, at this point in time, with respect to the current stocks of ammunition and where are we going in the near future? The interoperability posture is good for artillery, tank and mortar ammunition.

There are basically four models of 105mm artillery in NATO. The UK Abbot (SP) or L118 (towed) use separate loaded ammunition which is not interchangeable in other allied weapons. The U.S. produced M101A1, the French M1e50 and the Italian L5 all fire the U.S.-made ammunition.

Conversely, there are supercharge zones used in the M1e50 that are restricted in the U.S. weapons and UK cartridges for which firing tables do not exist for the U.S. howitzer. Much of the M1, HE ammunition in national stockpiles have old fuzes containing a single safety and, therefore, given an option, should not be fired by U.S. forces. In general, interchange capabilities for the 105mm are good and should remain that way.

The basic 155mm howitzers in NATO are the M114 and M109 Series. Again, France is the exception. All howitzers, including the French, fire U.S. ammunition of the M107, HE type. French ammunition of the OE 56/69 HE-type can be fired in U.S. howitzers but, again, firing tables are required.

Quantities of FH70 howitzers and associated ammunition from the trilaterial are already being introduced into the inventories of Germany, Italy and the United Kingdom. Ammunition interoperability fortunately has been addressed between the new U.S. and trilateral weapons by the project manager for Cannon Artillery Weapons Systems under the Quadrilateral Ballistics MOU.

Plans are in progress to conduct trials of U.S. and Trilateral ammunition combinations in each other's weapons and include sufficient firings for the generation of firing tables.

Neither U.S. nor trilateral 155mm weapons will be able to use French propelling charges, due to differences in the ignition system. However, French projectiles should be capable of being fired with U.S. charges, and acquisition of fire control information firing has been recommended.

It should be noted that the major problem in NATO is the existence of old and new weapons/ammunition simultaneously in stockpiles. This is a complication that leads to firing restrictions. This problem is most obvious with the M114A1 howitzer, which is in large numbers in NATO, but cannot fire the newer projectiles or charges. Improvements to this situation range from simple product improvement of the M114A1 to the M114A2 to replacement of it with M198 or L121 howitzers.

The 155mm is the NATO artillery caliber and, therefore, it is not surprising that this is where future interoperability problems could occur and where actions to avoid problems have been taken. While there are some problems, there are also solutions available. Interoperability, both now and in the future, with respect to ammunition, is good.

The 175mm ammunition is totally U.S. in origin. While the UK has made some modifications to the stocks, these are not major problems, since most nations will convert the 175mm to 203mm weapons. There are no concerns.

The 203mm (8-inch) howitzers and ammunition are U.S. in origin. Both M115 (towed) and M110 (self-propelled) weapons are in NATO. All nations having the M110 plan to convert to M110A2, thus providing greater projectile selection and range advantage. On the other hand, the M115 is old and can only fire the limited selection of current ammunition.

A technical data package is not available to improve the M115 capability as was done for the M114A1. At least one nation of the five, having M115 howitzers, plans to replace them with the M110A2. With that one notable exception of the M115, which deserves attention, there are no other ammunition interoperability problems with this caliber foreseen.

No other NATO nation has entered into the development of 203mm weapons or ammunition. NATO will look to the U.S. in the future for the design of newer projectiles.

Tank ammunition is probably the most outstanding example of interoperability in NATO. There are three calibers of weapons currently in NATO: 90mm, 105mm, and 120mm.

Two 90mm U.S.-designed tanks remain in NATO, the M47 and M48. The quantities of these tanks are substantial. In some countries they still represent their main armament. Current stocks of ammunition are of U.S. origin but are not adequately designed for the modern threat. An improved design, based on a scaled-down version of the 105mm APFSDS-T, offers considerable increased capability for upgrading the firepower of these weapons.

The NATO decision to adopt the UK L7A1 as the standard tank cannon probably was the most important factor in insuring interoperability of 105mm tank ammunition. In NATO, at the present time, are the M48A5, Leopard I, Centurion and M60A3 105mm tanks, all with a common cannon. However, ammunition is a mixture of U.S. and UK design with almost complete interoperability between the two, including ballistics.

This simplifies the automated fire control computer programming. It is simply a matter of annotating the card/cam to identify the ballistic equivalent cartridge for each nation.

There has been little done to evaluate the interoperability of the French AMX30 and its ammunition with the rest of NATO. Acquisition of firing data for the French projectiles would complete an already excellent interoperability study.

Even though the UK 105mm cannon is standard in NATO, the UK does not have the Centurion in its own inventory, they have long since changed to the 120mm Chieftain. The Chieftain has a rifled bore cannon that is not interoperable with anything that is or will be in NATO. In the future, this problem will be perpetuated, since the UK will develop a new rifled bore 120mm tank with its own class of ammunition.

However, Germans have developed the 120mm Leopard II and the U.S. is beginning production of the M1, with both using smooth-bore cannon and ballistically similar ammunition. Close cooperation between the two nations will insure interoperability of 120mm smooth-bore ammunition in the future.

The basic mortar calibers in NATO are the 81mm, 4.2-inch and 120mm. While some nations do have 60mm mortars, they are not considered a NATO caliber. Of the major caliber weapons/ammunition, mortars are probably the most complicated system that has been examined.

There are about six different 81mm mortar tubes, used by NATO, which can fire U.S., French and UK ammunition. They are mixtures of old and new weapon/ammunition combinations, some of which date back to WWII.

Fortunately, all tubes can fire all ammunition in stock but, in some cases, only with severe restrictions. Since muzzle velocity variations between the various weapons and ammunition does not exceed three percent, fire-control information is interchangeable.

Much of the HE, WP and illuminating mortar ammunition in NATO is U.S. in origin or close copies of the U.S. designs. Many of the HE and WP cartridges are packaged with single-safety fuzes that do not meet modern dual-safety requirements.

Other than the U.S., the nations introducing modern mortar weapons into stock are buying the UK-designed L16A2. A mixture of newer U.S., UK and Norwegian ammunition will continue to appear in the NATO national 81mm inventories in the future.

The 4.2-inch mortar is in the inventory of five NATO nations. All mortars of this caliber and ammunition are U.S.-designed. Some of the ammunition is manufactured in Europe and is produced to the U.S. TDP. Interoperability is not a problem with this system.

Five nations have the 120mm mortar. There are fin- and spin-stabilized cartridges with as many versions of ammunition as there are mortars. Little has been done to determine the degree of interoperability of this caliber. The U.S. has no 120mm mortars in service, but has considered the possibility.

What is the outlook for the future? During the past several years, the U.S. has not only made significant progress to identify where it stands with respect to interoperability, but has learned to appreciate the value of a close association with scientists and engineers from other NATO nations. The result has been the establishment of mutual trust in the abilities of each other and a willingness to make things work.

Up to now, the U.S. has talked about interoperability of hardware and associated software. Aside from the 120mm tank cooperation with Germany, much of what was accomplished in bulk ammunition was done after national programs were well into development.

Despite the degree of success achieved, this is not the way it should be done in the future. In fact, it is not the way it will be done. Insurance that it will not be comes in the form of program and management initiatives. To exemplify what has been accomplished, specific cases with which the author has been associated will be discussed in the paragraphs that follow.

Much of our recent progress started as bilateral efforts. TECOM has done an outstanding job in arriving at safety test agreements in this manner. The approach taken was a "tailoring" process which permitted consideration of alternative methods of arriving at the desired acceptable procedures.

There was much give and take in the process, but the results were well worth the effort. Agreements were signed with the UK and Germany, which identified procedures describing the conduct of a specified safety test, and if used, will allow the data of one nation to be acceptable to the other without requiring a large retesting program.

Another excellent example of innovative management was the negotiation of the Quadrilateral Ballistics Memorandum of Agreement signed by the U.S. and the trilateral (GE/IT/UK). This document descibes the 155mm ballistics parameters governing the design of ammunition for the FH-70 and the M198. The PM, Cannon Artillery Weapons Systems (PM-CAWS), is the U.S. agent for this agreement and its implementation.

Since it was obvious that the TECOM and PM-CAWS activities were complementary, they were combined, and the result was a Quadrilateral Safety Agreement, signed in 1980. Shortly after its signing, the safety agreement, backed up by documentation of test procedures, was introduced into NATO for consideration as a STANAG.

Although the original quadrilateral safety agreement was specific to the

155mm, its content with minor changes is applicable to all artillery and, furthermore, to all tube-launched ballistic ammunition; including naval guns.

The Quadrilateral Ballistic MOU itself is being considered as the basis for a STANAG describing the design parameters of projectiles and propelling charges for fielded NATO 155mm howitzers through the 1990 timeframe.

The document will be expanded to include the French AUFI, as well as new weapons/ammunition, being considered by other NATO nations. Once promulated, it will serve to insure that interoperability of ammunition in existing weapon systems will be maintained at least to the timeframe covered by the STANAG.

Beyond the year 2,000, NATO is looking for major improvements to the entire artillery system that will provide the interoperability required to satisfy the NATO/JCS priorities mentioned in the early section of this article.

There has not yet been an artillery system, designed by any country, which was influenced by NATO from the beginning. Recognizing that such a system would lead to the ultimate in interoperability, Panel IV (S.P. 2) requested the U.S. to present an information briefing on the artillery approach to satisfy the Mission Element Need Statement for the Division Support Weapon System (DSWS).

It is the desire to use the DSWS as the system model on which a NATO requirement could be established. While a national decision by the U.S. has not been made on the artillery solution to DSWS, it is expected that if the decision is affirmative, consideration would be given to making DSWS a NATO program.

As a final example, again the Panel IV (S.P. 2), STANAG 4144 has been written to describe procedures for obtaining firing table data that, if followed, will allow each nation to accept the data of another and avoid excessive duplication of costly tests.

This article describes only a small portion of what is being done in NATO. If there is one major problem to overcome in the interoperability area, it is a lack of communications of the accomplishments to the field. However, this is an age-old problem for which remedial steps are being taken. The returns on the investment are such that this problem has to be overcome.

In conclusion, a good deal is known about interoperability with our NATO allies. We never were in bad shape, we just lost track. While there are some problems, they are not insurmountable either now or in the future. Steps have been and will be taken to insure future interoperability of not weapons/ammunition, but to the entire systems from the outset of the program.

DR. EUGENE L. O'BRIEN is the chief, RSI/Foreign Exchange Branch, Requirements and Analysis Office, ARRADCOM, Dover, NJ. He has been involved with many munitions programs over the past 20 years, including ICM and Scatterable Mines. He is currently involved in an effort to establish and maintain ammunition interoperability in NATO. Dr. O'Brien has a BS and PhD in polymer chemistry from St. Peter's College and the Polytechnic Institute of New York.

RDA Magazine Readership Survey Results

A sincere thanks is expressed to the more tha 900 readers who have already responded to the Army RDA Magazine's readership survey which appeared in our May-June 1981 issue.

Approximately 52 percent of those who responded were from the military community, while 37 percent represented civilian government. The remaining 11 percent were equally divided among the industrial, academic, and "other" categories.

It was most encouraging to learn that 85 percent of our readers received all (6) of our annual issues. The remainder of our recipients get about one-half to three-quarters of our issues.

We also are happy to report that the largest portion of our respondents (80 percent) said that they receive their copies within the same month it is published, and that about 45 percent of the magazines are received directly by mail and 45 percent are obtained indirectly through intra-office distribution.

Although the magazine is not read from cover to cover, it is read by three-quarters of our audience for "most" of its content. A small portion of individuals indicated that they merely "scan" it.

More than 90 percent of our survey readers termed the information found in the *Army RDA Magazine* as being "very useful." The remaining 10 percent of our readers rated the information "slightly" to "moderately" useful. Two people indicated that the information was not useful.

Print sizes (question 8) were judged "about right" by 96 percent of our respondents, and both bylines and short news articles receive equal attention (question 9). Relative to question 10 (Which departments do you prefer to read?), our computations indicate that the heavy favorite is "capsules." "Conferences/symposia" and "personnel actions" share a second place spot, with "career programs" and "awards" capturing the "show" position.

Responses to question 11 (How do you feel about our question and answer interview article?) reveal that 53 percent of our readers have a moderate approval of our question and answer interview articles. A strong opinion of the interview feature was expressed by 46 percent of our readers, while only one percent dislike it. The art, illustrations and general layout of the magazine received a 75 percent "good" rating, and a 23 percent "very good" rating. Only two percent said it was "so-so."

Ninety-six percent of those responding to the survey said that *Army RDA Magazine* articles covered their subjects in sufficient depth (question 13). The remaining four percent was equally divided between "too superficial" and "too much depth."

Numerous suggestions relative to the content and layout of the magazine were received. Although we cannot accomodate all of your recommendations, we will certainly do our best to incorporate as many as possible. Some of the most repeatedly asked for suggestions were as follows: More illustrations, More medical articles, Electronics warfare subjects, Future R & D features, Articles from academia, More test and evaluation articles, Human factors stories, Other service stories, Lessons learned in R & D, More on armor developments, Increased emphasis on mobilization, and Avionics articles.

ATL Support to NASA

By Edward H. Dean

The U.S. Army Aviation Research and Development Command's Applied Technology Laboratory (ATL), Fort Eustis, VA, one of four laboratories of the U.S. Army Research and Technology Laboratories, is currently fatigue testing a series of windmill blades for NASA's Lewis Research Center, Cleveland, OH. Fatigue testing has been completed on one of the fan blades which will power the new wind tunnel at the NASA-Langley Research Center, Hampton, VA.

NASA-Lewis, in conjunction with the Department of Energy, is developing windmill blades to power wind turbine generators. These huge windmills, some with blade lengths of over 320 feet, will be erected in locations around the country where there is a relatively steady prevailing wind.

These blades are the highest cost items involved in windmill construction. The electrical generator, along with the tower on which it is mounted, are relatively standard industrial items which will function efficiently for many years with minimal maintenance.

The blades, however, are constantly exposed to the elements. Dust, rain, sunlight, lightning, and strong gusts of wind all take their toll over a period of time. It is therefore desirable that the blades represent the best trade-off between durability and cost.

In order to efficiently make this trade-off, candidate windmill blades of various configurations must be built and tested. It is here that the Fort Eustis based laboratory comes into the picture.

ATL has the capability to perform fatigue tests on windmill blade specimens which duplicate the loads encountered in actual use. The blade is mounted for testing on a rigid steel structure known as a backstop. The root end of the specimen is bolted to the backstop in a manner which simulates the mounting of the blade.

A hydraulic actuator is affixed to the tip end of the specimen. It is this actuator which applies the cyclical loads. During the tests, data denoting the strains encountered at various points on the test article are relayed to a computer where they are stored for future analysis.

Various candidate windmill blade configurations have been tested including those made of wood, aluminum and steel, and "composite" materials such as glass fibers joined together with high strength epoxy. Evaluation of these blades is still on-going, so the best blade configuration has yet to be selected. Testing is expected to be completed soon.

NASA-Langley currently has under construction a major research wind tunnel designated the National Transonic Facility (NTF) for acquiring aerodynamic data in the transonic speed range. This new facility, of closed loop configuration, will be utilized by the Department of Defense, other government agencies, industry, and universities.

The NTF utilizes air or nitrogen at temperatures ranging from 175 degrees to 320 degrees F for simulation of full-scale aerodynamic parameters. The advanced technology required, both in design and materials, has resulted in many systems being designed and constructed by NASA-Langley. The design, manufacture, and qualification testing of the fan blades that are used to achieve and maintain air velocity within the tunnel represents one such system being designed by NASA-Langley.

NASA-Langley, however, was not equipped to accomplish the full range of testing desired for the NTF blades. Two fatigue tests were required which simulate the operating conditions (360 rpm and 600 rpm) of the NTF fan system. The fan blade aerodynamic (bending) and centrifugal (tension) loads had to be applied and released simultaneously in each test. Total number of cycles for each test was 6,000.

The ATL Structures Laboratory Root End Fatigue Machine was used for this test. This machine had the capability of applying cyclical bending loads under a constant tension force. With minor modifications, the capability of cyclically applying the tension loads in coordination with the bending loads was added to this machine.

Using an adapter fitting, designed and constructed by NASA, the NTF blade was mounted in the test machine. Loads were applied gradually prior to the start of fatigue testing. As the loads were gradually increased, the blade and the test set-up was closely inspected to insure proper fit-up and freedom of movement.

After the initial series of checks, testing was begun on the simulated 360 rpm condition. This involved the application of 12,500 lbs bending load and 20,500 lbs tension load. After that test, the simulated 600-rpm test was conducted which required a bending load of 5,000 lbs. The NTF blade successfully passed both of these tests.

EDWARD H. DEAN is an aerospace engineer assigned to the Structures Laboratory, Aeronautical Technology Division, Applied Technology Laboratory, U.S. Army Research and Technology Laboratories (AVRADCOM), Fort Eustis, VA. He is responsible for planning, organizing, and conducting specific R & D projects related to aircraft structures and structural elements. Dean holds a BS degree in aerospace engineering from Auburn University.

Army Converts to Silicone Brake Fluid

Dr. Hermann J. Spitzer

At present, the Army uses three brake fluids: a polyglycol-based brake fluid (VV-B-680) in all tank-automotive equipment in temperate-tropical areas, a low temperature version (MIL-H-13910) for operating in arctic environments, and a castor oil-based brake fluid (MIL-P-46046) for storage and perservative applications.

Maintaining the three fluids in the Army supply system often created problems in logistics, supply, and distribution. A project to solve these and other maintenance-related problems caused by corrosion was started in 1967 at the U.S. Army Coating and Chemical Laboratory at Aberdeen Proving Ground, MD. It was continued at MERADCOM after the transfer of this function to Fort Belvoir in June 1974.

In cooperation with industry, MERADCOM developed a new military specification brake fluid, MIL-B-46176, which is based on di-organopolysiloxane fluids (silicones). This new brake fluid eliminates the need for the arctic and preservative brake fluid specifications and greatly reduces the use of conventional polyglycol brake fluids.

The new silicone brake fluid is hydrophobic (i.e., water repellent) and does not corrode any metals. It possesses high thermal and chemical stability while being non-toxic. The new fluid is formulated to provide excellent lubrication of rubber-metal and plastic-metal interfaces.

Silcone brake fluid also does not attack paint and has a very high dielectric strength, which may become the basis for new approaches in the design of electrical sensors for monitoring brake system operation and safety.

The hydrophobicity of silicone brake fluid is quite significant. Water absorbed hoses, wheel cylinder boots and cups and the dissolved minerals which it contains are the major cause of corrosion of metal brake parts in conventional hydraulic brake systems.

Abrasive products of this corrosion subsequently contribute to the wear failure (usually leaks) of elastomeric parts. Water absorbed into conventional brake fluid also increases low temperature viscosity resulting in sluggish brake release and/or wheel locking.

At high ambient operating temperatures, absorbed water reduces the vapor formation temperature of conventional brake fluids. For example, a 3.5 vol percent content, which is less than the average water content found in conventional brake fluid systems, will lower the vaporization temperature approximately 125 °F. This, of course, increases the tendencies and risk of vapor lock dramatically. Silicone brake fluid completely eliminates these problems, since its maximum absorption of water does not exceed 0.02 vol percent.

The new silicone brake fluid has excellent performance characteristics under extreme temperature conditions. Without the potential of boiling, vaporization or decomposition, the fluid can be used at temperatures as high as 560 °F and as low as -67 °F, without freezing or crystallizing, since the change in viscosity with temperature is relatively small.

Silicone brake fluid is completely compatible with elastomer materials used in conventional brake systems. Although it does not mix with conventional-type brake fluids, it is completely compatible with glycol brake fluids as a 2-phase mixture. In other words, an accidental mixing of the two fluids will not cause mutual percipitation or leaching or additives in this type of environment.

After comprehensive field testing in the tropic, arctic and desert environments and after a favorable cost analysis, the Army decided to implement silicone brake fluid in both the existing and future vehicle fleet. The implementation plan applies to combat and tactical wheeled vehicles, administrative and commercially procured vehicles, and construction and materials handling equipment.

The start of this one-year retrofit program, with the existing Army vehicle fleet, began 1 July 1981. During this 1-year period, silicone brake fluid will be on a free issue basis to the user. Existing stocks of conventional brake fluid (VV-B-680) that are returned in sealed cans will be credited to the users.

The method of conversion will be flush and fill, either through use of regular pressure bleeder, added application of pressure air flush, or by application of a modified flush and fill technique. MERADCOM is presently determining the feasibility of a modified, more effective flush and fill procedure to completely eliminate all residual conventional brake fluid.

The change from polyglycol to silicone brake fluid not only will have significant beneficial impact on the logistics and readiness of the existing U.S. Army vehicle fleet, but will also improve the reliability, availability, maintainability and durability of all vehicles.

New vehicles filled with silicone brake fluid should need no replacement of the fluid during the whole vehicle life. It is our belief that another importance of the decision by the Army to change to silicone brake fluid will be that all DOD and eventually the domestic automotive industry will adopt this decision.

DR. HERMANN J. SPITZER is a supervisory chemist in the Fuels and Lubricants Division, Energy and Water Resources Laboratory, U.S. Army Mobility Equipment R & D Command. He received his doctorate in physical chemistry from the University of Munich in 1963. His memberships include the American Institute of Physics and the American Physical Society.

Personnel Actions . . .

Keith Succeeds Guthrie as DARCOM CG

GEN Donald R. Keith, former deputy chief of staff for Research, Development and Acquisition, received his fourth star recently along with command of the U.S. Army Materiel Development and Readiness Command, following the retirement of GEN John R. Guthrie.

GEN Donald R. Keith

GEN Guthrie, who had completed more than 39 years of active military service, had served as DARCOM commander since May 1977.

Prior to becoming deputy chief of staff for RD&A in 1978, GEN Keith had commanded the U.S. Army Field Artillery Center and was commandant of the U.S. Army Field Artillery School at Fort Sill, OK.

From 1972-1976 he was assigned to the Office, DCSRDA, first as director of Developments, and then as director of Weapon Systems. This followed a tour as director of the Research and Analysis Director, Civil Operations and Revolutionary Development Support, U.S. Military Assistance Command, Vietnam.

Backed by more than 32 years of active commissioned service, GEN Keith holds a BS degree in military science from the U.S. Military Academy and an MS degree in science teaching from Columbia University. His military schooling includes the Army Command and General Staff College, Armed Forces Staff College, Industrial College of the Armed Forces, Artillery School (basic and advanced), and the Ground General School (basic).

GEN Keith is a recipient of the Legion of Merit with two Oak Leaf Clusters (OLC), Bronze Star Medal, Meritorious Service Medal, and the Army Commendation Medal with OLC.

Merryman Becomes RDA Deputy Chief of Staff

LTG James H. Merryman

LTG James H. Merryman has succeeded GEN Donald R. Keith as deputy chief of staff for Research, Development and Acquisition. GEN Keith has assumed new duties as DARCOM commander.

LTG Merryman, a veteran of more than 30 years of military duty, had served formerly as assistant deputy chief of staff for RDA. During 1978-80 he was commander, U.S. Army Aviation Center and commandant, U.S. Army Aviation School, Fort Rucker, AL.

From September 1977 to December 1978, he served at the U.S. Army Training and Doctrine Command, initially as deputy chief of staff for Personnel, and later as deputy chief of staff for Combat Developments. Other key assignments have included chief of staff, V Corps. U.S. Army Europe; and assistant division commander, 3d Armored Division, U.S. Army Europe.

Graduated from Henderson State Teachers College with a BA degree in biology, LTG Merryman has also completed the Army Command and General Staff College, the Armor War College, and the Armored School (advanced course).

His military honors include the Legion of Merit with Oak Leaf Cluster (OLC), Distinguished Flying Cross with two OLC, Bronze Star Medal with two OLC, Meritorious Service Medal, Air Medals, and the Army Commendation Medal with two OLC.

Sheridan Selected as Assistant DCS for RDA

Assistant deputy chief of staff for Research, Development and Acquisition, Office, Deputy Chief of Staff for RDA, is the new title of MG Stan R. Sheridan, following service since 1979 as director of Development and Engineering, HQ U.S. Army Materiel Development and Readiness Command.

MG Stan R. Sheridan

Graduated from the U.S. Military Academy in 1951, MG Sheridan earned an MS degree in mechanical engineering from the University of Southern California in 1959. His military schooling includes the Industrial College of the Armed Forces, the Command and General Staff College, and the Armor Office Career Course.

Prior to his tour as DARCOM D & E director, MG Sheridan had been assigned as DARCOM director of Battlefield Systems Integration. During 1975-78, he served as program manager of the Fighting Vehicle Systems, Warren, MI, following assignments from January-June 1975 as commander, Support Command, 2d Armored Division, Fort Hood, TX, and from 1971-74 as project manager for the M60 series Tank family.

MG Sheridan received the Secretary of the Army's Frank Pace Award in 1968 for his achievements as tank action officer, Office of the Army Chief of R & D. His responsibilities included the M551 General Sheridan, the M60A1E1/E2 Tank, the U.S./FRG Main Battle Tank, and associated equipment and components.

Listed among his military decorations are the Silver Star, Legion of Merit with two Oak Leaf Clusters (OLC), Distinguished Flying Cross, Bronze Star Medal with "V" device, Army Commendation Medal with OLC, Air Medal with 11 OLC, and the Purple Heart.

Gonzales Picked as DARCOM D & E Director

MG Orlando E. Gonzales

MG Orlando E. Gonzales, former chief, Joint United States Military Assistance Group, Korea, has succeeded MG Stan R. Sheridan as director of Development and Engineering, HQ U.S. Army Materiel Development and Readiness Command.

A veteran of more than 28 years of active military service, MG Gonzales served from 1978-79 as assistant deputy chief of staff, Air Transportation, Military Air-

lift Command, Scott Air Force Base. He had previously commanded the Western Area, Military Traffic Management Command, Oakland Army Base, CA.

During 1975-76, he was assigned as commander, 7th Transportation Group, Fort Eustis, VA, following a tour as product manager, AH-1 Cobra Series Aircraft, St. Louis, MO. He has served also as operations and training staff officer, Service Schools Branch, Office, Deputy Chief of Staff for Personnel, Department of the Army.

MG Gonzales received a BS degree in business administration from St. Benedicts College and an MBA degree from Auburn University. He also completed requirements of the Air War College, Army Command and General Staff College, and the Army Transportation School.

His military honors include the Air Force Distinguished Service Medal, Legion of Merit with Oak Leaf Cluster (OLC), Distinguished Flying Cross, Bronze Star Medal, Meritorious Service Medal, Air Medals, and Army Commendation Medal with OLC.

Starry Named Readiness Command CINC

GEN Donn A. Starry

GEN Donn A. Starry, commander of the U.S. Army Training and Doctrine Command since 1977, has assumed new responsibilities as commander-in-chief, U.S. Readiness Command.

Graduated from the U.S. Military Academy, GEN Starry holds an MS degree in international affairs from George Washington University. He has also completed requirements of the Army War College, Armed Forces Staff College, Army Command and General Staff College, and the Armor School (basic and advanced courses).

Backed by more than 33 years of active military service, GEN Starry served from 1976-77 as commander, V Corp., U.S. Army Europe. This followed a tour as commander, U.S. Army Armor Center, commandant, Armor School, and commander, U.S. Army Training Center, Fort Knox, KY.

From 1971-73, he was director, Manpower and Forces, Office, Assistant Chief of Staff for Force Development, Department of Army. Other key assignments included deputy director, Operations Directorate, Office, Deputy Chief of Staff for Military Operations, DA; and commander, 11th Armored Cavalry Regiment, Vietnam.

GEN Starry is a recipient of the Silver Star, Legion of Merit with two Oak Leaf Clusters (OLC), Distinguished Flying Cross, Soldiers Medal, Bronze Star Medal with V device and OLC, Air Medals, Joint Service Commendation Medal with OLC, Army Commendation Medal, and Purple Heart.

Otis Takes Over as TRADOC Commander

GEN Glenn K. Otis, deputy chief of staff for Operations and Plans, DA, since 1979, has succeeded GEN Donn A. Starry as commander of the U.S. Training and Doctrine Command. Starry has assumed new duties as commander-in-chief, U.S. Army Readiness Command, MacDill, Air Force Base, FL.

Graduated from the U.S. Military Academy, GEN Otis holds an MS degree in mathematics from Rensselaer Polytechnic Institute and has completed requirements of the Army Command and General Staff College and the Army War College.

His key assignments have included commander, 1st Armored Division, U.S. Army, Europe; deputy commander, U.S. Army Combat Development Activity; deputy commander, U.S. Army Training and Doctrine Command; and chief, XM1 Tank Task Force, U.S. Army, Fort Knox, KY.

GEN Otis wears the Distinguished Service Cross, Silver Star, Legion of Merit with three Oak Leaf Clusters, Air Medals, and the Purple Heart with OLC.

GEN Glenn K. Otis

Vander Els Takes MERADCOM Command

COL Theodore Vander Els is the new commander of the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, following a year of studies at the U.S. Army War College, Carlisle Barracks, PA. Prior to attending the AWC, he was chief, War Plans Branch, ODCSOPS, HQ USAREUR, Heidelberg, Germany.

Listed among his other key assignments are commander, 9th Engineer Battalion, VII Corps, Aschaffenburg, Germany; staff officer, the Engineer School, Fort Belvoir, VA; staff officer, Plans and Policy Directorate, HQ AFSOUTH, Naples, Italy; and faculty, Department of Engineering, U.S. Military Academy.

Vander Els is a graduate of the U.S. Military Academy, holds an MS degree in civil engineering and an MS degree in nuclear engineering from Massachussetts Institute of Technology, and has completed requirements of the Army Command and General Staff College and the Engineer School basic and advanced courses.

He has 20 years of active military service and is a recipient of the Legion of Merit, Bronze Star (2d Oak Leaf Cluster), Meritorious Service Medal, and the Army Commendation Medal.

COL Theodore Vander Els

Crawford Chosen as SOTAS Program Manager

COL William R. Crawford has been named program manager of the Standoff Target Acquisition System (SOTAS). He has served as deputy commander of ERADCOM for the past two years.

A signal officer, COL Crawford was commissioned in 1954 upon graduation from Alabama Polytechnic Institute. He holds a master's degree and PhD in business administration from the University of Alabama. Early in his career he was stationed at Fort Monmouth, both as a student in the Signal Officer Basic course and later (1959-1961) as aide-de-camp to the commander

of the Army Training Command.

Prior to his ERADCOM assignment, COL Crawford commanded the 1st Signal Brigade and was assistant chief of staff for Communications-Electronics, U.S. Forces Korea and Eighth U.S. Army, Seoul, Korea. Before leaving for Korea, he served as comptroller, HQ, Army Armament Research and Development Command, Picatinny Arsenal in Dover, NJ.

A veteran of two tours each in Germany and Vietnam, he has been decorated with the Silver Star, the Legion of Merit, three Bronze Stars, three Meritorious Service Medals, and four Army Commendation Medals. COL Crawford attended the Industrial College of the Armed Forces and the Command and General Staff College as well as the Signal Officer Advanced Course.

Burke Follows Benoit as HDL Commander

COL Allan R. Burke

COL Allan R. Burke, former director of Combat Developments in the U.S. Army Ordnance Center and School, Aberdeen Proving Ground, has succeeded COL William R. Benoit as commander of the U.S. Army's Harry Diamond Laboratories, Adelphi, MD.

Commissioned in the Ordnance Corps through ROTC in 1958, COL Burke has served a variety of tours in the U.S., Vietnam and in Germany. Following a tour in Germany, he was assigned in 1976 as assistant project manager, M60 Tank Production U.S. Army Tank Automotive Command.

Graduated from Purdue University with a bachelor's degree in mechanical engineering, he also holds a master's degree in industrial engineering from Arizona State University. His military schooling includes the Army Command and General Staff College and the Army Air Defense and Ordnance Schools.

He wears the Legion of Merit, Bronze Star Medal, Meritorious Service Medal, and the Army Commendation Medal.

Hall Becomes Command/Control Deputy PM

COL Dennis C. Hall

COL Dennis C. Hall has assumed duties as deputy project manager for Command and Control Systems, U.S. Army Communications Systems Agency/ Project Managers (DCS Army).

COL Hall is responsible for the centralized management of development, acquisition, installation and life cycle support of communications systems. He is also responsible for the improvement of Army air traffic control facilities at airfields worldwide.

He has master's degrees in electrical engineering and information technology and is a graduate of the Industrial College of the Armed Forces.

His staff assignments include duty with the JCS, DCA, and most recently, as a DARCOM liaison officer to the Canadian forces. He has commanded a platoon at Fort Hood, TX, a company at Fort Campbell, KY, a satellite facility at Camp Roberts and a division signal battalion at Fort Lewis, WA. He has served in the 2d Armored, the 101st and 82d Airborne and the 9th Infantry Divisions.

COL Creel Succeeds Conover at WES

COL Tilford C. Creel recently succeeded COL Nelson P. Conover as commander and director of the U.S. Army Waterways Experiment Station, Vicksburg, MS. COL Creel, former Savannah (GA) district engineer, will be responsible for a $70 million research, testing and development program.

He received a BS degree in civil engineering from John Hopkins University, and holds a master's degree in education from Northeastern University. His military schooling includes the U.S. Naval War College.

Listed among his key assignments are assistant division operations officer, 25th Infantry Division, Vietnam; commander, Engineer Battalion (combat), Fort Devens, MA; 18th Engineer Battalion, 7th Infantry Division, Korea; legislative liaison, Office, Secretary of the Army; and director of Civil Works, Upper Mississippi Basin and Great Lakes, Office, Chief of Engineering.

COL Tilford C. Creel

COL Creel wears the Bronze Star Medal with OLC, Meritorious Service medal with OLC, Army Commendation Medal, and the Air Medal.

Dr. Sculley Assumes Duties as ASA (RDA)

Duties as assistant secretary of the Army for Research, Development and Acquisition were assumed recently by Dr. Jay R. Sculley, a former professor of civil engineering and department head at the Virginia Military Institute, Lexington, VA.

Actively involved in engineering research through the VMI Research Laboratories, Inc., Sculley joined the VMI faculty in 1970. He served four years as an assistant professor of civil engineering before departing VMI in 1974 to become general manager for Corrugated Services, Inc.

Sculley returned to VMI in 1975 and was appointed as an associate professor. He became a full professor in 1979. In addition to teaching a seminar in systems engineering, he has served as the VMI superintendent's representative to the VMI Honor Court.

Graduated with a BS degree in civil engineering from VMI in 1962, Sculley also received MSE (1970) and PhD (1974) degrees from Johns Hopkins University. Additionally, he served 33 months as an officer in the U.S. Air Force and was employed as a design engineer with the DuPont Co.

Capsules . . .

New Paints Improve Tactical Equipment Protection

Development of new specifications for polyurethane camouflage paint, which will protect both tactical equipment and the working

environment of the soldier, has been reported by the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA.

The new specifications were devised for the dual purpose of developing paints that will protect tactical equipment from chemical and corrosive agents while also complying with lead and chromate standards established by the Occupational Safety and Health Administration.

The new paints are composed of polyester and a catalyst that form an impervious film that prevents chemical and corrosive agents from penetrating equipment surfaces. If equipment painted with these coatings becomes contaminated by chemical agents, it can be decontaminated in the field by washing instead of transporting it to rear areas for elaborate procedures which are now required with conventional coatings.

Additionally, the new paints contain no lead or chromate. These are potentially hazardous substances which could cause serious health problems. Adoption of the new specifications by the Army, which is currently under consideration, will mean that all tactical equipment will be painted with these coatings.

Contracts Call for Seeker Technology Demonstration

The U.S. Army Missile Command (MICOM) has awarded competitive contracts to Hughes Aircraft Co., Canoga Park, CA, and Texas Instruments, Inc., Dallas, TX, for a seeker technology demonstration on Tank Breaker, one concept under consideration as a Dragon replacement for the 1980s.

Hughes received approximately $15 million and Texas Instruments $11.4 million to produce seekers and conduct captive flight tests demonstrating the focal plane array guidance. Following the competive 18-month program of fabrication and testing, the new technology could be selected for more advanced development.

MICOM's Infantry Manportable Anti-Armor Assault Weapon System Office (IMAAWS) under MAJ James McCullough, is managing the Tank Breaker program for the Advanced Research Projects Agency. Captive flight tests will be conducted at Redstone Arsenal.

Meanwhile, the Army is considering other concepts for the IMAAWS role and has asked the Training and Doctrine Command to define Army requirements for a light infantry, anti-armor weapon. Upon completion of the study in early 1982, the Army will proceed toward a development program with the most promising concepts.

New Generator Will Power Radar System

The U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA, has exercised a $4.4 million contract option with Delco Electronic Division of General Motors Corp., and a $2.8 million option with Solar Turbines International for initial production of a 10 kilowatt, 400 hertz gas turbine engine driven generator set for the Army's Firefinder System.

The generator will supply power for the mobile mortar-locating radar system which can detect and track enemy mortar and artillery fire. A computer in the system calculates the trajectory of the round and traces it back to its point of origin or forward to its point of impact.

Power conditioners, which regulate the flow of electricity the system generates, are manufactured by Delco. Power plants and frames are made by Solar, which also mates the Delco power conditioner to these units to form the complete generator set.

The option being exercised is for 82 units plus spare parts and packaging. Total production contracted for to date is 194 sets. The mortar-locating Firefinder system is scheduled to be fielded later this year.

ET Laboratories Award Firefinder Contract

The U.S. Army Engineer Topographic Laboratories (ETL) have awarded a $470,000 contract to Command, Control and Communication Corp. for a Firefinder Digital Elevation Data Dubbing Facility (DEDDF).

Scheduled for delivery in August 1982, the system will extract digital elevation data from the Defense Mapping Agency's 9-track magnetic tapes and reformat and rewrite the data onto Raymond cassettes in the special format for the computer-controlled Firefinder weapon locating radar systems.

The Firefinder computer-controlled counter-mortar and counter-artillery radars sense incoming rounds in mid-flight and backplot the trajectory to the enemy weapon. Firefinder transmits the enemy weapon's location to the computerized Tactical Fire Direction System (TACFIRE), which will electronically command friendly batteries to return accurate fire, before the enemy has time to relocate his weapons.

Firefinder needs the digital elevation data for automatic height correction. Expected to be the first digital elevation data processor to be delivered to a combat unit, the DEDDF could also be programmed to support other automated weapon systems.

BRL Designs "ACE" for Artillery Control

Mathematicians and weapon systems analysts at the Army's Ballistic Research Laboratory (BRL), have designed a computer game as a research tool. Their Artillery Control Experiment (ACE) is an interactive, real-time multi-player computer game, designed to study field artillery fire support coordination on a simulated battlefield.

ACE consists of several distinct computer processes "piped" together under control of the Bell Telephone UNIX operating system.

With ACE, it's possible to study artillery computer loading, to contrast alternative command structures and to compare alternative communication methods . . . all current topics of growing interest with the availability of "smart" munitions (the munitions related to the engagement of moving targets) and the ever increasing variety of automatic data-processing equipment being supplied to field artillery units.

ACE is designed to bring together the collective experience of developers and users of artillery systems by utilizing data communications over ordinary telephone lines.

Participants in a typical scenario, could include BRL personnel and the Office of the Project Manager for Cannon Artillery Weapon Systems, at Dover, NJ, and a tie-in to the Field Artillery School at Ft. Sill, OK, and the project manager for the "Tacfire" system at Ft. Monmouth, NJ.

Course Taught on Water Purification Unit

A 2-week new equipment training course was conducted recently at the U.S. Army Mobility Equipment Research and Development Command (MERADCOM), Fort Belvoir, VA, for the first military users of the 600-gallon-per-hour Reverse Osmosis Water Purification Unit (600 GPH ROWPU). The course covered normal operation and maintenance procedures.

Lecture and workshop sessions were conducted by the Command's Energy and Water Resources Laboratory engineers. Participants were from the Marine Corps, Air Force, and the Army's 82nd Airborne Division.

Mr. Ed Russell, chief of the Laboratory's Fuel and Water Quality Branch, said the purpose of the 2-week session was to teach participants to operate and maintain the system. Back in their own units they will conduct training for other key personnel to ensure

that trained operators are available when the 600-GPH ROWPU is fielded next year.

The 600-GPH ROWPU was developed and type classified by MERADCOM. It produces potable water from salt water, brackish or polluted water, or water contaminated by nuclear, biological or chemical agents.

As a first time buy item, 41 units have been contracted for to date, at an approximate cost of $8 million. The work is being performed by Univox of Los Angeles and Superior Engineering and Electronics Co., of San Diego. Pre-production tests were conducted at Univox last December and two units will undergo initial production testing shortly.

Awards...

RTL Receives 1980 Army Excellence Award

The Army's Award for Excellence for 1980 has been presented to the Army Research & Technology Laboratories (RTL), AVRADCOM. The Award of Excellence was based on several factors, including: program accomplishments, efficient management of laboratory personnel, management initiatives and accomplishments, fiscal obligations performance and significant improvements achieved.

Approximately 21 Army research laboratories participated in the competition. The Army Research & Technology Laboratories are the Army's principal aviation R & D activity of the Army Aviation R & D Command, AVRADCOM, St. Louis, MO.

AVRADCOM Commander, MG Story C. Stevens commented that "it is the age-old philosophy that your operation is only as good as the people in it. This lastest award is only one indicator of the numerous accomplishments that have become commonplace with RTL and its Laboratories, and attests to the high caliber of the personnel we have at RTL and throughout the AVRADCOM organization."

Laboratory Director Dr. Richard Carlson added: "this award is long overdue and represents the combined efforts of all the members of the Laboratories. The Laboratories will continue to make significant technical contributions year-after-year, and recognition of this sort is certainly well deserved."

HQ RTL is located at NASA Ames Research Center, Moffett Field, CA, and operates four laboratories as follows: Aeromechanics Lab, Moffett Field; Propulsion Lab, NASA-Lewis, Cleveland, OH; Applied Technology Lab, Fort Eustis, VA; and Structures Lab, NASA-Langley, Hampton, VA.

BRL Employees Cited for Outstanding Service

Two engineering personnel and a mathematician have been honored for outstanding civilian service at a special award ceremony at the Ballistic Research Laboratory (BRL), Aberdeen Proving Ground, MD.

Mr. Stanley S. Lentz, a mechanical engineer who directs the Mechanics and Structures in BRL's Interior Ballistics Division, and Mr. Robert F. Lieske, a mathematician who is chief of the Indirect Fire Weapons Section in BRL's Launch and Flight Division, were both awarded the Meritorious Civilian Service Medal, the second highest DA honorary award.

In addition, Mr. Lawrence D. Johnson, an engineer who serves as BRL's armor coordinator was awarded the Commander's Award, presented by the Army Research and Development Command (ARRADCOM) for excellence in engineering development. BRL is a major ARRADCOM research activity.

Both Lentz and Lieske, were cited for performing duties as a supervisory in a manner that established inspiration and a record of achievement. Johnson was recognized for exceptional achievements in weapons systems engineering and concepts analysis.

Lentz, a physicist, currently directs a staff of 29 research and development personnel with an annual budget of more than $2 million. He has been involved in most of the Army's automatic weapons dynamics and projectile/gun tube interaction studies since he joined BRL in 1951.

Lieske started his Federal service career at BRL. His 27 years of work in ballistic research, has earned him an international reputation on techniques and procedures for delivering projectiles on target.

Johnson is responsible for coordinating intracommand activities in armored system armaments as well as for the exercise of the Armored Combat Vehicle (ACV) Program at BRL and the development of analytic methodology relevant to systems performance and effectiveness.

Patent Granted for Novel Microorganism

Dr. Benedict Gallo, a research microbiologist at the U.S. Army Natick Research and Development Laboratories, Natick, MA, was recently granted a patent for a novel microorganism which is a mutant strain of Trichoderma Reesei. The Supreme Court recently decided that live, human-made microorganisms are patentable and Dr. Gallo's strain, which he named MCG 77, became the first Army patent for a microorganism.

MCG 77 produces cellulose enzymes at a much faster rate than its parents and is, therefore, capable of making such enzymes in larger quantities with increased efficiency. These enzymes are used to hydrolyze cellulose to simple sugars, which can be utilized for single cell protein synthesis or, in fermentation process, to produce a variety of useful chemical compounds.

The project, which was started at the Natick Labs as a means of converting cellulosic waste material, such as municipal trash, cardboard, paper, etc. to glucose and subsequent refinement to ethanol, a clean burning fuel, was transferred to the Department of Energy in September.

Career Programs . . .

Ordnance Hall of Fame Accepts Nominations

Nominations for the 1982 Ordnance Hall of Fame are now being accepted by the Ordnance Center and School, Aberdeen Proving Ground, MD. The Ordnance Hall of Fame honors those who have made significant contributions which advanced the cause and mission of the Ordnance Corps, or who have been awarded the Congressional Medal of Honor while assigned to the Ordnance Branch. Six individuals are normally inducted each year.

Nominations are open to retired or deceased individuals, both military and civilian and must include documented information on the individual and his or her contributions. Each nomination should be accompanied by as much background material as possible on the candidate's accomplishments. The nominations are then reviewed by a board of senior ordnance general officers.

Nominations should be sent to: Commanding General, U.S. Army Ordnance Center and School, ATTN: ATSL-DOSM, Aberdeen Proving Ground, MD 21005. Closing date for 1982 nominations is 15 January.

WES Developing Tactical Bridge Access/Egress System

The Army presently has many types of operational bridge and raft systems and equipment that can be rapidly deployed. However, the Army does not have a military vehicle roadway system that would allow large vehicles to drive to and from the bridge site in poor soil conditions or which can be emplaced as fast as the current military bridges are deployed.

The Geotechnical Laboratory (GL) at the U.S. Army Waterways Experiment Station (WES), in Vicksburg, MS, is currently involved in a project to help solve this problem. The U.S. Army Mobility Equipment R & D Command (MERADCOM) and the Office, Chief of Engineers, asked WES to provide research studies, technical service consultation, and testing in the development of a tactical bridge access/egress system.

WES was brought into the project mainly because of it's experience with developing the rapidly emplaced airfield landing mats. Mr. Hugh Green, chief, Material Development Unit of the Pavement Systems Division of GL, is heading up the WES work on the project.

The complete bridge access/egress system must solve a 3-fold problem. It must provide an exit roadway out of rivers and other obstacles for fording/swimming assault vehicles. Second, the access/egress system must deploy an access lane for the actual bridge or raft equipment to reach the launch site. Finally, the system must provide some type of roadway to and from the bridgehead that can support a high volume of heavy-vehicle traffic.

To maintain the element of surprise, all components of the access/egress system must be able to be rapidly emplaced with as little manpower as possible. The egress points for the fording/swimming vehicles and the bridgehead must overcome poor soil conditions, inclement weather, and a maximum slope of 25 percent (14 degrees.)

The Army initially wanted to investigate the possibility of using currently available or modified depot materials, including airfield landing mats, for use in the access/egress system. WES did all the testing and evaluation in this area of work.

Green's group did extensive testing on the trafficability of the landing mats. Some of the tests were done on clay beds prepared in the hangers. Also, a test track was built that incorporated a 25 percent slope for the mat testing. Testing for the fording/swimming vehicle phase was conducted on the banks of Brown's Lake at WES.

Tests were conducted on the M8A1 and M19 landing mats and on the T17 membrane. Tests were run in both wet and dry conditions. The mats were modified in some test runs such as testing them in an inverted position to increase vehicle traction.

However, the mats failed to meet all of the set requirements. They failed to supply the necessary traction and/or the rate of placement was too slow.

MERADCOM then let a contract on the design, development, and fabrication of an all new access/egress system. Pacific Car and Foundry of Seattle, WA, which also produces one of the Army's current bridge launchers, won the contract. They have developed accordian style linked mats using input from WES on materials and vehicles.

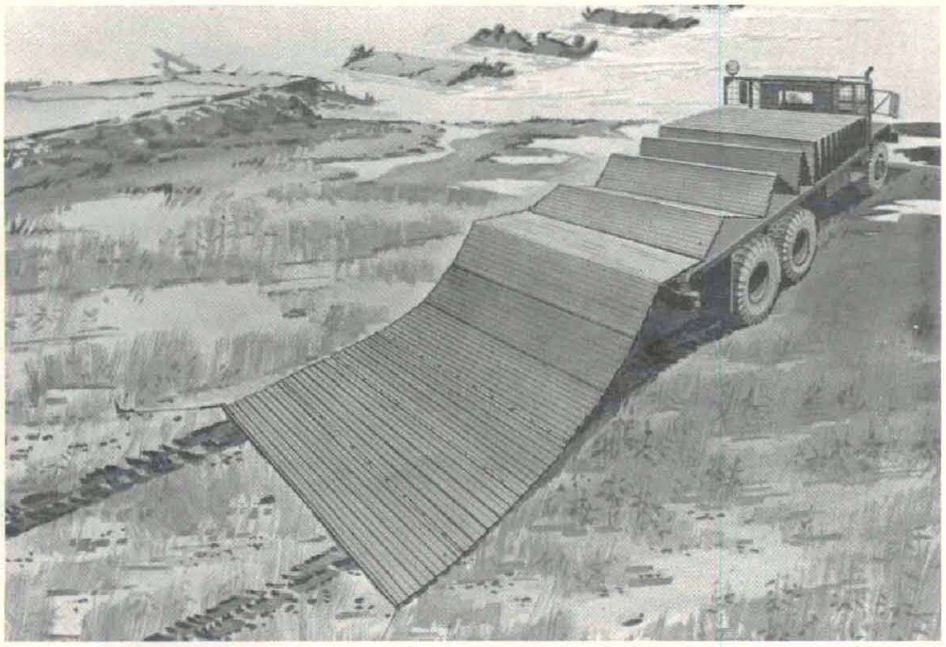
A 6 by 6 Army truck will be utilized to transport and deploy the linked roadway. The roadway is designed to be anchored at one end, and as the truck moves it will be pulled off in one long continuous lane. WES will soon receive some of this newly designed roadway for testing and evaluation.

Requirements of the access/egress system before acceptance by the Army are tough. The fording/swimming vehicle egress must hold up for at least 25 passes by a MLC 70 vehicle (MLC = military load class; number = tonnage) on a 25 percent slope (e.g., the M60 tank). Two exit points approximately 50-65 feet long would have to be deployed with 15 minutes.

The bridge equipment access lane must withstand a minimum of 50 passes by vehicles of at least the MLC 25 class. This lane would have to be placed at a rate of at least 410 feet per 30 minutes by a 10-man squad.

The bridge traffic access/egress system is required to allow a platoon of engineers to place about 984 feet of roadway in 45 minutes. This roadway should withstand 2,000-3,000 vehicle passes with 10 percent rated in the MLC 70 category.

If this particular tactical bridge access/egress system is successful, it hopefully would become operational soon. Until that time, the Army may have somewhat of a gap in their overall bridge operations.



Rapid emplacement access/egress mat (drawing), developed under contract by Pacific Car and Foundry, will be tested and evaluated by the U.S. Army Waterways Experiment Station (WES), Vicksburg, MS.

DEPARTMENT OF THE ARMY

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