# ARMY RD&A MAGAZINE

JANUARY - FEBRUARY 1987

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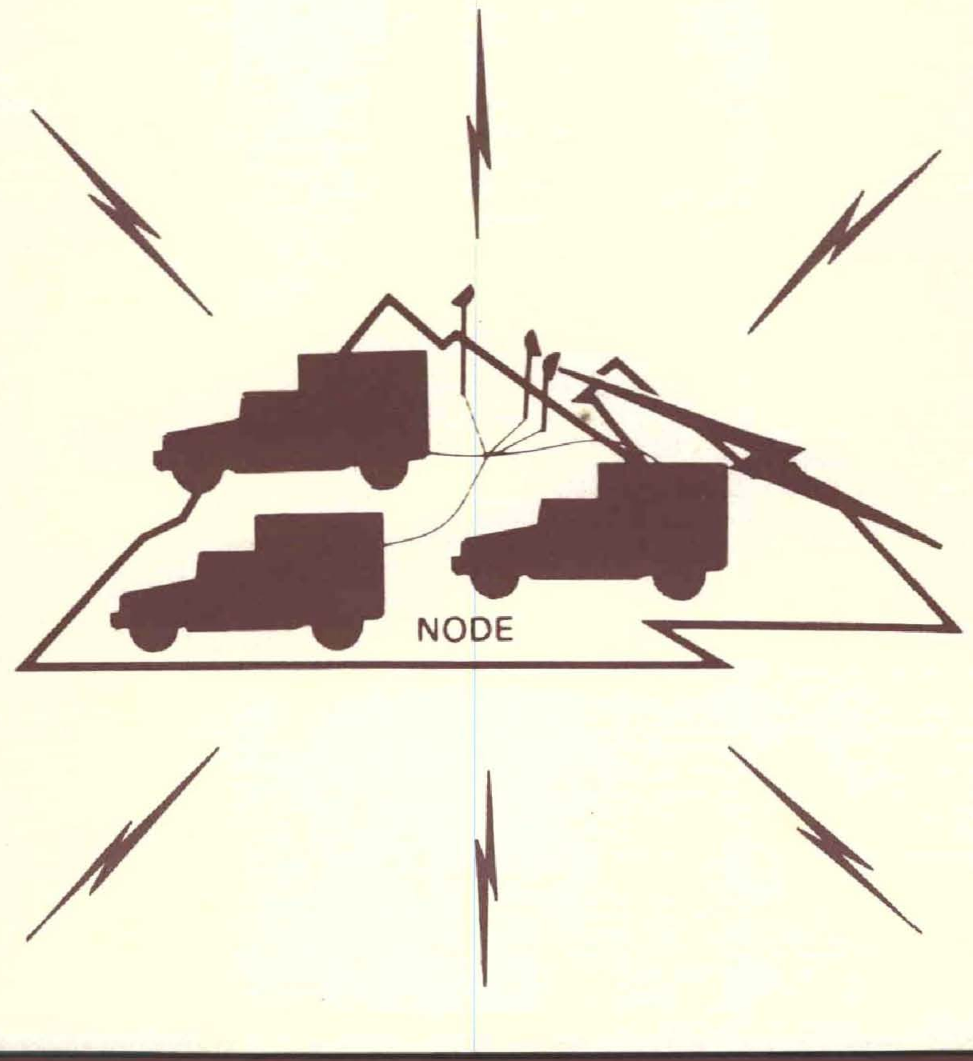


## A MAJOR NDI ACQUISITION

A R M Y

Research
Development
Acquisition

# RD&A

**Vol. 28 No. 1 JANUARY-FEBRUARY 1987**

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## ABOUT THE COVER

The Mobile Subscriber Equipment system, as depicted on the front cover, is the subject of an article describing a major nondevelopment item acquisition. The back cover is related to a feature story on the Army's establishment of University Research Initiative Centers.

## FEATURES



## DEPARTMENTS



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# NDI: The MSE Acquisition Strategy

**By Robert R. Lehnes**

## System Description

Why do we need Mobile Subscriber Equipment (MSE)? Today's communications system is too expensive, it ties us to wires and cable, requires too much manpower and is immobile. That is why we're buying MSE. It is also a cost and manpower effective communications system. Many of the bad things with today's system are improved with MSE. Many of the "ilities" such as survivability, adaptability, reliability, flexibility, etc. are also enhanced with the Mobile Subscriber Equipment system.

We like to call MSE "the Bell System of the battlefield" because that is precisely what it is. Everything you would need in the Bell System to make a telephone call from your home or from a mobile cellular radio/telephone in your car are the things that the MSE system does for the Army on the battlefield. MSE totally integrates all of the functions of a communications system. Transmission equipment, switching equipment, communications security, system control, vehicles, generators, are all part of the MSE system and are being bought from a single contractor.

MSE is the first time that the Army has ever acquired a totally integrated/turn-key tactical communications system from one contractor.

So you can better understand the MSE system, I will now describe the five functional areas of the system. The first functional area is the subscriber terminals. Subscriber terminals are the things that you would have in your hand to communicate over the MSE system; for example, telephones, facsimile machines, alphanumeric terminals for data processing/communications and mobile radio/telephones. Those items constitute user equipment. Mobile subscribers are provided access to the system. Whether you are in your jeep or other vehicle, or at your command post, you can have a radio/telephone and be constantly in communication with the system throughout the corps area.

**MSE IS THE BELL SYSTEM OF THE ARMY**

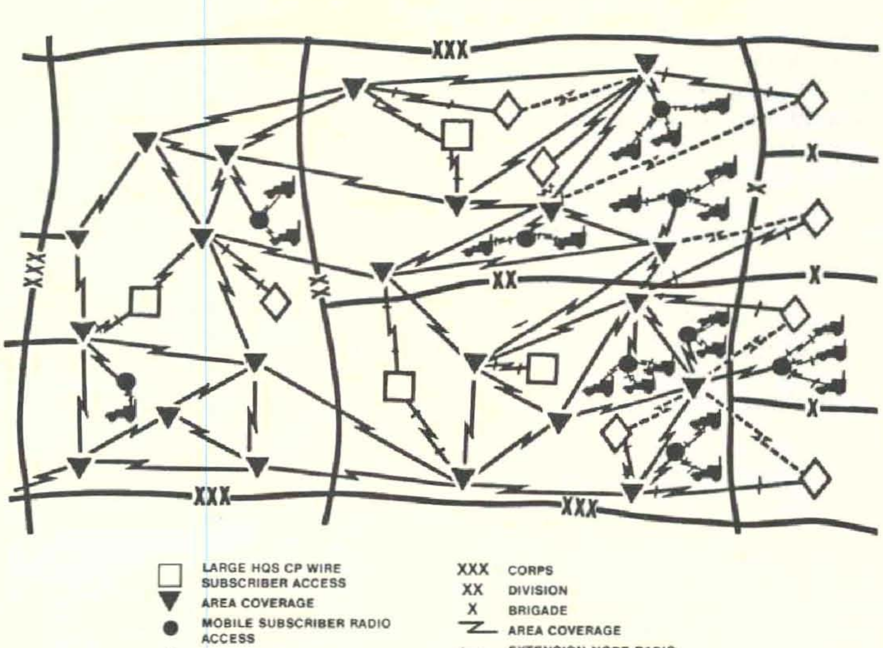



*Figure 1. MSE System Architecture*

At command posts or large headquarters where there are high concentrations of wire subscribers using telephones, the system also provides access for those subscribers. This access to the system comprises the second and third functional areas; that is, wire subscriber access and mobile subscriber access.

The area coverage network is the fourth functional area and ties it all together via automatic circuit switches connected by Line-Of-Sight radios. And lastly, the system control functional area manages the entire network and controls the whole system for a corps and the five divisions.

Figure 1 is a very difficult illustration to understand; however, if explained in terms of the five functional areas, it is really helpful in understanding the MSE system architecture. The illustration shows a corps area with the squares representing a large headquarters or large command posts with the diamonds being smaller ones. The area coverage network consists of the triangles which are the node centers and the jagged lines which show that the node centers are all connected by radio to permit coverage of the whole system. The next part of the system is the extension access to the system. The large and small headquarters are served by extension switches which are connected by radio to the node central. Mobile subscribers are then connected to the node centers through the circles which are radio access units. The mobile subscribers talk through the radio access units into the system. When you put it all together you get a really complicated scenario, but that's a true depiction of the architecture of the MSE system.

## Acquisition Strategy

I will now move on to the MSE acquisition strategy. MSE is the largest tactical communications acquisition ever attempted by the Army. It is a $4.3 billion acquisition program. We are going to buy this system and field it to the U.S. active Army, National Guard and reserve forces at the same time. We have never done that before. The reserves have always gotten the leftovers. We are going to be giving them MSE at the same time. This means that when called up, the supporting units will be able to communicate immediately with their parent units and instantly become an integral part of the communications system.

The basis of the MSE acquisition strategy came from high levels in the Army and is very unconventional. We provided a general performance requirement to the bidders, rather than provide detailed specifications or drawings. Contractors came back and bid what their system would do. They were required to bid an existing system which, in fact, is what a nondevelopment item is all about.

Acquisition regulations were waived as necessary by the MSE program. Naturally, we had to comply with the statutes, conform to law, but were allowed to waive any acquisition regulation we wanted to. That's a first. We encouraged the use of commercial practices. We told bidders to come in and tell us what they have and to bid it the same way they always do it—not to do it differently just because they are bidding it to the Army. We wanted to buy an existing system, "warts and all." The system exists and that is what we're going to buy. We'll adapt the Army to use it—not the other way around.

The Request For Proposal (RFP) contained only five required features that the system had to do. Those were the five functional areas. The contractor could bid anything as long as it did those five things. We are buying a complete system. For the first time we bought a pure turn-key system from a contractor. We are not going to government-furnish anything to the contractor, GTE. They are to provide the trucks (the High Mobility Multipurpose Wheeled Vehicle) which they will buy from AM General. They will provide generators, shelters, communications-electronics; everything including training, fielding, and logistics support. We didn't mandate military specifications. They told us what their system would do and we decided if that was good enough. We didn't tell them how to do it, we let them tell us.

The MSE contract is a firm-fixed-price contract with six priced options. We have range quantity options for additional equipment. The contractor was required to bid not only basic hardware and initial spares but also spares and logistics support for 15 years after we field the last system. Those are fixed prices adjusted only for escalation. We have fixed prices obtained in a competitive environment for the entire life cycle of this system.

Figure 2 shows the standard acquisition life cycle and how NDI differs from it. As you can see, NDI can save a considerable amount of time in the acquisition cycle of a system or equip-

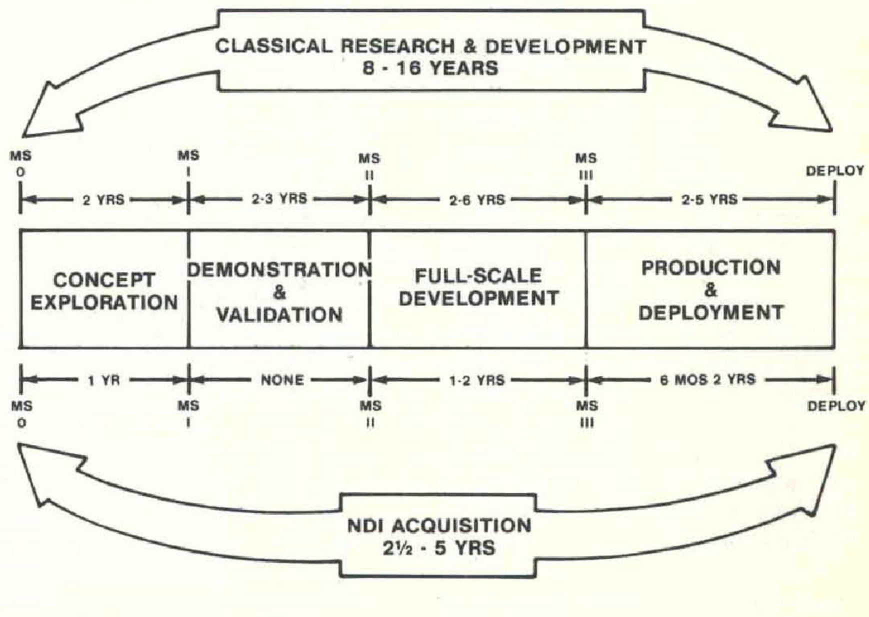



*Figure 2. Acquisition Life-Cycle Model*

ment. Although the illustration shows the entire acquisition cycle, the real difference with NDI occurs in the middle two phases.

The standard life cycle has what we call a concept exploration phase, which leads into demonstration and validation followed by full scale development and then into production and deployment. The only difference in NDI is those two middle phases. Demonstration and validation and full scale development are combined into one phase in NDI. This phase has been referred to as the acquisition documentation phase. Now what do we do during that time? That's when we prepare the RFP, after we have decided to go NDI, receive proposals and evaluate them. That's the difference between the two life cycle models.

Everyone knows the three milestone decision points in the standard acquisition cycle, but how did we obtain these decisions in the NDI MSE acquisition? The Milestone I decision was basically a memo from OSD to the under secretary of the Army which stated that a Defense Systems Acquisition Review Council (DSARC) wasn't needed and left the decision up to the Army. Later, the under secretary directed an NDI procurement. We moved out. In NDI, you don't need a Milestone II decision because you're not going into that phase. Milestone III is your production decision and your type classification and normally you have a formal In-Process Review or an Army Systems Acquisition Review Council/DSARC at the proper level to give you the go ahead.

There are some important things needed for a Milestone III decision: a decision coordinating paper, a test and evaluation master plan, and a type classification package. Since we didn't do all those things, how would we fulfill the requirement for MSE? We did it as part of the source selection process. The type classification (TC standard) package was put together by the PM from the results of the source selection board which briefed up to the senior advisory council and up to the senior selection authority who was the secretary of the Army in our case. The decision briefing on the source selection was the basis for a Milestone III decision to include the production contract award and type classification of the system.

## NDI Myths

Next, I want to talk a little about NDI myths. The first myth is that all NDIs are created equal. That is not true, because every NDI program is different. All are individual programs with unique circumstances. You can't apply blanket things to NDI. NDI can be as simple as buying a radio that the Marine Corps has developed. It can be buying a commercial system or equipment that meets the needs of a less stringent environment than we would normally specify. Or, it can be as complex as buying the Mobile Subscriber Equipment system. You can't put NDI in a standard-sized box because it doesn't fit. Each box has to accommodate a different size.

Another of the myths is "off-the-shelf." The shelf that this equipment is supposedly on, doesn't actually exist. I mentioned waivers to regulations. That's another myth. We did get a lot of waivers for acquisition regulations when we were going through the MSE acquisition but we still had to justify a lot of what we were doing. Although we got the waivers, we know that somewhere down the road someone is going to come back and say, "You didn't comply with this. You'd better do it." You have to be attuned to that and know what things you didn't do and be prepared to address them when they surface.

Some time ago I was asked by LTG Lawrence F. Skibbie, AMC deputy commanding general for RD&A, to do a review of the MSE acquisition cycle. What he asked me to do was to compare what we did on MSE with the standard model—what things didn't we do and why. Is somebody going to come along two years from now and bite us in the tail and say, "You didn't do this. You'd better get your act together." So I did it. I took every single document, the decision point briefing papers and all the acquisition regulations and showed him either why we didn't do it, why it wasn't needed or how we got the necessary information.

Everything we would have done in a normal development we had to do on MSE. We had to generate those documents. Some we didn't do when we would normally have done them but have had to do them since. For example, with the Computer Resource Management Plan, we didn't even know what computer resources we were going to have, so we couldn't do it until after award. The type classification package, as I said before, was part of the evaluation board report. The bottom line is that we really didn't get away with much being NDI. We had to go through the same types of things that would be done on a normal development program and that's a key point.

The result of the briefing, and LTG Skibbie agreed, was that we satisfied the intent of all decision milestones and documentation requirements that are in the standard life cycle management model. We satisfied every one of those, whether we actually did it or not. We saved two to six years of development time and probably half of a billion dollars in R&D costs. Perhaps most important, we're going to get Mobile Subscriber Equipment into the hands of the troops in about five years; a substantial decrease over other methods.

Blanket relief to policy is another myth. A lot of people called our office to remark on this and said, "I heard you went NDI and got relief from all kinds of things." Sure we did that, but once we awarded that contract, all of those policies started appearing on my desk. The Army secure lighting program, chemical agent resistive coating paint and tri-color camouflage are all coming across my desk now. So if you think you're getting away with something, it's not true.

You can use R&D dollars to try to make an NDI decision by conducting market surveys, investigations, or tests to see what's out there. But when you procure the systems going to the operational inventory, you should be using procurement dollars. You can, however, use R&D dollars to look into potential product improvements to the program.

Another myth in my mind is, "better is better." When you're utilizing the NDI method, better is not necessarily better. One of the things that we have done so wrong for so long is trying to improve things that we haven't even gotten out into the field yet. Let's buy what exists today; and, if it's better than what we've got now, let's put it out in the field now. That's one of the challenges we need to put on industry: stop trying to market improvements on something when we haven't put it in the field yet. Let's concentrate on getting it out there in the hands of the troops and then let's talk about improving it.

Still another myth is the "cookbook" approach. You take NDI, add dollars, and you come out with a product at the other end that meets the Army's needs. There's no cookbook for NDI. There are some pamphlets and manuals that the AMC and TRADOC communities have published on NDI, but these are certainly not cookbooks. They don't tell you how to do it. You have to go into each program and face each little inchstone, each major milestone, each little wicket, one at a time. There is just no easy way. We, at PM MSE, were lucky because we had very competent and very strong guidance from the highest levels of management in the Army that allowed us to do the innovative things that we did. Without that guidance we probably would still be floundering with the sixth generation of the RFP.

## Challenges for the NDI Manager

Switching now to the challenges that face the NDI manager, we find that he cannot just sit back and wait for his system to be delivered. One of the biggest challenges to be faced is how do we insure that what we've selected as NDI, whether commercial off-the-shelf or otherwise, will meet the Army's needs once delivered. As an example, let's discuss how we are going to be satisfied that MSE will perform in the harsh environment of the field Army.

First, I'll discuss the test and evaluation philosophy we are using on Mobile Subscriber Equipment. MSE will be evaluated continuously throughout its acquisition cycle. This continuous evaluation program is divided into four phases. The first phase was prior to award of the contract. The bidders were required, as part of their proposal, to submit test plans, procedures, data and reports to substantiate the specified performance of their system. This data was evaluated as part of the source selection process. In addition, an actual demonstration of the performance of their offered system, in the field, was also required.

The second phase occurs during the production leadtime of the system. During this period, initial production tests are conducted. These tests are witnessed by the government. As equipment builds up into the sub-system, assemblage and system level, additional tests are run such as the production reliability acceptance test and the product assurance test and evaluation. The latter test, a formal government test, ends up at the totally integrated system level.

Another challenge, especially for MSE, is funding stability. We cannot afford to go through budget cuts every single year. Particularly on this program, we have a five to six year program at a firm fixed price. If funds are cut, we have to renegotiate the contract. We can't do that.

One more challenge that I see, is to fight off the "weenies." The PM is probably going to spend much of his effort fighting off those little guys that have their own Army program or requirement that they have to see put on your NDI program. All of these well-meaning individuals are going to come out of the woodwork and try to force their special interests onto the NDI program. Our responsibility is to say, "No, we are not going to do that."

Another challenge to the manager is probably one of the biggest ones for the PM. It is known as "requirements creep." We must not let ourselves get into the mode of allowing additional requirements to creep into the system that didn't exist there before. There are a lot of things that would be nice to have that we might want to get out there. But we must buy what it is we signed up to buy and worry about these "nice-to-haves" later.

Yet another challenge relates to industry and its role as an NDI team player. I mentioned before that marketing tries to go beyond what it is the product does now. I'm not criticizing industry for marketing, because that's their job—to find new places for new products and new markets. That's fine; but on certain NDI programs, we need to push what exists today and get it out there to the soldier. We can't over-market programs.

The third phase consists of the initial acceptance and fielding of the system. During this phase, a destination (field) final acceptance test is performed followed by unit training. The unit then conducts a field training exercise which prepares them for the final "proof of the pudding," a follow-on-test and evaluation conducted by the Operational Test and Evaluation Agency. If successful, the Army will then field Mobile Subscriber Equipment to the entire active, reserve and national guard components. Subsequent to fielding, the last phase of the continuous evaluation program will consist of fielded system reviews and sample data collection.

Environmental requirements have been considered from the start. The request for proposal asked potential bidders to submit evidence that their system would perform in the field. Such evidence took the form of performance/product specifications and test plans/reports. These data were evaluated as part of the source selection process. The key here, of course, is how to insure that the product the contractor delivers withstands the environment he said it would.

The first thing we did was to make the product specification submitted with his proposal part of the contract and, thereby, under government configuration control. The other thing we did was to take the environmental requirements (et al.) of the specifications and make them a part of the contractor's testing program. We, therefore, have environmental requirements for each piece of equipment specified in the system, government configuration control over them, and requirements for test on the first system procured and periodically during production.

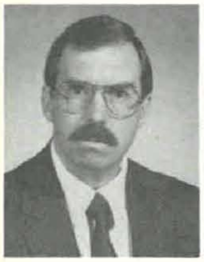
The final challenge, but certainly not the last or least one for the NDI manager, is logistic support. Most, if not all, NDIs will not come with the standard logistics support package needed by the services. For this reason, sustainment of the NDI after fielding must be considered during the preparation of the solicitation. Such things as the use of commercial manuals, contractor testing, training and maintenance support, availability of spares and repair parts, etc. must all be considered early-on to ensure the supportability of the NDI.

## Conclusions

NDI is here to stay. It will be the primary acquisition strategy of the near future. But it is not a panacea. The NDI manager must recognize that his program is unique and must tailor his strategy according to its needs. NDI doesn't get the manager "off-the-hook" for anything. You must be prepared to address all those things you would be asked to address in a normal full-scale development acquisition. If these things aren't being asked of you now, cheer up, they will be eventually. Be prepared for them!

I like to consider NDI as having ended as soon as you award the production contract. NDI is just another way to get there. The contract should have adequately covered the logistics supportability of the system to include training if necessary. The contract must also specify the product you are acquiring; not just "Brand X, Model 123." Put in a product specification, even if it is only the contractor's commercial vendor sheets. Make him live up to them. That way, you won't be surprised with the Chevy that is delivered when you thought you'd ordered and paid for a Cadillac. Don't accept, "It's NDI. You take what you get."

I described the NDI acquisition of the MSE system and, as you've seen, it is unique. I hope it will shed some light on a few of those unknowns that face future NDI managers or at least prepare you for them. NDI is a new way of doing business, and all of us on the DOD/Industry acquisition team must do our part if it is to succeed.



*ROBERT R. LEHNES is the deputy project manager for systems and engineering of the Mobile Subscriber Equipment system. He has a B.S. degree in electrical engineering from the New Jersey Institute of Technology and an M.S. degree in management science and computer science from Fairleigh Dickinson University.*

# Researchers Design Space-Age Gun

A speeding bullet travels slightly more than 3,000 feet-per-second, when fired from the Army's M16 rifle. When launched from the Army's electro-magnetic propulsion launcher, however, an 11-ounce plastic cube flies more than 14,200 feet-per-second.

Ever since the Chinese invented gunpowder in the ninth century, weapons increasingly relied upon the chemical propellant's explosive nature. The Army's electro-magnetic (EM) gun, breaks away from this conventional method. Instead, it launches projectiles at super-speeds by creating an electromagnetic field.

Also known as a rail gun, the EM gun has two opposing, parallel copper rails to conduct electricity. The bullet or projectile has a copper base that maintains contact with the two rails. When the gun is triggered, an electrical current surges up one rail to the projectile, jumps through the projectile's copper base and surges back down the other rail. This creates a strong magnetic field, sending a powerful force forward, hurtling the projectile out of the barrel.

Projectiles traveling at such high velocities pack a powerful punch. During testing, researchers at the U.S. Army Armament RDE Center (ARDEC) have fired plastic projectiles that have easily smashed through steel plates. Targets typically are ripped apart by so much force, a force that comes from kinetic energy.

Although the idea for an EM gun has been around since the turn of the century, weapons researchers are just now on the brink of major discoveries. Dr. Ted Gora, a physicist and chief of ARDEC's EM Propulsion Lab, said that the Army's research in this arena is revolutionary. He compares current research on EM propulsion to that of research on jet engines in the 1950s. "We know it's possible to achieve fantastic speeds," he said. "Once we cross the threshold, we'll dramatically change the way weapons work."

EM propulsion, funded in part by President Reagan's Strategic Defense Initiative (SDI), has several applications. The SDI application is a defensive earth- or space-based weapon designed to shoot down enemy missiles, thus protecting the United States from nuclear attack. The Army is also exploring the use of EM propulsion in tactical weapons, such as tanks, howitzers, and eventually, hand-held weapons.

"An advantage of EM propulsion in tactical weapons is the ability for a projectile to reach its target almost instantaneously," said Gora. Anti-aircraft gunners, he explained, will benefit from EM propulsion. Aircraft in combat are difficult to hit because they fly evasive maneuvers and because, with current technology, projectiles take a relatively long time to reach the target. Gunners, therefore, don't shoot where an enemy aircraft is. Rather, they shoot where an enemy aircraft might be. With EM propulsion, however, the gunner can aim at the aircraft and fire. The swift speed of the projectile will eliminate the guessing game of where the aircraft might be.

The individual combat soldier, too, will benefit from ARDEC's EM propulsion research. According to Gora, the Army will eventually scale down the components necessary for EM propulsion so that the technology can be incorporated into small arms such as rifles.

Scaling down the components, as well as refining the technology, are critical thrusts right now. The Army's prototype EM gun is big, stretching about 20 feet and weighing about 12 tons. In addition to its 12-foot long copper rails, the gun is comprised of a homopolar generator, a motor, an inductor and a switch.

Gora said to fire the gun he needs about two million amperes of current, enough to light up a city the size of San Diego for a fraction of a second. To create that much current a 3-foot flywheel spins a 6,500 revolutions-per-minute and must stop within a quarter of a second when triggered. The generated current then flows through fat wires to an inductor, a device that fine tunes that current, and then to a switch that controls when the current flows to the copper rail sending the projectile on its way.

# Establishment of Army University Research Initiative Centers

**By Dr. Robert E. Weigle**

## Introduction

The U.S. Army Research Office (ARO) has made 22 grant awards to 11 universities totalling nearly $16 million as the first step in establishing Centers of Excellence for the conduct of research essential to Army long-term needs. This program is part of the overall DOD University Research Initiative (URI) program that was announced in the latter part of 1985 and was intended to further strengthen the DOD/University relationship. These initial grants are for the purposes of establishing Army graduate fellowships at the URI Center sites and to provide for the essential instrumentation and equipment required to carry out the research.

Approximately 250 fellowships will be awarded during the first year. Instrumentation and equipment costing in excess of $10 million will be acquired during the coming months and located in the centers. The Army commitment for center support is for a five-year period and will represent an investment of nearly $126 million.

## Selection Process

In response to the ARO Broad Agency Announcement published in December 1985, 202 proposals from universities in 41 states were received and subsequently evaluated by a team of subject matter experts drawn primarily from the Army community but also included representation from other government agencies (Navy, Air Force, Defense Advanced Research Projects Agency, National Aeronautics and Space Administration). Evaluations of all proposals centered on criteria that considered the scientific and technical merits, Army relevance and potential contribution, past performance, capabilities and qualifications of investigators and the procedures proposed for fellowship selection and exchange of scientists and information.

Since one of the primary purposes of the URI program is to strengthen the University-Army relationship, particular attention was paid to the approach proposed for bringing university researchers into Army labs and RDE centers and for providing opportunities for Army scientists to take up residence at the centers.

Site visits were conducted at those universities judged to have been most responsive to the Broad Agency Announcement. Recommendations were then made to Assistant Secretary of the Army (RDA) Dr. Jay R. Sculley who made the final decision. The DOD-wide announcement of the successful proposers was made by Defense Secretary Caspar Weinberger on June 26, 1986. The Army URI Centers are shown in the accompanying chart.

## Progress Reviews

A somewhat different methodology will be employed in reviewing progress at each of the centers. An evaluation panel comprised of Army RDE center and laboratory scientists will overview center research results and will serve as the principal means of interaction with the center scientists. We are deliberately structuring the review process in this fashion to better assure a strong Army-University cooperation not only towards the earlier application of the research results, but to encourage an active exchange of scientists.

To provide a better perspective of the centers' research interests, a brief description of each is provided below. Army scientists having a specific interest in any of these areas of research are encouraged to participate in the center reviews. As theses centers become operational, a review schedule will be established and distributed to all interested organizations.

## Manufacturing Science, Reliability and Maintainability

This URI Center will strongly interface the National Center on Composites recently established by the National Science Foundation at the University of Delaware. As might be expected, program emphasis is on polymeric composite materials and the development of improved, reproducible, fabrication techniques that permit in-process quality control for greater reliability. Research results will be of considerable benefit to Army logistics concerns because an increased reliability performance of structural materials in Army systems is essential.

## Electro-optics, Signal Processing and Image Understanding

This center will be affiliated with the Institute of Optics that has made outstanding contributions to the optical sciences. Research will include digital image processing, X-ray and non-linear optics, laser systems development and associated work important to pattern recognition and extraction from background noise and clutter. Rochester is the only institution in this country having an undergraduate program in optics, and it is an added advantage to the Army that the center is located amid such a wealth of professional expertise. Application of the research results will be directed towards improvements in current capabilities to acquire, identify and track targets of interest.

## Advanced Propulsion Systems

A broad program of research will be undertaken here that is directed at Army goals, objectives and problems related to heat transfer, fuel effects, combustion efficiency, spray dynamics, materials and lubrication. While much of the research is focused on reciprocating engines, a number of efforts will be of benefit to gas turbine engine technology. Improved engine performance and increased fuel economy are anticipated results which will be of considerable benefit in reducing operational logistics.

## Geosciences

The research to be pursued at this center will provide a stronger science base for applications by the Army laboratories and RDE centers, particularly in areas that include advanced sensing research in lidar and satellite meteorology, propagation physics, meteorologic modeling, hydrology and geoscience information extraction. The scientist exchange procedures are also considered outstanding and should benefit the Army by providing the vehicle for early exchange of study results. Application of research findings will provide better predictive methods for such concerns as terrain traversability, weather forecasts and effect on equipment performance, and atmospheric effects on performance of sensors and chemical and smoke/ obscuration systems.

## Fast Reaction Kinetics of Energetic Materials

While this is one of the smaller center programs, it is nevertheless quality research that addresses the difficult area of condensed phase processes in energetic materials using techniques such as photofragmentation of clusters in molecular beams and gas-surface collisions. Of considerable potential benefit are the provisions to encourage and facilitate research at the University of Southern California by Army scientists and their willingness to provide graduate training at Army labs and RDE centers. Research results will contribute to improved performance propellants and explosives.

## Intelligent Control Systems

As a close community of scientists, the investigators represented by the consortium are currently engaged in the principal and essential elements of research important to intelligent control systems. Robotics, computational geometry and motion planning will comprise the bulk of the Harvard program. Vision and stochastic control research interests will be undertaken at Brown, and communications, signal

### URI Centers

| Center Area | University |
|---|---|
| Manufacturing Science, Reliability and Maintainability Enhancement | University of Delaware<br>Newark, DE |
| Electro-Optics, Signal Processing and Image Understanding | University of Rochester<br>Rochester, NY |
| Advanced Propulsion Systems | University of Wisconsin<br>Madison, WI |
| Geosciences | Colorado State University<br>Fort Collins, CO |
| Fast Reaction Kinetics of Energetic Materials | University of Southern California<br>Los Angeles, CA |
| Intelligent Control Systems | Consortium of MIT, Brown and Harvard Universities<br>Boston, MA<br>Providence, RI |
| High Frequency Microelectronics | University of Michigan<br>Ann Arbor, MI |
| Ultra Dynamic Performance Materials | University of California<br>San Diego, CA |
| Biosystems and Biotechnology | Cornell University<br>Ithaca, NY |
| Advanced Construction Technology | University of Illinois<br>Urbana, IL |
| Advanced Construction Technology | MIT<br>Boston, MA |

processing, computing and artificial intelligence research will be carried out at the Massachusetts Institute of Technology (MIT). It should be noted that there is a strong overlap in each of these areas at these three universities which will provide the basis for the integration of these fundamental constituents into the science and technology of intelligent control systems. Ultimate applications of this research will be directed towards assisting the field commander in making real-time assessments of large volumes of data and intelligence information.

## High Frequency Microelectronics

This center will be housed in a new $30 million state-funded building that will provide ample space for planned research activities. Work in quantum-well transistors of submicron size for application in ultrafast electronic devices will be undertaken. Other research interests center on improved communications and signal processing employing millimeter wave and optoelectronic devices. This research addresses many of the elements important to the resolution of problems related to improved command, control and communications.

## Ultra Dynamic Performance Materials

This center's research program begins with the identification of the underlying mechanisms associated with materials behavior at high strain rates, develops the constitutive models to describe this behavior in a quantitative way, and then incorporates these models into existing computer codes to assess their ability to predict the large deformation behavior of materials subjected to ballistic impact. This center also pursues the development of new algorithms to take advantage of parallel architectures now required for new supercomputers. Since the university currently has a new Cray-XMP machine, a strong interaction with the Army research community is expected as the Ballistic Research Laboratory is currently installing a similar machine. Applications of the research will contribute to the development of improved armors as well as high velocity, kinetic energy type penetrators.

## Biosystems and Biotechnology

This center's research activities are expected to make a major contribution to the broader-based Cornell biotechnology programs now being conducted at four colleges. The Army-sponsored research will be predominately on protein structure and function with special emphasis on enzymes and receptors. Research will encompass all aspects of biosystems structures and processes. Procedures for information exchange and for interaction with Army scientists offer useful mechanisms for the university to integrate its current and emerging areas of strength into the mainstream of Army technology. Studies are expected to impact a number of areas of recognized Army requirements that include soldier health and performance, defense against chemical and biological agents, and novel military materials and processes.

## Advanced Construction Technology

Two Advanced Construction Technology Centers have been established. One is located at the University of Illinois where research is directed at advanced coatings, composite structural materials, cementitious materials, integrated design techniques, structural damage due to high-energy loading and microelectronic non-destructive evaluation of structural systems, electromagnetic pulse metrology and roofing systems technology and design.

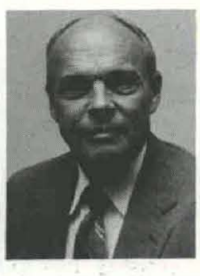
The second center, located at MIT, will concentrate its research on a comprehensive, integrated, cohesive systems approach to improved construction techniques. The integration of design for construction is consistent among all three of the MIT major research thrusts of robotics, lightweight materials and computerized design and construction. It provides a complete, holistic, interdisciplinary approach to the entire process of all elements of military construction. Results of research from these two centers will have far reaching effects, not only for their military significance but for their potential to revolutionize the construction industry.

## Summary

The URI Centers' research programs are strongly interdisciplinary in character and reflect the broad nature of the Army's science interests. It is essential that the technologies relevant to these URI Center research efforts be advanced, if the military capabilities of the Army are to be significantly improved. The exploitation of the science base that will be expanded in the center areas is the key to technology invention and ultimately to a military application. Such technology applications will most likely occur as a consequence of defense industry contributions. So, it will serves Army interests to encourage the URI Centers to develop strong industry affiliations.

It is worth noting that one of the strengths of the URI Centers is the existing relationship with the industry community. This very effective and close interaction ensures a direct coupling with the public while economic development is further fostered. The Army, by support of these centers, has effectively leveraged that capability at no cost. Our goal is to assure that the university-industry relationship is capitalized upon in the interests of the nation's defense posture.

For 35 years, the Army Research Office has served as one of the primary interfaces with the nation's science community. Much of the research, originally and in many cases solely supported by the Army, is now reflected in military hardware that has significantly improved the Army's fighting capability. We must continue to strengthen those science ties through the URI Centers and exploit the research results to benefit the American soldier.



*DR. ROBERT E. WEIGLE is director of the Army Research Office, Research Triangle Park, NC. He has a BCE degree in structures, and an M.S. degree, and a Ph.D. in applied mechanics, all from Rensselaer Polytechnic Institute.*

# Identification Friend or Foe Technology

By MG James C. Cercy

## Introduction

The U.S. Army Laboratory Command (LABCOM) was created a year ago to accomplish four objectives:

- to focus technology on high priority user needs;
- to integrate technology base activities across laboratories and research, development, and engineering (RDE) centers;
- to facilitate the transition of technology to battlefield systems; and
- to leverage the research and development efforts and investments of others, including industry, other services, and our allies.

This past August, a technical demonstration in Florida graphically displayed the way LABCOM is accomplishing each of those objectives. The demonstration was part of the Noncooperative Identification Friend or Foe Technology Evaluation (NIFFTE) program. The LABCOM demonstration in August took place a year ahead of the prototype demonstration scheduled for 1987. The demonstration:

- focused technical efforts on a critical, high priority user need to identify hostile enemy systems;
- integrated different technical efforts of Army Materiel Command (AMC) laboratories, RDE centers, and contractors;
- facilitated transition for fielded systems by tying them in with the Air Defense project manager and plans for the Forward Area Air Defense system; and
- leveraged the independent research and development (IRAD) funds of competitive contractors by announcing the opportunity to participate and take data prior to competing in the 1987 prototype demonstration.

## A New Mind-Set

This current Army research project demonstrates a new mind-set in Army research and development that may well set new standards for conducting business in the Army research community. Previously, Army attention has been heavily weighted on the side of the acquisition cycle. By intensive management of technology efforts, as evidenced in the NIFFTE demonstration, it is possible to have significant impact on the acquisition cycle through careful maturation of technology prior to system development.

The Noncooperative Identification Friend or Foe Technology Evaluation effort focused on the needs of the soldier. In addition to the success of the demonstration, the project has been successful in leveraging the efforts of others, taking advantage of nondevelopment items, which are hardware and

***SGT John T. Archer, left, mans an AN/TSQ 97A air traffic control center, while he and SGT Andrew G. Toso maintain contact between aircraft, the NIFFTE site, and the central control facility.***

techniques already on the shelf and proven, so that new systems would not have to be developed at the bench level.

## Coordinated Effort

Concurrent with the research and development efforts taking place within LABCOM, a parallel and coordinated effort has gone on within the U.S. Army Missile Command to help make transition of the project efficient when the prototype demonstration phase of the project ends. Integrating tech base activities across labs and RDE centers insures the teamwork necessary in materiel development and acquisition; it also helps prevent duplication of effort. Facilitating the transition of technology to battlefield systems is one key to maintaining technological superiority.

COL Billy White of the U.S. Army Combat Identification Systems (ACIS) Office, which reports to LABCOM has maintained tight control of the NIFFTE program. Control in this instance meant retaining ACIS oversight of each step of the project and streamlining wherever possible. COL White first obtained a consensus from the U.S. Army Training and Doctrine Command (TRADOC) on the need for fielding a system to answer a specific need.

From that point on, COL White and those working with him kept up the ties established with TRADOC. His program is guided by the need to mature the critical technologies quickly so they may be handed off to developers, who provide a system to the soldier, filling a need in the field.

The program has significantly involved IRAD funds. Technological barriers to success in the program were identified and then targeted for focused research.

The ACIS Office took advantage of a variety of defense resources before proceeding with the project. Information on the existing technology base and on deficiencies identified through the Mission Area Materiel Plan came from such varied but interested groups as the Aviation Center and School, the U.S. Air Force Tactical Air Command, and a number of Army labs. With the assessment of the existing technology and analysis of the technology barriers, data were gathered and the hurdles to overcome were pinpointed.

## Contracts

With this solid base of knowledge to work from, several contracts were let for prototypes to be built for demonstration, telling contractors to make sure the prototype was reasonably field-hardened. That way, hardware issues are dealt with as the project proceeds, eliminating the need for a separate, follow-on project to resolve hardware issues.

At the same time that the ACIS Office advertised in the Commerce Business Daily for bidders on the prototypes, it let industries know that they could participate in the 1986 demonstration and receive ACIS Office support at the demo site, even if they hadn't won a contract for prototyping.

In the plain English that COL White uses to describe the program, he said, "Next year's going to be a horse race. If you can get your horse ready, you can be in the race." Using IRAD funds, a number of contractors took him at his word and brought their horses to the 1986 demo, giving the Army a broad base of competitors for its investment. The Combat Identification Systems Office estimates that for an investment of $3 million, LABCOM got more than $15 million worth of demonstration efforts because of the industries' willingness to commit Independent R&D funds to this development effort. The broad applicability of the NIFFTE technologies practically ensures numerous future opportunities for contracts as new systems are developed using the mature NIFFTE technology.

The ACIS Office support at the demonstration site consisted of preparing the site, including building an earth berm if required to maintain visual line of sight, providing commercial power to each site, building roads, and installing a personal computer at each site that interfaced with the contractor's equipment so that the ACIS Office could gather data, which it shared with the contractors. Each participating industry had the same opportunity to gather baseline data at the site prior to the 1986 demonstration.

## Payoffs

There will be payoffs across mission and technological boundaries from this project. Systems were demonstrated in August as packages of technologies, eliminating the expense of demonstrating each technology separately.

The success to date at the technology base level of the Identification Friend or Foe program also illustrates the bottom line approach to Army research that must drive our efforts. An effective AMC technology base program helps the U.S. Army maintain technological superiority over potential adversaries and protect against technological surprise.

The project's successful August demonstration raises the possibility for an Army procurement following an FY87 demonstration, just four years after initial concept analysis. If the technology is shown to be mature through the demonstrations this past year and in 1987, a system could be fielded in 1989, a considerable step forward in meeting the stated goals of AMC's new accelerated acquisition policy.

## Conclusion

With the proper initiatives and control, the goal of an accelerated acquisition cycle is possible. Good management requires oversight at each early stage of acquisition, from a consensus on the soldier's need to focusing of technology base research to the transitioning of the research efforts over to a commodity command for use in systems. LABCOM is charged with oversight and with managing the AMC tech base. This command can help shorten the acquisition cycle without increasing the cost to the government. In fact, in many instances there will be significant cost savings with the result of superior equipment in the field quickly, a goal important to us, to AMC and to the American public.

*MG JAMES C. CERCY is the commanding general of the U.S. Army Laboratory Command. He holds a B.S. degree in civil engineering from the University of Delaware and an M.S. degree in mechanical engineering from the University of Arizona.*

# Enhancing the Display Interface of the Commander's Independent Thermal Viewer

**By Dr. Aaron Hyman**

## Introduction

The U.S. Army Armor Center (USAARMC) at Fort Knox has been particularly concerned with improving crew performance with proposed tank sub-systems. It thus asked in FY85 that the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) advise the Armor Center on possible enhancement of the soldier-machine interface for the Commander's Independent Thermal Viewer (CITV). The aim was to get started on requirements for a product enhancement phase even before the basic system was delivered. ARI appointed the author as the principal scientist responsible for providing this consultative service.

## CITV Development

Current Army plans call for development of a Commander's Independent Thermal Viewer for use in tanks, and the U.S. Army Tank-Automotive Command has been tasked to accomplish this.

Specifically, the CITV will be designed to give the M1 tank commander an independent surveillance and target acquisition capability during conditions of darkness and degraded battlefield visibility. It will have a passive infrared (IR) imaging system which will operate in the eight to 14 micrometer spectral region. The viewer is expected to function with the tank on-the-move as well as when the latter is stationary. Viewing will be in 360 degrees of azimuth, with elevation line-of-sight adjustable from about plus 20 degrees to about minus 12 degrees. There will be two sizes of rectangular fields of view. The wider one will present a real-world angle of approximately 10 degrees horizontally by 7.5 degrees vertically. The narrower field-of-view will cover about one-third this subtense.

The CITV will provide the commander with real-time viewing for conducting surveillance and target acquisition, and will be an integral part of the fire control system. It will have three modes of operation. In one, it will permit independent surveillance (i.e., viewing direction will be independent of that of the primary gun system). In another, the commander can override the gunner's control of turret and main weapon (i.e., the commander can slave the turret and main weapon to the viewer and operate the fire control system). In the third mode, the CITV is slaved to the turret and main weapon so that the commander only monitors what is seen by the gunner, with the gunner in control of the main weapon.

The thermal viewer should prove to be an excellent augmentation to the tank's fire control system. For example, while the gunner is attending to one target, the tank commander can select the next target. Also, it is a valuable back-up fire control device, should the one for the main weapon fail. What is more novel about the CITV, however, is its independent surveillance capability. With it, a tank commander who is required to conduct a buttoned-up night operation will, for the first time, have a scanning periscope of useful viewing range.

## Human Factors Concerns

Advances in weapon systems and equipment can increase the fighting power of soldiers only if these systems are usable by the soldiers. Thus, in the area of equipping the force, ARI is concerned with developing human factors requirements which will aid in maximizing the effectiveness of soldier-machine interaction and so help the Army ensure that new and emerging systems can be manned effectively.

In its analysis of the display interface for the new viewer, ARI noted two aspects which needed additional consideration. One was retention of spatial orientation by the observer, and the

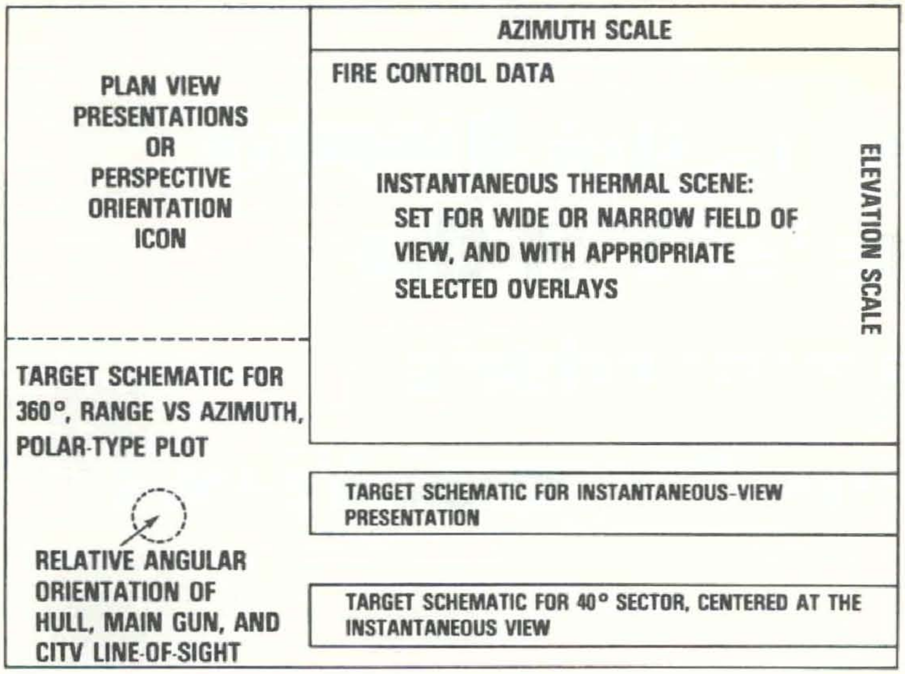



***Figure 1. Potential Location for Proposed Sub-Displays***

other was record keeping of the location of targets detected during surveillance activity. What is different about the CITV as compared to the thermal viewer now used with the tank's primary gun is that the line-of-sight for the CITV can be independent of the direction of the gun. This permits surveillance in 360 degrees of azimuth, but burdens the tank commander regarding orientation and target location handoff. Is there a way to unburden him?

One way is to surround the thermal scene with supporting sub-displays in order to reduce demands on the tank commander's short-term memory, particularly during the stress of battle. Figure 1 shows such a layout.

## Spatial Orientation Aids

Regarding spatial orientation, a simple plan-view icon showing gun azimuth and CITV line-of-sight with reference to the hull (as shown in the lower left of Figure 2) can be helpful. But is it enough? Perhaps a better subdisplay for providing immediate "intuitive" appreciation of the direction of the main weapon and of the CITV line-of-sight, particularly after the commander has been attending to non-CITV tasks, would be an orientation icon presented in 3-D (i.e., perspective) view, as shown in the upper left of Figure 2. This icon also symbolizes the size and elevation of the thermal "window."

In addition, for precise definition of CITV viewing direction, numerical azimuthal and elevation scales can be presented above and to the right of the thermal scene, respectively, as shown in Figure 2. Since the CITV sub-displays will be computer generated, it is simpler to reference them to hull direction, gun direction, CITV line-of-sight, a stabilized CITV direction, or even north if such an input becomes available.

Where possible, it is best to test concepts before implementing them, and so a Fort Knox test-bed could be instrumented for evaluating the proposed orientation sub-displays.

## Surveillance Aids

A novel approach was also developed regarding surveillance with the new thermal viewer. The term "cognitive coherence" is the phrase coined to identify this approach. The author defines it as the design concept or principle of aiding one's grasp of a total situation by presenting two or more related information sub-displays in a manner so they logically and partially-redundantly reinforce each other.

The sub-displays involving surveillance are presented in Figure 3. To ac-

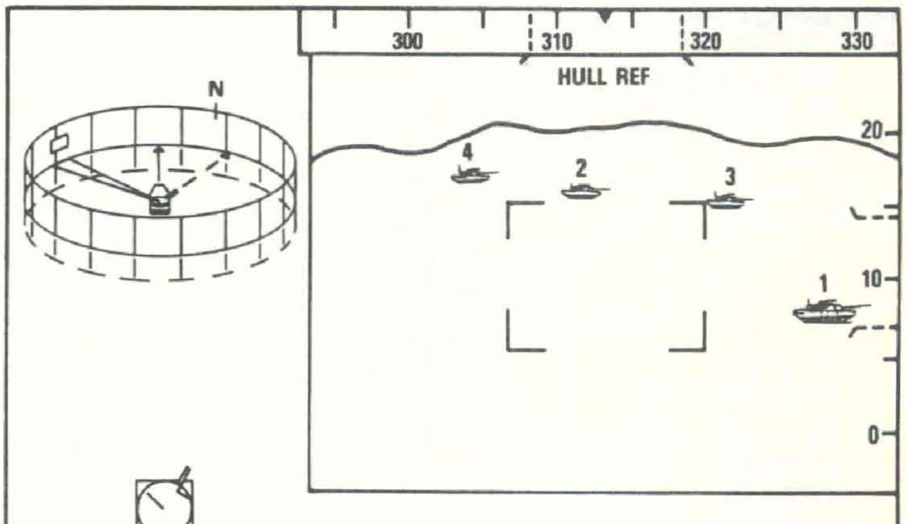



***Figure 2. Orientation Sub-Displays***

complish computer entry of a detected target, the new system needs to permit recording the azimuthal location of this target, and simultaneously passively estimating its range. One procedure is to have a circular cursor superimposed on the target and adjusted, as required, so its diameter and the vertical dimension of the target are equal. For a defined target, a range estimation is thus obtained. Then, using cognitively coherent sub-displays, sequentially transform, into a 360-degree schematic plan view, the target locations uncovered by the observer during his successive viewing of real-world images.

Thus, with the world scene in the upper right region, one could place directly below it two rectangular sub-displays in which the target symbols would indicate azimuth vs. range information. In the upper rectangle, a symbol's horizontal position corresponds identically with a target's azimuthal location in the instantaneous scene; and target range is represented by the vertical location of this symbol. The lower strip, on the other hand, has a fixed azimuthal scaling of 40 degrees, and thus portrays target presence in the 40-degree sector centered on the midpoint of the instantaneous thermal view. Space between the two rectangular strips may be used for additional alphanumeric symbols, to augment information about identified targets.

Then, to convert to a schematic plan view showing the location of detected targets, their positions are automatically mapped onto the small annulus with its inner ring representing a selected near reference range, and its outer ring, a more distant reference range. Such a bird's-eye view may be helpful even though this sub-display is somewhat spatially distorted. Transformation from frontal to plan view is aided by a two-stage presentation. Target symbols are shown in both a circular 40-degree sector that is angularly magnified 4 1/2 times, and in the properly scaled 360-degree annulus with which it is concentric. Like the 40-degree rectangular strip, the magnified circular sector is centered on the midpoint of the instantaneous thermal view.

Sequentially viewing the cognitively coherent sub-displays developed, the commander can quickly step through: from a plan-view, 360-degree annulus; to a plan-view, magnified, 40-degree, circular sector; to a frontal-view, 40-degree, rectangular representation; to a frontal-view, full-window, rectangular representation; to the displayed frontal scene; and vice versa.

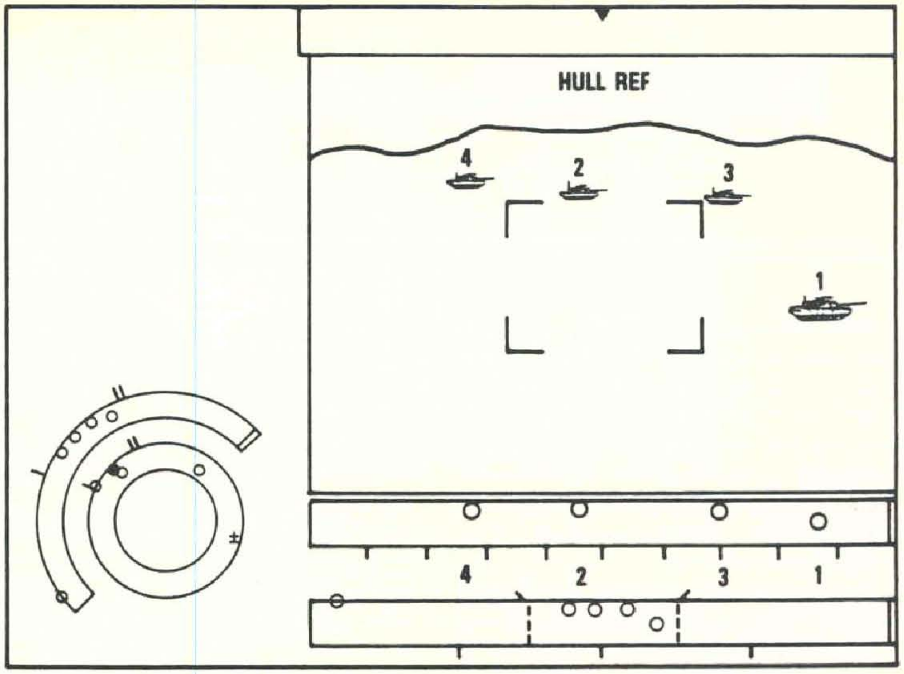



*Figure 3. Surveillance Sub-Displays*

To an untrained viewer, coordinated use of the several sub-displays just discussed may appear complex. But test-bed assessment with trained operators could establish their utility, and determine which should be retained as is and which should be modified or even dropped out as unnecessary for the user. The aim is to have an operator transition most rapidly and with perceptual ease between the symbolic 360-degree plan view of target locations and a desired or selected CITV thermal scene.

## Summary

In support of the U.S. Army Armor Center request for technical consultation regarding enhancement of the display interface for the Commander's Independent Thermal Viewer, ARI has designed some novel sub-displays which it proposes be presented in conjunction with the real-world image provided by the CITV. A Working Paper (BISTA-WP-86-02) describing these and other sub-displays in greater detail has been written and submitted to the Army Armor Center. Major attention was given to aiding the tank commander in executing his surveillance task, and to helping him retain appropriate spatial orientation. Field test-bed assessment of the utility of these sub-displays can be the next order of business.

*DR. AARON HYMAN is a principal scientist at the U.S. Army Research Institute for the Behavioral and Social Sciences. For more than 35 years he has conducted and managed research in vision, perception and human factors. He holds a B.S. degree in physics and an M.S. in education from the City University of New York, and a B.S. in optometry and a Ph.D. in psychology from Columbia University.*

# NDI at the Belvoir RDE Center

## By Gayle D. Peterson

Research and development is a high risk process which consumes a considerable amount of time and resources. While it is often necessary to develop new and improved equipment, many of the Army's requirements can be met much faster and with far less risk through the nondevelopment item (NDI) approach.

This approach has been used successfully by the Troop Support Command's Belvoir RDE Center (BRDEC) in materiel ranging from construction and materials handling equipment to bridges and water supply systems. In fact, "we're probably one of the premier users of NDI within AMC," according to BRDEC Commander COL Edward M. Lee Jr.

The Army's new streamlined acquisition strategy calls for the elimination of the demonstration and validation phase of the development cycle. This should be accomplished during the tech base and proof of principle phase of development. An RDE center like Belvoir must demonstrate that a system is feasible and its operational risks are acceptable before going into the development and production prove-out phases. In other words, an RDE program should start with a "winner."

James Stephens, chief of the Programs Management Division of Belvoir's Logistic Support Directorate, thinks NDI is a winner. "With NDI, the user knows what he's getting. It's also one of the fastest ways to get new technology into the field. A full development cycle can take six to 10 years. By that time the technology can be obsolete. NDI can cut the time from requirement to fielding down to as little as two years—and we know we're getting current technology."

Lynwood Root, chief of the Mechanical Equipment Division, believes NDI is also a good way for the Army to keep the civilian industrial base active in peacetime. "Twenty years ago, when we first had a requirement for a rough terrain forklift, nobody had anything. It was a complete R&D effort. Now we can get all we need through NDI. Industry began to find its own uses for them once we came up with the concept.

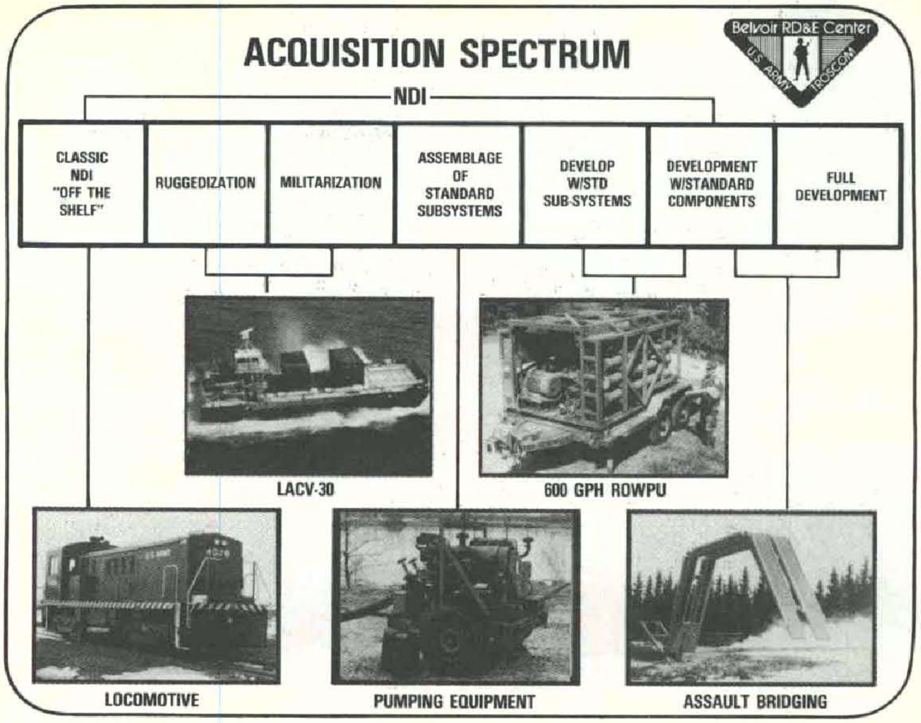
"When we started work on the 10,000-pound rough terrain forklift, it took us 14 years to field it. By going commercial like we did with a front/side loading truck used to handle missiles in warehouses, we did a market survey in six months, wrote the performance specifications, and the item was fielded in two years from the approval of the requirements document."

The market investigation is central to NDI acquisition. It involves keeping abreast of technology through current literature, industry briefings, scientific meetings, information exchanges between the United States and other foreign military powers, industry reports and presentations, and evaluations of industry prototypes at government test sites. The goal of a market investigation is to use this information to search for equipment which may satisfy user requirements. Some other important questions asked at this time are:

- Are there NDI products that can satisfy a user's need? If none are available off-the-shelf, can one be modified or will a new development be required?
- Are available products efficiently transportable via highway, marine craft, railroad and aircraft in their operational configurations?
- Are these products available in sufficient quantities to meet Army requirements without unique or separate production runs?
- Are there support systems, including parts and backup capabilities, that satisfy Army needs for the life of the system? If not, this may lead to a "life of type" buy to support the product.
- What is the extent of competition?
- Are commercial standards and warranties adequate to protect Army interests?
- Are commercial training, operating and maintenance manuals available and adequate?
- Do companies making the NDI have good product quality history?
- Is the manufacturer willing to demonstrate the item at an Army facility?
- Does the NDI incorporate accepted human factors engineering features?
- Are commercial configuration management controls adequate?
- Does the item meet Army safety, health and environmental needs?

Market investigations may vary from informal telephone inquiries to comprehensive industry-wide reviews where a team of representatives from the military developer and user talk to potential manufacturers and the civilian users of their equipment. These teams use a questionnaire to gather data on how satisfied the civilian user is with the equipment and what kind of support and services he receives from the manufacturer. This technical information sheet will be used to prepare a purchase description. These investigations are normally conducted in two steps. First, the developer conducts a general market survey of the market place to determine the nature of available products and the number of potential contractors. At this point, he decides if there is enough information available to make an NDI decision or what additional information may be needed. If there is, the next step is to make that decision and prepare the appropriate requirements and solicitation documents. This may include purchasing or leasing equipment for tests to furnish data for purchase descriptions.

During this phase, design characteristics are evaluated in terms of supportability issues, costs and compatibility with support equipment. These data are included in the source selection criteria. Logistic support analysis is an integral part of the market investigation and is tailored to provide phased delivery data on interim and subsequent support requirements. Also taken into account at this time are maintenance considerations, providing spare parts during initial fielding, and making provisions for preparing technical manuals for the item in a military format. All this will eventually become part of the technical data package for that item.




"Nearly all my programs are NDI," Root continued. We work from performance parameters rather than standards that dictate design specifications for the final piece of equipment. For example, say we need a forklift truck. We tell potential manufacturers that we need something that will move a certain number of containers in a certain amount of space in a certain amount of time with a certain amount of people and we let them take it from there. We describe the mission and let them come up with the design. In other words, we tell them what we want it to do rather than saying we want an automatic transmission or a specific type of boom. That way, we always get the latest technology and we keep our contracts more competitive.

"Once the military user has defined the mission, we analyze it thoroughly. We ask ourselves: do we need that capability and, if so, why. Then we conduct a market investigation to determine who is making equipment that comes close to meeting our requirements and check with the civilian users of that equipment to see how they are using it and how satisfied they are with equipments and services. Sometimes it's very similar, but sometimes there are big differences. You can talk to users, for example, and they can tell you what their construction equipment will do. But if you ask them if it works in rain or snow, that can't tell you because they don't usually work in that kind of weather. Well, the Army does, so you buy representative samples, test them, weigh the advantages and disadvantages, and come to some sort of a tradeoff."

One new piece of equipment being developed this way is the 6,000-pound variable reach rough terrain forklift. The Army needed a piece of equipment that could unload Multiple Launch Rocket System pods and other types of ammunition and supplies from containers mounted on trailers or positioned on the ground. Following the market investigation, we participated with the Tank-Automotive Command for the award of three contracts for prototype forklifts. After testing, the manufacturers whose designs are successful will be allowed to bid on the production contract.

According to Nicholas A. Caspero, chief of the Production Engineering and Standardization Division, NDI is nothing new. "We've been using it for years. Once we get in a requirement, we conduct a market investigation to see what's out there. Then we've got three choices, we can buy an item off the shelf, modify it for military requirements, or take standard components and make them into a new system. It's a matter of form, fit and function. Employing this strategy, we provided the Rapid Deployment Force with a total water supply system...and we did it rapidly and economically."

Hansel Y. Smith, another division chief from the Logistics Support Directorate, thinks the most difficult point to fix is where NDI ends and R&D begins. "NDI," he claims, "can be anything between a box of nails from the hardware store and Star Wars. Think of it as a graduated scale. On one end is pure commercial. Say the user wants a bulldozer. We can go out and buy a commercial one. Then the user might say he wants rifle racks and blackout lights on it. Now we've moved a little bit down the scale because no commercial bulldozer has those options. Later on, the user decides he wants to drop it out of a plane. That's still farther down the scale toward full scale engineering development. It's theoretically possible to break the bulldozer into two parts, drop it out of a plane and reassemble it on the ground, but that isn't the way it was originally designed to be used. Here we have to get involved in some testing to verify that it can be done. Finally clear down on the development end of the spectrum, let's go way out and imagine that the user requires that the bulldozer fly. Obviously, there's no commercial design that even comes close to meeting this requirement, so we have to start from scratch and go through a complete design and testing cycle. The farther away from pure commercial you get, the more time and money are involved and the greater your risk.

"Because of this, we get involved at the beginning when the requirements are being drafted. All our expertise is aimed at Milestone I. Our job is to know what's at the commercial market place so that when a requirement is identified we can provide the user with the information he needs to make a decision. This also includes information on foreign equipment and even some unfriendly systems." Two important items which were selected from foreign sources were the ribbon bridge erection boat, originally built by a British firm, and the recently type classified Israeli mine clearing plow. Belvoir also looked at foreign equipment when the Army's new landing craft was recently procured by TROSCOM. "We looked at craft all over the world," Smith recalled. "You wouldn't think commercial shipping would have much use for a vessel of that type, but they had them in Africa, in Asia, and even in Australia, where they were being used to carry livestock between two islands."

***(Continued on page 20)***

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***This listing is valid a***
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**9 MM**

LTC Richard C. Williams

**AAH**

BG William S. Forster

**ACCS**

BG Edward R. Baldwin

**ACS**

LTC Carl E. Drewes

**ALSE**

LTC Karl R. Griffin (Act.)

**AMMOLOG**

Photo Not Available

COL James G. Voss

**AMWS**

COL James L. Higginbotham

**APACHE ATE**

Photo Not Available

MAJ Robert S. Mair (Act.)

**AVD**

LTC Michael F. McGaugh

**AWC**

COL James D. Howard

**BFVS**

COL William O. Coomer

**BIN MUN**

COL Robert D. Orton

**BLACK HAWK**

COL William E. Turner

**BORESIGHT DEV**

Photo Not Available

Thomas J. Jackson (Act.)

**CIE**

COL Robert R. Sarratt

**COBRA**

COL John N. Bertelkamp

**FATDS**

COL Paul T. Wickliffe

**FIREFINDER**

COL Ronald C. Baldwin

**FUZES**

MAJ Richard O. Bailer (Act.)

**GFD**

LTC Daniel E. Adams

**LIGHT TAC VEH**

COL Joseph A. Petrolino Jr.

**M1**

COL William R. Rittenhouse

**M113**

LTC Dennis C. Deming

**M1A1**

COL(P) Joseph Raffiani Jr.

**M60**

COL William M. Kearney

**M9 ACE**

LTC Joseph G. Papapietro

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*of Dec. 1, 1986. A list follows on page 19.*

**ADCCS**

COL Kenneth N. Brown

**ADS**

BG William J. Fiorentino

**AHIP**

COL John N. Tragesser

**AIS**

MG Alan B. Salisbury

**ARD**

LTC John C. Gale

**ASE**

COL Curtis J. Herrick

**ATACMS**

COL Thomas J. Kunhart

**ATSS**

LTC James Kriebel

**CAWS**

COL Joseph R. Cote

**CCE/ SMHE**

LTC Joseph B. Evans

**CH-47**

COL Michael B. Howe

**CHAPARRAL/ FAAR**

COL Hezekiah Richardson

**CHEM DEMIL**

COL Jan A. Van Prooyen

**CHEM MUN**

BG David A. Nydam

**HAWK**

COL Samuel N. Liberatore

**HEAVY TAC VEH**

COL Walter B. Heggie Jr.

**HELLFIRE/ GLD**

COL William J. Schumacher

**IFF**

MAJ(P) Thomas V. Rosner Jr.

**LAV**

COL Kurt J. Chandler (USMC)

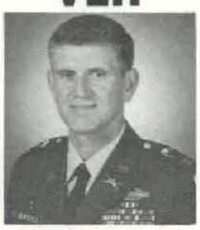
**LHX**

BG(P) Ronald K. Andreson

**MCD**

COL James C. Fields

**MED TAC VEH**



COL Donald W. Derrah

**MEP**

COL Charles S. Green Jr.

**MICNS**

LTC David R. Gust

**MLRS**

COL Nicholas R. Hurst

**MORTAR SYS**

LTC Robert D. Danforth

# AMC Program/Project/ Product Managers

**(Continued)**

**MSCS**

COL Joseph P. Fitzgerald

**MSE**

COL John R. Power

**PLRS/ PJH**

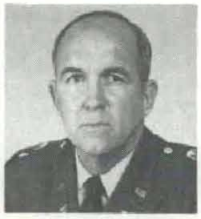
Photo Not Available

LTC Franklin G. Bridges

**PSE**

LTC Paul W. Neal (Act.)

**PWS**



COL Ted R. Maddry

**REMBASS**

MAJ(P) James L. Mitchell

**RPV**

COL David W. Keating

**SANG**

BG William H. Riley Jr.

**SATCOM**

COL Gene A. Venzke

**SEMA**

LTC Larry D. Holcomb

**SINCGARS**

COL Domenic F. Basile

**SMOKE**

COL Francis M. Durel II

**STINGER**

COL Robert A. Drolet

**TAC INTEL/ EW**

COL Alex Johnson

**TAC VEH**

BG James W. Ball

**TADS/ PNVS**

COL David E. Sullivan

**TANK SYS**

BG Peter M. McVey

**TEMOD**

LTC Bruce D. Sweeny

**TMAS**

COL Donald R. Kenney

**TMDE**

COL Douglas H. Barclay

**TOW**

COL James B. Lincoln

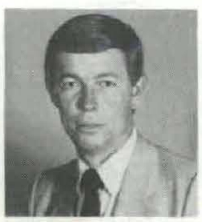
**TPS**

LTC Steven W. Butcher (Act.)

**TRADE**

COL Richard J. Lunsford Jr.

**TSS**



Jerry L. Wilson

**UAV**

James E. Shepard (Act.)

**UH-1**

LTC Donald A. Foster

| NUC MUN | NVD | OPTADS | PATRIOT | PERSHING | PLRS/TIDS |
|---|---|---|---|---|---|
|  | Photo Not Available |  |  |  |  |
| COL Nicholas Barron | MAJ Carl Messinger (Act.) | COL Philip S. Threefoot | COL Larry R. Capps | COL Thomas M. Brown | COL Stanley M. Clough |

## Acronym List of AMC Program/Project/Product Managers

**9MM** ....................9MM Pistol Program
**AAH** ....................Advanced Attack Helicopter
**ACCS** ....................Army Command and Control Systems (Provisional)
**ACS** ....................Army Communicative Systems
**ADCCS** ....................Air Defense Command and Control System
**ADS** ....................Air Defense Systems (Provisional)
**AHIP** ....................Army Helicopter Improvement Program
**AIS** ....................Army Information Systems
**ALSE** ....................Aviation Life Support Equipment
**AMMOLOG** ....................Ammunition Logistics
**AMWS** ....................Advanced Manportable Weapon Systems (Provisional)
**APACHE ATE** ....................APACHE Automatic Test Equipment
**ARD** ....................Armor Training Devices
**ASE** ....................Aircraft Survivability Equipment
**ATACMS** ....................Army Tactical Missile System
**ATSS** ....................Automatic Test Support Systems
**AVD** ....................Aviation Training Devices
**AWC** ....................Amphibians and Watercraft
**BFVS** ....................Bradley Fighting Vehicle Systems
**BIN MUN** ....................Binary Munitions
**BORESIGHT DEV** ....................Boresight Devices
**CAWS** ....................Cannon Artillery Weapons Systems/ JPM Guided Projectiles
**CCE/SMHE** ....................Commercial Construction Equipment and Selected Materials Handling Equipment
**CH-47** ....................CH-47 Modernization/Army V-22 Aircraft Programs
**CHEM DEMIL** ....................Chemical Demilitarization
**CHEM MUN** ....................Chemical Munitions (Provisional)
**CIE** ....................Clothing and Individual Equipment
**FATDS** ....................Field Artillery Tactical Data Systems
**FUZES** ....................Fuzes (Provisional)
**GFD** ....................Ground Forces Training Devices
**HEAVY TAC VEH** ....................Heavy Tactical Vehicles
**HELLFIRE/GLD** ....................Hellfire/Ground Laser Designators
**IFF** ....................Identification Friend or Foe
**LAV** ....................Light Armored Vehicles
**LHX** ....................Light Helicopter Family
**LIGHT TAC VEH** ....................Light Tactical Vehicles
**M1** ....................M1 Abrams Tank
**M113** ....................M113 Family of Vehicles
**M1A1** ....................M1A1 Abrams Tank
**M60** ....................M60 Tanks
**M9 ACE** ....................M9 Armored Combat Earthmover
**MCD** ....................Mines, Countermines and Demolitions
**MED TAC VEH** ....................Medium Tactical Vehicles
**MEP** ....................Mobile Electric Power
**MICNS** ....................Modular Integrated Communication and Navigation System
**MLRS** ....................Multiple Launch Rocket System
**MORTAR SYS** ....................Mortar Systems
**MSCS** ....................Multi-Service Communications Systems
**MSE** ....................Mobile Subscriber Equipment
**NUC MUN** ....................Nuclear Munitions
**NVD** ....................Night Vision Devices
**OPTADS** ....................Operations Tactical Data Systems
**PLRS/TIDS** ....................Position Location Reporting System/ Tactical Information Distribution Systems
**PLRS/PJH** ....................Position Location Reporting System/ Joint Tactical Information Distribution Systems Hybrid (Provisional)
**PSE** ....................Physical Security Equipment
**PWS** ....................Petroleum and Water Systems
**RPV** ....................Tactical Airborne Remotely Piloted Vehicle/Drone System
**SANG** ....................Saudi Arabian National Guard Modernization Program
**SATCOM** ....................Satellite Communications
**SEMA** ....................Special Electronic Mission Aircraft
**SINCGARS** ....................Single Channel Ground and Airborne Radio System
**SMOKE** ....................Smoke/Obscurants
**TAC INTEL/EW** ....................Tactical Intelligence/Electronic Warfare Systems (Provisional)
**TAC VEH** ....................Tactical Vehicles
**TADS/PNVS** ....................Target Acquisition Designation System/Pilot Night Vision System
**TANK SYS** ....................Tank Systems
**TEMOD** ....................Test, Measurement and Diagnostic Equipment (TMDE) Modernization
**TMAS** ....................Tank Main Armament Systems
**TMDE** ....................Test, Measurement and Diagnostic Equipment
**TPS** ....................Test Program Sets
**TRADE** ....................Training Devices
**TSS** ....................Topographic Support Systems
**UAV** ....................Unmanned Aerial Vehicles (Provisional)
**UH-1** ....................UH-1 Aircraft (Provisional) nd Diagnostic Equipment (TMDE) Modernization

## NDI at Belvoir

*(Continued from page 15)*

Even with all its benefits, NDI isn't without its challenges. "It's a controversial idea," Smith points out. "It requires you to operate on the assumption that military use of an item will be very similar to the way a civilian customer would use it. One of our first NDI efforts was a dump truck. This sounds simple enough, commercial industry is full of dump trucks. We did a market investigation and decided on a manufacturer. When we went to him to settle the final specifications we were offered a choice of options—different engines, different transmissions, different axles, etc.—all straight from the commercial seller's book. When we made our selections, however, we found out that he couldn't provide us with data on how the truck would perform. Even though these options were all common, commercially available components, none of his buyers had ever ordered a truck with that exact combination. You have to have confidence in the market place. It's a philosophy of 'is this item good enough to do the job? verses nothing but the best will do.' The military user must make some compromises."

"Another area we have to watch very carefully is spare parts," Root added. "Because we use performance requirements rather than military standards, we may end up with several different configurations of the same item in the inventory. This could require units to keep several sets of spare parts for the same item. Take a simple thing like a starter motor battery, for example. Different manufacturers use different shapes and sizes and some have the positive and negative electrodes on opposite sides from others. This could mean different battery trays and cables requiring stocking these different configurations for individual vehicles. You have to decide whether you are going to accept the tradeoff for the savings benefits on NDI versus decreasing standardization of components thereby increasing logistics burden. One way to reduce this risk is through multi year procurement and 'buyout' of high mortality spares.

"Another thing you run into is that when you but an item commercially you also get the commercially-prepared manuals that go with it. These may not always be suitable for Army users and must be adapted for the military."

Another area of Belvoir's concern is data rights. "We explore the feasibility of acquiring the system data rights for future procurements. Considerations here are the projected need and the affordability of the data," Wendell L. Keyes, Belvoir's associate technical director for engineering and acquisition said. "Another alternative is to try to reverse engineer a part or an item to come up with our own data that we can use for competitive procurement. Belvoir has the lead for the AMC pilot program in reverse engineering."

NDI offers many advantages for the Army, particularly in this era of budget austerity. According to Keyes, "it has proven its value in the past and, if we maintain adequate funding for market surveillance and investigations through better balancing of our resources, it will continue to play an important role in the future."

*GAYLE D. PETERSON is a public affairs specialist in the Public Affairs Office at the Troop Support Command's Belvoir RDE Center. A graduate of the University of Missouri School of Journalism, she spent three years as a radio announcer before joining the federal government as an intern in 1976.*

# Precision Locating System Demonstrated in Europe

Help is in sight for military police, ambulance drivers and truckers unsure of the best route to take, thanks to a navigation aid being developed by the Army Materiel Command (AMC).

The Precision Locating System, developed at AMC Laboratory Command's Harry Diamond Labs, Adelphi, MD, uses laminar-flow technology. An encased, slow-moving stream of air flows across sensors tied by computer to an indicator "dot" on a small TV screen mounted in the vehicle. A transparent road map is attached to the screen. As the vehicle moves, airflow on the sensors moves the dot along the map, indicating the driver's exact location. A thin line follows the dot to show the route just traveled.

LTC Robert Mathewson of Harry Diamond Labs recently demonstrated the device at Headquarters, U.S. Army Europe, in Heidelberg. Mathewson came at the invitation of Andrew Eckles, science adviser to USAREUR Commander in Chief GEN Glenn K. Otis, as part of the AMC Science Assistance Program, known as ASAP. He briefed AMC-Europe and USAREUR officials on the potential value of the system to transportation, military police, medical and armor units.

"Soldiers will have to use map reading skills they have already learned," Mathewson said. "But this system will help them enormously if they're in a new area, lost or in a hurry."

The device Mathewson demonstrated was originally offered as a limited option by a commercial auto maker, but he said similar yet simpler systems designed at the Harry Diamond Labs can be tailored to specific military unit needs.

"We have developed one model which costs $1,500 or less," Mathewson said. "That's cheap compared with some commercial models that cost as much as $60,000. And ours does everything a soldier needs."

Mathewson explained that the future of the system depends on ASAP, without whose financial help, he explained, the program will quickly die. He said further funding and successful evaluations by potential users will determine the future of the precision locating system.

The Science Assistance Program brings rapid solutions to user problems through research and development conducted at AMC labs. ASAP is just one facet of AMC's support to readiness in Europe and an enhancement of the ongoing force modernization program.

# Medical R&D Command Spinoff Benefits

## By Charles Dasey

### Introduction

Military research and development has produced a long list of technological innovations that led to benefits beyond the original military goals of the research. Such spinoff benefits continue today. In the medical arena, the U.S. Army Medical R&D Command (USAMRDC), headquartered at Fort Detrick, MD, is responsible for important contributions to biomedical research and medical care.

The contributions can be divided into four categories: basic research, drugs and vaccines, medical materiel and equipment, and medical care in disasters and mass casualty situations.

### Basic Research

The first category is basic research funded by the command. Most requirements for new medical materiel stimulate the awarding of contracts for basic research. Basic research, as defined by the Department of Defense, includes initial and exploratory product-directed research. It is distinguished from the non-product-directed basic research of the academic community by its tie to specific planned products and military requirements.

The command funds nearly 250 contracts for basic research. A typical example is a set of six contracts awarded for research that will lead to the cloning of the human gene for acetylcholinesterase (ACHE), the nerve-regulating enzyme which chemical warfare agents inhibit. Civilian investigators were asked to clone the gene so that ACHE could be produced in quantity and examined in its interaction with chemical warfare agents. The purpose was to analyze the effect of the agents on the enzyme, to locate the binding sites, and to evaluate ACHE as a potential treatment for chemical warfare casualties.

An investigator from the University of California framed his opinion of the benefit of the research for a reporter in 1984. "I'm delighted that the military is willing to pay for this research because if I can get the money from them instead of NIH, that saves $100,000 for another investigator. This is high priority research we'd be doing no matter what. We'll learn a lot of basic things about how the body functions from acetylcholinesterase. To take chunks of military money and divert it to health is good for the country."

Another investigator, whose contract calls for the cloning of components of the Rift Valley Fever virus as part of an Army vaccine development program, sees his effort located in "a worthy area that is scientifically very interesting." An investigator under contract to help develop a recombinant anthrax vaccine claimed, "I wouldn't be in this field if I hadn't gotten money from the Army." Army support strengthens the nation's biomedical research base. Military needs are met, and the enhanced research base can be focused on other complex medical problems.

### Vaccines

The USAMRDC's Military Disease Hazards Research Program has the responsibility of conducting research to protect against diseases that represent hazards of deployment—diseases such as malaria, hepatitis, and dengue fever, which are endemic in certain areas of the world, are not of interest to the U.S. civilian population because they do not occur in the United States, and which, therefore, are not of primary interest to the National Institutes of Health (NIH) or the commercial drug and vaccine producers. The Army must view them as potential threats because of the possibility of deployment to areas where they occur, and therefore requires a vaccine and drug development effort as a source of protection. The Army also needs vaccines and drugs to protect against agents that could be used in biological weapons.

The Army is not the only agency attempting to produce a malaria vaccine, but, because of the traditional threat to personnel posed by malaria, the Army (specifically the Walter Reed Army Institute of Research) is a major player in the effort. There are approximately 100 million new cases of malaria and one million deaths from malaria each year. A successful vaccine will be a major world health benefit.

While a new vaccine may one day prevent malaria, its symptoms are currently treated with antimalarial drugs. Antimalarial compounds developed by the command include mefloquine, which is under review for Food and Drug Administration (FDA) approval for widespread human use, halofantrine and enpiroline, in the latter stages of development, and quinghaosu, in the preliminary investigation stage. The command is recognized worldwide for contributions in treating malaria.

Other vaccine development efforts with potential spinoff value include:

- Hepatitis A. Widespread administration of an effective Hepatitis A vaccine would provide immunity for travelers to foreign countries where it is endemic.
- Chikungunya. This is a disease of the tropics that causes a severe flu-like illness; it could be controlled with a vaccine.
- Q Fever. This disease occurs on all continents and threatens slaughterhouse workers, veterinarians, dairy

***Hand held dental X-ray system, developed by the U.S. Army Institute of Dental Research in conjunction with the National Bureau of Standards, fits in a 12-inch by 12-inch by 12-inch carrying case. The X-ray gun and rechargeable battery pack weighs about 10 pounds. The system can also be operated with a 28-volt vehicle battery. It will be field tested at Fort Lewis, WA early this year. Field dental X-ray systems currently in use weigh 218 pounds and take up 11 cubic feet of clinic space.***

workers and farmers. A military experimental vaccine exists, but it can cause adverse side effects. An improved, licensed vaccine would protect more people at high risk for this disease.

- Dengue Fever. This is an infectious disease causing an acute, febrile illness. From the military standpoint, this naturally occurring disease is a threat because it can quickly incapacitate large numbers of soldiers. A vaccine could immunize deploying soldiers. It would also save the lives of many children in endemic countries, in whom the disease is sometimes fatal.

- Scrub Typhus. This is a disease occurring from Australia to Afghanistan. It could be limited by a successful vaccine, which in turn would reduce health care costs.

Another benefit of Army vaccine development efforts is that new and novel approaches can be explored. Researchers at the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) at Fort Detrick are working with Rift Valley Fever virus in an attempt to develop broadly applicable vaccine technologies. Genetic engineering offers the potential for development of safer, more effective, and more efficiently producible vaccines in the future. Army funding of basic research in this area is laying important groundwork for future successes as researchers gain mastery over exciting new tools and possibilities.

## Drug Development

Drug development complements vaccine development in the search for new forms of protection. An energetic program is under way at USAMRIID to evaluate the safety and efficacy of use of antiviral compounds combined with immune-stimulating therapy for virus infections. The leading candidate, ribavirin, is currently in Medical R&D Command sponsored advanced field trials in several countries, including the Peoples Republic of China. Continued success should lead to near term FDA approval for use against debilitating and life threatening virus infections such as Rift Valley Fever and Korean Hemorrhagic Fever.

Since these diseases are equally threatening to civilians in endemic areas, FDA approval will make this drug available for the treatment of civilian patients. Ribavirin is also one of the drugs the NIH is evaluating for treatment of AIDS patients.

## Materiel and Equipment

Infectious disease research carries over into the third type of spinoff benefit, new medical materiel and equipment. The Army is funding development of a biological agent identification and diagnosis system as a way to rapidly identify organisms used in a biological attack, or to rapidly diagnose the cause of sudden illness in a soldier. The system uses DNA and RNA probes to identify infecting agents. Development of the system puts the Army in the position of transferring very current laboratory achievements to usable hardware. User-friendly systems to accomplish quick identification and diagnosis of infectious agents could be adapted to civilian human and animal health care in the United States and overseas.

Many infectious diseases are spread by insects, and the Army is developing an improved insect repellent, using microencapsulation/time-release technology, to provide effective protection for 12 hours. The Army is also developing an insect repellent product that can be impregnated into the uniform fabric which will provide protection for at least 30 days. Although improved insect repellents would probably have little effect on serious world health problems, they would be readily accepted by American consumers, such as hunters, fishermen, and hikers.

The digital X-ray system being developed by the Army through the University of Wisconsin integrates state-of-the-art technology into a processing, displaying, and archiving system which requires no water, chemicals, or darkroom to produce radiographs. This system, which is expected to be slightly larger than a personal computer, will greatly decrease the turnaround time for obtaining radiographs in the emergency department, intensive care unit, and operating room. A 30-pound, handheld X-ray machine will expose a reusable plate which is read by a laser, displayed on a screen for interpretation, and stored on a credit-card size device. The prototype should be delivered in late 1988, with production commencing shortly thereafter.

The U.S. Army Institute of Dental Research is developing a light-weight, hand-held, real-time imaging field dental X-ray. In addition to its use in combat, this piece of equipment could be used by dentists who treat invalid and "shut-in" patients in their own homes or in nursing homes. The field X-ray will also have great application in underdeveloped countries where much of the health care is provided by field teams from the United Nations or the World Health Organization.

Automatic syringes or autoinjectors were developed for the Army. They contain antidotes to be self-injected by the soldier during a chemical warfare attack. There are ongoing efforts to develop improved versions of the autoinjector. Autoinjector technology provides a means for patients and nonmedical personnel to quickly administer lifesaving drugs. Autoinjectors are already commercially available with medication to counteract insect stings, insecticide exposure, and certain types of heart attack.

Civilian application of this technology was recently forecasted by The Washington Post business section. Heart disease patients will carry injectors with them, call a physician at the first sign of an attack, and self-administer a drug according to the physician's instructions. This technology could be applied to other lifesaving pharmaceuticals which require quick injection directly into the body.

## Disasters and Mass Casualties

The fourth category of spinoff benefits includes medical equipment and treatment in civilian circumstances that mimic those of war. The scene of an airplane crash, an earthquake or a terrorist bombing is often compared to a war zone to describe mass casualties and mass destruction. Military medical research intended to benefit military casualties can also save lives in such civilian emergencies.

For treatment of shock, the hypertonic saline/Dextran resuscitation fluid currently entering clinical trials will facilitate on-site care of mass casualty victims. With the new fluid, less than one quarter of the volume of currently used solutions is needed to effect the same clinical response. This will allow a single rescue vehicle or several emergency medical technicians to carry enough resuscitation fluid to treat large numbers of casualties. The clinical studies are being conducted at a civilian trauma center.

The blood substitute, Stroma-Free Hemoglobin, is expected to have a major positive impact on support of the civilian trauma patient. This solution, made from outdated red blood cells, carries oxygen and helps expand the blood volume of the severe blood loss patient. No refrigeration or blood typing is necessary, so blood loss can be countered with Stroma-Free Hemoglobin at accident scenes and in the emergency room before blood compatibility testing is complete. Clinical testing should commence by 1990.

Finally, the Army Institute of Dental Research has developed an exquisitely simple application for computer technology designed to speed the identification of victims of disasters. Computer Assisted Post Mortem Identification (CAMPI) is a computer software system which quickly sorts through antemortem dental records and compares them to postmortem dental remains, looking for matches. The system speeds the postmortem identification process in mass casualty situations. Designed for military use, the system has attracted the interest of county medical examiners and coroners in many states. The CAMPI system was successfully used after the September 1986 Aero Mexico airplane crash in California, at the request of the Los Angeles County Coroner's Office.

## Conclusion

Research for the soldier conducted by the U.S. Army Medical R&D Command continues in response to the many health and safety hazards posed by the many military environments. Secondary or spinoff benefits represent windfall profits for all to share.

*CHARLES DASEY is the public affairs officer at the U.S. Army Medical R&D Command. He holds a B.A. degree in English from Fordham University and is a graduate of the Army's Advanced Public Affairs Course.*

***INFANTRYMAN 2000* Studies of what future wars will be like have indicated that the individual soldier will also change. In this concept, the soldier wears an eyes-up display in his helmet, he has a throat microphone, a weapon that fires both large and small projectiles, a nuclear/biological/chemical oversuit, a two round vertically launched missile system in his backpack, and anti-personnel mine resistant armored boots. He could project as much stopping power as a small tank. (Photo courtesy of TRH, London)**

# Alternative Approaches to Animal Testing in Toxicological Evaluations

By Dr. Harry Salem

## Introduction

Classically, toxicology is defined as the study of poisons, but in its modern context, it is considered to be the study of safety assessment. The findings are applied to predict health hazards and risks to humans. These estimates are based on animal studies, and the extrapolation is considered a reliable predictor of potential adverse human health effects.

The use of laboratory animals in biomedical research and toxicology testing is an issue of increasing public concern, which has resulted in efforts by the scientific community to identify and evaluate alternative non-mammalian or animal systems. Improved testing methods and screening procedures are being developed for alternatives to animal testing, although animal testing will probably never be entirely eliminated.

Alternative systems whether in vitro (cellular), or computer models, cannot provide the information on the modulating effects of an integrated biological response as found in the whole animal. However, promising alternative screening methodologies should reduce the number of animals required for testing, and at the same time find acceptance in the scientific and regulatory communities.

The Army Materiel Command's Chemical Research Development and Engineering Center (CRDEC), Research Directorate, Toxicology Division, is also concerned about and sensitive to the issue of animal testing and has recently begun a program to develop alternative methods of toxicological testing. This article reviews the CRDEC research program to develop alternatives to animal testing for compiling toxicological data bases on chemicals of military interest.

## The Search for Alternatives

The search for acceptable alternatives to intact animal testing is driven by the three R's, replacement, refinement and reduction—replacement of animal testing, refinement of intact and alternative systems, and reduction in the number of animals used or utilization of animals lower on the evolutionary scale.

The use of intact animal testing is necessary, and is almost exclusively conducted on animals bred specifically for laboratory tests under responsible and humane conditions. Among the most sensitive issues of public concern is utilization of the rabbit to test chemicals, drugs and cosmetics for their irritating effects on the eye in the Draize test. As a result, several centers have been established at universities such as Johns Hopkins and the Rockefeller University, and in industry where attempts are being made to replace this test with non-animal models.

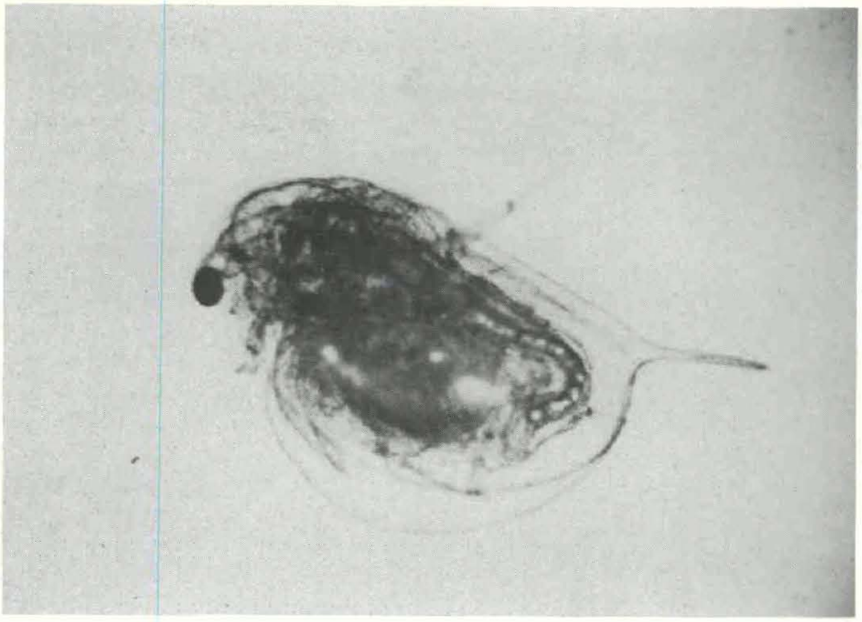
We at CRDEC feel that screening procedures in non-animal models may be useful for evaluating the eye irritation effect of chemicals, and then only chemicals selected in the non-animal model will have to be tested in the rabbit eye. Thus, fewer rabbits will be necessary for testing. CRDEC's program in searching for alternatives to the Draize Eye Irritation test is two-fold.

## Collaborative Efforts

CRDEC and the Laboratory for In Vitro Toxicological Assay Development at the Rockefeller University are collaborating in validation studies designed to assess the correlation of in vivo (whole animal) Draize rabbit eye irritancy data developed at CRDEC with in vitro data developed on the same chemicals at the Rockefeller University. The Rockefeller University in vitro systems include: an assay designed to measure the effect of chemicals on the passage of nutrient (uridine) into cells in culture; an assay designed to evaluate the effects of chemicals on the uptake of a dye (neutral red) by cells in culture; and a modified in vitro technique to evaluate the response of eye tissue to chemicals.

The goals of the cellular non-animal techniques are to develop methods that can differentiate the severity of irritants and correlate them with results obtained by the in vivo rabbit eye assay.

A complex range of physiological reactions including vascular changes, inflammation, cellular degeneration, and recovery are evaluated in the Draize test. Although it is unlikely that any one in vitro alternative to the Draize test will fully reflect the complexity of the interactions seen in the rabbit ocular response, a battery of tests as described above may provide sufficient information to reduce the number of Draize assays conducted.



***Water Flea** (Daphnia Magna) **is used in a 48-hour assay and results are correlated with rodent toxicity.***

## Other Alternatives

Another alternative approach to animal testing has been the development of a set of structure-activity relationship equations by computer modeling. Such a system has been developed for the rabbit skin irritation assay. The use of these equations permits the estimation of the probable degree of skin irritation for chemicals that have not been subjected to bioassays in animals. CRDEC plans to collaborate with Health Designs Inc. to develop a set of equations for the rabbit eye irritation assay similar to that developed for the skin irritation assay. Given such a set of equations, it should be possible to estimate the eye irritation potential of an untested compound from the chemical structure, partition coefficient and molecular weight. Such estimates would eliminate the need for testing all chemicals in a series under consideration using the actual bioassay.

CRDEC is making other efforts to reduce the number of intact animals used in toxicology research. In an effort to get comparative toxicity data in alternative systems, CRDEC's Dr. Wayne Landis, in his collaboration with Health Designs Inc., has produced a preliminary data base for modeling of the structure activity relationships between organic chemicals and their toxicity to algae, the water flea, and fish. We have also investigated the relationship between invertebrate and vertebrate toxicity.

The toxicity of organic chemicals are correlated between a 48-hour water flea bioassay and rodent oral and intraperitoneal toxicity. The preliminary research indicates a low but statistically significant correlation. These methods will be used to screen environmental toxicants and have a tremendous potential for reducing the numbers of vertebrate animals utilized in toxicological evaluations by replacement with the invertebrate species mentioned above.

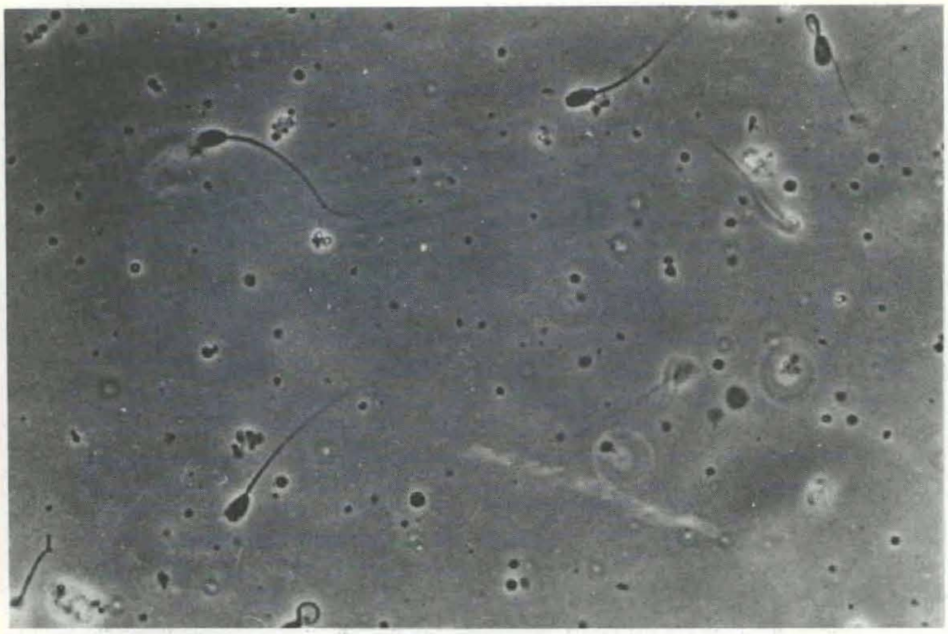
Drs. Robert Mioduszewski and Jay Valdes are collaborating with the Health Sciences Center at the University of Texas to develop a peripheral neuronal model system for the study of human estimates of toxicity using cultured rat and human lymphocytes. These cells use communication mechanisms similar to those used by neurons and are activated by a variety of chemicals, bacteria, viruses and antigens.

## In-House Effort

The alternatives to animal testing described so far have been primarily collaborative efforts with other institutions. CRDEC also has an in-house research effort to develop alternative methodologies. Drs. Sandra Thompson and Robert Anderson have developed a battery of short-term in vitro assays to quantify many parameters of lung injury required for toxicological evaluation of inhaled chemicals. These assays measure the impact of particulate exposure on macrophages, cells normally present in the lungs which engulf foreign particulates. A large number of cells can be lavaged (washed) from a few animals thereby reducing the number of animals required to study the mechanisms of action from toxic insult. These assays combined with enzymatic analysis of lavage fluid are being used to screen compounds of military interest so fewer compounds will require chronic inhalation testing in animals.

Another area of research in alternative methods being explored is that of predictive toxicology. With a limited number of species of animals available for toxicological studies and with a paucity of human epidemiologic data, the investigator is expected to predict human response to chemicals from the effects on a test animal. The reliability of animal data extrapolation to humans can be enhanced by the addition of more in vitro tests utilizing cells available from both experimental animals and humans (for example, a number of mineral dusts such as silica and asbestos) damage cell membranes). Therefore, red blood cellular disruption has been used to assess the relative toxicity of these compounds. Since red blood cells are easily obtained from humans as well as animals, these techniques would allow comparison of animal to human toxicity making the predictability of test animal models more credible.

Extensive studies have also been conducted to develop alternative methods for evaluating the effect of chemicals on the nervous system. Drs. Jay Valdes



***Photomicrograph of rabbit sperm used to study anti-fertility.***

and Roy Thompson are studying neurotoxicants using tissue from the Torpedo fish for an ionchannel assay. This method shows great promise as an alternative screening procedure for potential neurotoxicants. Dr. Eugene Olajos uses avian species in studies on the effects of toxicants on nerve function, chemistry and structure.

Another area of great interest to toxicologists is that of mutagenicity testing using primarily in vitro bacterial systems. The correlation of mutagenicity with carcinogenicity reduces the need for some carcinogenicity bioassays. Most regulatory requirements include the Ames Assay in the battery of genetic tests, and these are conducted by Fred Lee in our evaluation of chemicals of military interest. The interest in mutagenicity is extended to teratology (birth defects) and reproduction studies, both customarily requiring intact animals. Our efforts in teratogenesis assays focus on lower forms of animals such as the Xenopus (frog) embryo development and Hydra reaggregation assays. These non-mammalian assays under development by William Starke, have so far not demonstrated the potential for a reliable and acceptable test to replace or reduce the number of mammalian species currently being used.

Dr. Landis and his co-workers Haley, Johnson and Muse, conduct environmental bioassays in a standardized aquatic microcosm. In this system, the effect of chemicals is studied on daphnids, algae and other diverse species of aquatic organisms. Microcosms are designed to simulate natural biological communities under controlled conditions to determine the impact of chemicals on an aquatic community.

CRDEC no longer uses dogs, cats or non-human primates in toxicological evaluations. Our human risk estimates must be made based on data from rodents and appropriate in vitro studies. In an effort to develop a more reliable human risk estimate with the imposed restriction of using only certain animal species, the swine and ferret (canine family) are incorporated into our multispecies toxicological assay. This is being done in an attempt to increase the reliability of human risk estimation.

The development of in vitro tests by Dr. Ronald Young to study the effects of chemicals of military interest on reproduction appear promising. The effect of chemicals on sperm motility is a test which requires only the collection of spermatozoa from animals or humans. Chemicals are screened for antifertility characteristics by observing inhibition of motility or changes in swimming patterns of these sperm. In vitro fertilization of an egg is another assay recently developed to screen various compounds. This test can be used to assess the effect of a chemical on fertilization. Sperm or eggs exposed to a chemical in vitro or in vivo can be used. Because large numbers of eggs can be obtained by superovulation techniques, few animals are required. These tests are applicable to the assessment of the reproductive effects of sub-lethal and/or subchronic doses of chemicals or toxins.

## Summary

The Chemical Research Development and Engineering Center has taken a lead in developing alternative approaches to animal testing for toxicological evaluations, and has demonstrated a commitment to the safe use and handling of chemicals. Through research collaborations, CRDEC has also established an atmosphere of cooperation with other biomedical institutions by addressing areas of mutual concern to all toxicologists, allied scientists, and animal welfare groups.

It is not now possible, nor is it likely to become possible to totally eliminate animal testing (either acute, subchronic, or chronic), and also maintain an acceptable level of public and military safety in the use of chemicals. However, the alternative methods will reduce the number of experimental animals used and provide us with research tools to determine mechanisms of action. We are still a long way from replacing, and probably never will replace animal testing, but we will reduce the numbers of animals used and retain the research tools to determine mechanisms of action.

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# Artificial Intelligence and Operational Planning

By Dr. Gerald M. Powell, MAJ Gary Loberg, Harlan H. Black, and CPT Martin L. Gronberg

## Introduction

Early in 1984 the U.S. Army Communications-Electronics Command formed the Battlefield Artificial Intelligence Technology Branch to perform basic research and exploratory development in artificial intelligence (AI) in support of the Army's command, control and communications systems. After identifying individuals who could make multiple-year commitments as application-domain experts, a research plan was constructed in early 1985 and is currently being implemented. The application area is operational planning, and the principal experts are corps planners at the Army War college.

A major reason for choosing this problem is to reduce the time required for operational planning. Since operational planning is characterized by human reasoning and visual processing, AI methods are viewed as a key to provide planners with automated planning assistance.

## Operational Planning

Operational planning is performed at U.S. Army corps headquarters and the operations order or plan received by the corps provides the situation description and the corps' mission. In developing a plan or order, the corps commander and staff make decisions addressing key plan issues.

The situation description and mission correspond to the initial-and goal-state concepts found in many AI planning theories. The decision-making issues correspond less directly to action operators like those in robot planning. To understand the battlefield situation for planning purposes, it is necessary to know about the capabilities and intentions of the enemy opposing the corps, the militarily significant features of the terrain in the corps' area of operations and the quantity and capability of the friendly forces available to the corps.

To achieve the mission, which is the input that initiates planning, it is necessary to understand the mission description. This means understanding such things as the objectives, tasks, and constraints of the operation. Finally, in generating a plan to accomplish the mission, the corps planner addresses a set of decision issues. These issues constitute the major plan elements and describe the concept of the operation.

However, the relationship between established AI theories of planning and operational planning is tenuous, leaving this an open research area. Several issues influence this relationship between theory and practice, namely: imprecise situation descriptions, abstract and uncertain relationships between states of the world, operators available to planners, and the dynamic and hostile environment in which a plan is to be executed.

## The ARES Project

ARES is basic research and exploratory development to investigate the application and extension of AI techniques to the Maneuver Control Functional Segment (MCFS) of the command and control subordinate system. The research strategy of ARES is to develop a test-bed system that will perform as a decision assistant to a key decision maker of the MCFS.

A major goal of ARES is to demonstrate an AI based aid performing two functions of the functional segment : planning for future operations while the battlefield context is static, and controlling ongoing operations in the context of a dynamic battlefield. The following sections describe ARES research areas.

## Terrain Analysis

Military planning requires an understanding of the nature of terrain. The terrain analysis actor (problem-solving process) of ARES will consist of a software interface to the other actors and a digitized terrain data base.

Formalizing the terrain reasoning process is a difficult problem for human experts who do terrain analysis. The geographical area must be structured into regions that are of military significance to the problem at hand. Traditionally, humans have dealt with the vast array of terrain information through the use of maps. Maps depict such information in a fixed and implicit manner, suggesting a direct relationship between maps and the data base needed. Therefore, the first part of the problem is to use a representative technique to organize and to store in the data base all of the map and overlay information potentially relevant to planning.

The second part of the problem is to develop an interface to the data base, which will permit the terrain reasoning required by other actors. The interface will be similar functionally to the visual processing of the human that is used as the means of searching the map for the specific facts that currently are relevant to the human's analysis. Our attempt to model human approaches to terrain reasoning is based on our belief that these approaches are less vulnerable than non-artificial intelligence techniques to small perturbations in their input. Also, the corps planner is more likely to understand the program's knowledge and thus feel easier with its results.

It can be very inefficient and uneconomical to use large digitized terrain data bases containing all of the basic terrain factors needed for terrain reasoning because they require large sections of data to be examined, manipulated and stored. This suggests the need to apply an AI approach to abstract the raw terrain data into some kind of hierarchical, semantic form. This allows reasoning using typed objects rather than uninterpreted pixels. Thus, an object-based approach is being used to represent the terrain data and the knowledge of terrain influences on devices, force units, capabilities and strategies.

An inference engine and interface to the other actors will be constructed so that the knowledge base and the terrain data base will be able to respond to specific requests about the terrain.

## Situation Analysis

The enemy opposing the projected corps operation is a critical element of the battlefield situation. The corps maintains a data base of the enemy order of battle (EOB) at all times. The EOB includes everything known or suspected about the enemy, such as identified units, activities, and command relationships. Although the enemy order of battle provides snapshot descriptions of the enemy, it does not provide the description of enemy forces required by planners. The information required by planners describes what are believed to be the enemy's capabilities and probable courses of action. This information must be derived from the description provided by the EOB. This derivation process is one factor reflecting the complexity of the enemy forces segment of the situation description. Other factors focus on the quality of the information contained in the EOB; it is often inaccurate, incomplete, out of date, and at multiple levels of grain.

Knowledge of enemy forces can be usefully divided into two classes: force structure and doctrine. Knowledge about force structure describes the part-whole relationships of enemy units and significant attributes of enemy units such as the size, key weapons, significant capabilities and type. Doctrinal knowledge describes enemy plan structures such as types of operations, goals and unit geometries.

From an artificial intelligence perspective, the situation analysis problem can be characterized as one of interpretation and plan recognition. Plan recognition remains an open research area even for problems having much less complexity than battlefield situation analysis.

Our study of human problem solving in situation analysis has focused on the problem solving strategies of our analysts and the relationships between those strategies, the characteristics of the problem, and the constraints on the human information processor. Also, research has focused on developing a knowledge base of enemy units. Several organizational schemes were devised to support various reasoning methods.

## Course-of-Action Generator

The mission analysis conducted by the corps produces a complete refinement and statement of the corps mission. Based on this new mission statement, the staff begins producing and exchanging information required for developing plan alternatives, or courses-of-action.

Course-of-action generation at the operational level of warfare is best characterized as a complex planning activity. Assuming the terrain analysis and situation analysis actors provide valid interpretations and predictions of the planning situation, the major sources of complexity are the number of agents whose activities are to be controlled by the course-of-action and the means available to the planner to transform the initial state in the goal state. An examination of this complexity, conducted with the Army War College, has aided in developing and understanding the function of military plans in the operational environment.

Corps planning is characterized by the presence of multiple active agents. Additionally, the agents are dissimilar in that they possess different capabilities, and these capabilities must be understood fully. The task is to plan the activities of these agents so that the initial problem is transformed into the final goal.

Planning the actions of multiple, dissimilar agents is a complex activity for humans as well as for any potentially automated system. Our investigations with the Army War College clearly show that corps planners do not plan actions of subordinate units; instead, they reduce their problems and provide a framework for composing the solutions to these simpler problems as the planned operation is being executed.

We have succeeded in defining a structure of five elements for a course-of-action that allows both of the requirements. These elements are: the Scheme of Maneuver, which provides the framework for the solution composition; the Task Organization, which allocates maneuver resources to the various subproblems; the Task Allocation, which allocates tasks to the subproblems; the Command and Control Measures, which allocate terrain and enemy forces to the subproblems; and the Support Priorities, which allocate logistics resources to subproblems.

## Soldier-Machine Interaction

Since planning is a cognitive process involving visual aids, soldier-machine interface issues are important. ARES uses an object-oriented tactical graphics system which displays and manages its map backgrounds, map overlays, symbology, and text. A graphics access language, the ARES Display Language, was designed to enable all actors to access the tactical graphics system in a uniform manner.

In this environment, using a military unit as an example, by indicating the unit's position in a data hierarchy, an actor acquires graphical display capability. This provides a modular approach to project development. Device independency is stressed in both the language and implementation and the language supports a multi-actor environment where actors create and maintain their own view of an overlay plane of symbols.

Symbology underlays were selected for the ARES tactical display system. A full size color tactical map background was photographed on a piece of acetate and was attached to the front of a rear projection screen. The symbology is projected from behind the screen and is managed by the computer. The user can draw on the map with a tool similar to a light pen.

Ease of use is a major issue in the

design and specification of the soldier-machine interaction. The interface provides support for multi-window editing of the various problem-solving components. Utilizing message passing, the soldier-machine interface specifications provide a model and structure for communication between the ARES actors.

Major research concerns regarding the soldier-machine interface are screen declutter and the automated positioning of tactical symbology.

## ARES Representation Language

Our understanding of the operational planning problem led us to choose an object-based approach to structuring and representing domain knowledge and problem-solving information. However, we have identified a number of extensions to this approach that are required to model more adequately the complexity inherent in our domain and we have implemented some of these extensions.

## Conclusions

A new artificial intelligence research laboratory, which eventually will have a facility for classified computing, houses CECOM's five Symbolics 3670 LISP machines and another six machines have been ordered.

In light of progress demonstrated by other systems, we believe a knowledge-based approach offers promise for advances in understanding and solving difficult military problems. Our plan is to demonstrate the effectiveness of AI techniques for increasing significantly the performance of operational planning in a soldier-machine system.

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# ARI Establishes Academic Chair

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI) has announced the establishment of a visiting research chair to create a lasting in-depth relationship between nationally recognized scholars, ARI, and the Army. Appointment to the chair is for one year to allow social scientists to conduct research having direct applications to military manpower issues.

Named the S.L.A. Marshall Chair, the research memorializes the name and accomplishments of BG Samuel Lyman Atwood Marshall who died in 1977. Cited by President Nixon in 1972 and, for more than 35 years America's most honored and prolific military historian, Marshall was one the founders of the War Department's Historical Division.

The first recipient of the chair is Morris Janowitz, currently the Lawrence A. Kimpton distinguished service professor of sociology and the social sciences at the University of Chicago. He assumed the chair on Oct. 1, 1986 and will serve until June 30, 1987. Janowitz holds the Career of Distinguished Scholarship Award presented to him in 1985 by the American Sociological Association and is the founding chairman of the Inter-University Seminar on Armed Forces and Society. He is also founding editor of Armed Forces and Society: An Interdisciplinary Journal and is a fellow of the American Academy of Arts and Sciences.

As the visiting research chair, Janowitz will conduct research relating to current and future military manpower issues. At the same time during his tenure, he will author a book chapter or article which will become part of an ongoing ARI series of distinguished research publications. It is anticipated that he will also conduct two or three seminars at ARI headquarters in Alexandria, VA.

The concept of appointing the best minds in academia to a visiting research chair at ARI originated with Army Vice Chief of Staff GEN Maxwell B. Thurman. In addition to the major purpose stated above, the concept has the following additional objectives: to sponsor creative and top quality research, to strengthen relations with the university community, and to advance social science knowledge in matters of long-term concern to ARI and the U.S. Army.

"One of the Institutes missions is to remain current with the latest research efforts in the behavioral and social sciences," stated COL W. Darryl Henderson, ARI's commanding officer. "The establishment of this Chair will significantly assist ARI in meeting this goal. ARI will be constantly in search of scholars who have demonstrated proven ability to conduct research needed by the Army."

The agreement between the university and the institute was signed during a luncheon ceremony at the Quadrangle Club in Chicago. The ceremony was attended by Janowitz; Henderson; Dr. Norman M. Bradburn, provost of the University of Chicago; Dr. Edward O. Laumann, dean of social sciences, University of Chicago; Dr. William J. Wilson, chairman of the Department of Sociology, University of Chicago; and Dr. Charles C. Moskos, professor of Sociology, Northwestern University.

# From The Field . . .

## Tobyhanna Chosen as Center of Excellence

Tobyhanna Army Depot's role in fielding the Microfix battlefield intelligence system has resulted in the depot's selection as the Center of Technical Excellence (CTX) for a new, more powerful system.

Tobyhanna was recently designated as the U.S. Army Depot System Command's CTX for the All-Source Analysis System (ASAS), an automated intelligence system now under development for the Army. It is being developed in conjunction with the Enemy Situation Correlation Element, the Air Force version. Both systems will meet the services' need for automated analysis of battlefield data which would flood into command posts from an array of sensors.

Automated analysis is required to accurately and rapidly process data, enabling the commander to concentrate air and ground combat power at critical points on the battlefield.

"The depot's ability to respond to the Microfix non-developmental item (NDI) program was a key factor in our designation as the ASAS CTX," says John Lesniak, the depot's force modernization officer. NDI programs, such as Microfix, speed the fielding of new systems by adapting already-developed equipment that is available from civilian industry, other services, federal agencies or other nations.

"The urgency of Microfix development required us to far exceed our normal levels of support," agrees Robert Young, an engineer with the Microfix project and now the ASAS CTX manager for the the depot. "It was a quick reaction project and we did our preparation on the fly."

U.S. Army Forces Command first identified the need for automated intelligence gathering and analysis. The project received high visibility because it represented a major change from the "stubby pencil" method of intelligence gathering, Lesniak explains.

"It was known that more powerful systems were under development, but there was an immediate need for an interim system such as Microfix," Young says.

Developed by Georgia Institute of Technology, Microfix consists of a commercially-available microcomputer and other "off-the-shelf" computer components. Complicating the development of a depot support package was the fact that more than 20 subvendors were involved in Microfix.

Beginning in late 1982, depot personnel participated in all levels of planning support for Microfix, including development of training plans and programs of instruction, acquisition of test equipment and other critical maintenance and supply functions. Depot personnel developed acceptance procedures for 5,000 line items, including circuit cards, power supplies and other parts.

By early this past year, the depot was positioned to provide 100 percent maintenance support for Microfix, only about three years after Tobyhanna's initial involvement.

"The skill of depot personnel, extensive research of commercial literature, and formal training by contractor personnel were the key factors in the depot's successful efforts," Young says.

Depot involvement is credited with saving about $870,000 on the project, Lesniak says, including substantial savings generated by employees' suggestions and value engineering proposals.

The initial Microfix fielding occurred in Germany in late 1983. Depot personnel were involved in training and providing maintenance support. Lessons learned resulted in detailed recommendations by depot personnel requiring modifications of fielded systems and those in depot inventory.

More than 600 Microfix systems are now in the field and more than 1,000 may eventually be fielded, Young says. Depot support continues as additional technical modifications are identified and maintenance support is required.

Meanwhile, depot attention is shifting toward the ASAS program. The first test of ASAS components took place at Fort Bliss, TX, in March 1985. Microfix systems were used as work stations with the ASAS components and depot technicians with Microfix expertise participated in the test. "Our people impresses the ASAS program manager and gave the depot good visibility," Young says.

"Based on our experience with Microfix, we are ready to provide support for similar systems such as ASAS," Young explains.

As part of the Center of Technical Excellence assignment, depot personnel are already participating in integrated logistical support (ILS) planning meetings. This includes membership in the integrated systems support management team, logistic support analysis review and management team, the training support group, which identifies required training for depot technicians, and the ILS data call, which is the technical package specifying depot requirements to support a new system.

Eventually, a depot will be selected as the prime maintenance depot for ASAS. Tobyhanna's involvement as the Center of Technical Excellence has several benefits, Lesniak explains. If Tobyhanna is selected as the prime depot to support ASAS, it is better prepared for its role because of knowledge gained as the CTX. If Tobyhanna is not selected, the CTX role has served the Army by developing a cost-effective ILS package for the selected depot.

## Belvoir Reduces Generator Noise

The standard generator that powers the Army's Regency Communications Network has been modified by the Troop Support Command's Belvoir RDE Center to comply with local noise ordnances in populated areas.

In addition to a significant reduction in the noise level, electrical engineers at the center have increased the generator's output from 15 to 20 kilowatts and "hardened" it to resist nuclear attack.

"The requirement came from the project manager for the system because they needed a set that would comply with local noise ordnances" according to Dr. Larry I. Amstutz of the Power Generation Division of the center's Logistics Support Directorate. "We decided to do the work in-house because the time schedule was too short to send it out on contract."

Work on the project involved modifying a standard 15-kilowatt generator to convert it to 20 kilowatt. "That was easy," Ronald B. White, project engineer explained. "What was hard was to silence it within a reasonable weight and cost, and still fit it on the same trailer."

The modified set consists of the same basic parts as the original unit so that it can be easily supported in the field. "We put a silencer on the inlet air filter, installed a better muffler, isolated the vibration between the housing and the generator's working parts, and installed noise baffles in the generator's cooling inlet and exhaust," White said. "And we did all that while increasing the weight by less than 300 pounds. That's something we're really proud of."

Thanks to the modifications, the generator now registers less than 65 decibels at seven meters in any direction, about as loud as a normal conversation. Before the modifications, the set registered 80 to 85 decibels and was so loud its operator was required to wear hearing protection.

The center worked on this project with the Tobyhanna Army Depot. After building the initial prototypes, the center will turn over the technical drawings to the depot which will then modify the remaining sets, referred by Regency Communications Network.

***Generator which was modified to meet noise ordnances in populated areas is now about as loud as a normal conversation. Modifications were made by the Belvoir RDE Center to permit its use with the Army's Regency Communications Network.***

## Tobyhanna Installs Fiber-Optics Cables

Tobyhanna Army Depot personnel recently completed their first production of fiber-optics cables and connections, effectively demonstrating a high-tech capability under development at the depot for the last 18 months.

The work was part of a depot-supported upgrade of the Army's Corps Theater ADP Service Center. The upgrade adds a communications subsystem to the center's central processing unit van, providing new capabilities for the powerful, mobile data processing systems used by the Army in the United States and Germany.

The subsystem employs fiber-optics technology instead of the standard copper wire cables, says Jerry Tucky, an electrical engineer with the project. Fiber-optics technology transmits information by light pulses over minute glass fibers, rather than by electronic signal over copper wires. Such technology offers many advantages, including substantially greater capacity, lower weight and smaller size, and increased communications security.

"We eliminated hundreds of cables per system because of the fiber-optics," explains Paul Dougher, project coordinator at the depot.

"One fiber-optics cable can carry as much information as 900 copper wires," Tucky adds. "Fiber optics also is much more secure, it's virtually impossible to tap into it." Despite its glass composition, fiber-optic cables are also extremely rugged since they are protected by a wrapping of Kevlar, a tough synthetic material.

For this project, technicians in the depot's Shelter Facilities and TMDE-Optics Sections placed connectors on fiber-optics cables for use within the center's central processing unit vans and also for external communications purposes, according to Dougher.

Such work requires near-surgical skills, including the use of surgical scissors, microscopes and diamond-tipped cutters. A key step in the process is the methodical and repetitive polishing of cable ends to insure proper connections.

Following the fabrication work at the depot, teams of Tobyhanna personnel installed the communications subsystem, including protective equipment and fiber-optics modems and cables, into Corps Theater ADP Service Centers in Boston and Los Angeles. Cables have also been shipped to Germany for installation by a depot team.

Along with equipment installation and acceptance testing at the sites, Tobyhanna personnel train the center's soldiers in the use of the maintenance kit that accompanies the fiber-optics gear.

# Capsules . . .

## Army Awards Advanced Combat Rifle Contract

The U.S. Army Armament Research, Development and Engineering Center has awarded five competitive contracts for development of the successor to the M16 weapon system. The new system is referred to as the Advanced Combat Rifle.

The five Advanced Combat Rifle contract awards are initially restricted to a six month development effort. After that period, the competing contractors must demonstrate the unique features of their weapon systems to a visiting panel of government technical experts.

The government will then select the most successful candidates, based on previously established criteria, for continued development ultimately ending in a demonstration to the Army of the weapon systems effectiveness under simulated combat conditions.

Winning contractors are: AAI Corp., Cockeysville, MD; Ares Inc., Port Clinton, OH; Colt Industries, Hartford, CT; McDonnell Douglas Helicopter Co., Culver City, CA; and Steyr-Daimler-Puch, Steyr, Austria.

## Battery Tester Yields Big Dividends

A relatively small investment by the U.S. Army Laboratory Command (LABCOM) has paid the Army big dividends in cost avoidance, productivity and safety in the purchase, testing and use of lithium batteries.

An investment of $226,000, obtained through the Productivity Capital Investment Program, was used to acquire a state-of-the-art automated battery evaluation system. The system is now in use at the Battery Test Facility at the Electronics Technology and Devices Laboratory (ETDL), Fort Monmouth, NJ.

According to Richard S. McDaniel, chief of LABCOM's Management Review and Analysis Division, the system has yielded substantial dollar savings and increases in productivity while insuring the production of high quality, safe lithium batteries.

McDaniel points out that since the system went on line in January 1985, 19 of 197 lots of batteries submitted for testing have been rejected as faulty and not fielded. "Had those bad lots been purchased, losses would have amounted to about $1.37 million," he says. "In addition, the potential for costly contractual litigation, due to inadequate battery testing and delays, has been virtually eliminated."

In addition, the incidence of safety failure from the use of faulty batteries in the field has been reduced by about 10 percent through use of the new system, according to Gabe DiMasi, a general engineer in ETDL's Power Sources Division. "Safety has been increased because of better quality assurance. Now we are assured that we have a good product going into the field," DiMasi said.

Lithium batteries are used in a variety of military applications and systems he said. Currently, the Battery Test Facility is testing two percent of all Army lithium batteries, which are procured by the Communications-Electronics Command at Fort Monmouth.

According to DiMasi, the new battery evaluation system's main advantage over the old system is automation. The new equipment automatically programs Army specifications to measure and record battery performance in terms of time, voltage and temperature during various types of discharge and after storage. This eliminates the need for constant manual monitoring and adjusting.

"It's completely computer controlled and at the end of the testing, we get a readout of the results. There is no manual interference once the batteries are hooked-up for testing," he says. DiMasi adds that the new automated system can test 60 batteries at a time compared to only 12 batteries for the old manual system. The new system can test as many as 120 batteries per day if the demand calls for it.

Also, the system's automated features permit operation by lower-graded personnel. The old system was operated by a GS-12 and a GS-11 while the new system is run by a GS-9 and a GS-7, DiMasi says.

According to McDaniel, the cost in salaries and overtime to test 120 batteries per day with the old system would have been $770,264 per year as compared to a cost of $58,163 per year with the new system—a savings of $712,101 and 18 work years of effort as well as a productivity increase of about 900 percent.

## AMCCOM Achieves Cost Savings

The Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL, has successfully reduced the cost of a component part of the M485 projectile through competition.

The part had been procured by AMCCOM on a sole source basis, and was last procured in September 1983 at a unit price of $188. When a new requirement surfaced in early 1986, an effort was begun to compete this item in an unrestricted solicitation. When the award was ultimately made in May, the unit price was reduced 41 percent for a total cost avoidance of $1,511,172.

AMCCOM has also recorded another success in reducing the cost of a panoramic telescope for the Fire Support Team Vehicle and the Improved TOW Vehicle. The unit price on the last sole source contract was $5,180. To develop competition, AMCCOM tried to obtain the technical data package from the prime contractor. When this failed, the command decided to compete the requirement between the prime contractor, its current supplier, and its previous supplier. As a result of this breakout action, the current supplier was the low bidder and was awarded the contract at a price of $3,350, a 35 percent reduction on each unit.

Total cost avoidance for FY86 is $442,860. Sufficient requirements exist to exercise the contract's 200 percent option which would mean an additional future cost avoidance of $885,720.

## Avionics Equipment Contract Awarded

Bell Helicopter Textron will ground and flight test military avionics equipment in an Advanced Composite Airframe (ACAP) Program flight test vehicle under a 22-month contract. The U.S. Army Aviation Systems Command's Aviation Applied Technology Directorate (AATD) awarded the contract.

The objective of this $1,553,087 program is to assess the electromagnetic capability and interference of the avionics package operating in an all-composite airframe helicopter as compared to a conventional (metal) helicopter.

"By determining and assessing any electronic degradation in the ACAP, methods can be developed to remedy anticipated problems in future lightweight Army production helicopters," explains Jon Schuck, AATD project engineer.

## VE Proposal May Save $2 Million

A value engineering proposal submitted as part of a product improvement package for the Army's "A" DeLong pier barges will save the service nearly $2 million. The proposal, which was the idea of Robert M. Smith, an engineer in the Logistics Support Directorate at the Belvoir RDE Center, calls for eliminating the wood planking that forms the support structure for the pier and replacing it with less expensive deck coating systems.

"A" DeLong pier barges are used for loading and unloading containerized cargo along coastlines and inland waterways. The steel barges are being modernized and strengthened to support 250-ton cranes and rough terrain cargo handlers. A typical deck covering for the pier consists of wood planking secured to the steel deck. Center engineers estimated the cost of replacing a single deck at more than $500,000.

Smith determined that the main function of the deck was to provide traction, and that wood, although recommended, was far more expensive than other commercially available covering systems. A survey conducted last February showed that there were at least 19 commercial systems that had the potential to replace the wooden decking. These included non-skid epoxy coatings applied with a roller to raise a rough surface, epoxy coatings with silica grit applied for traction and asphalt combined with grid steel.

The center decided to test the systems on a prototype pier barge currently being modernized. Under test conditions, the coatings have already withstood traffic that would have required replacement of a wooden deck.

Results so far have shown that these lightweight coating systems provide good traction, are easier to repair and can be installed at a cost of only $60,000 to $70,000, far less than a wooden deck.

# Awards . . .

## Picatinny Engineers Save Army $10 Million

Three Army civilians, all employees at Picatinny Aesenal, recently received Presidential Awards plus a $35,000 group Special Act Award recognizing them for a cost-avoidance measure that already has saved the Army nearly $10 million.

Michael E. Grum and Carl E. Boone of the U.S. Army Armament Research, Development and Engineering Center (ARDEC), and Paul C. Ng, with the U.S. Army Production Base Modernization Activity, both in Dover, recommended that the government abandon its plans to provide sole-source contracting to a private company.

Under such an agreement, the government would have had to invest some $9.9 million to purchase equipment necessary to manufacture the 2.75-inch MK66 rocket motor fin and nozzle assembly used in air-to-air missiles fired from combat helicopters and other aircraft. In return, the private company agrees to work solely for the government and only on the project under contract.

From their research, the three engineers showed that the necessary resources for manufacturing the 2.75-inch rounds already existed within private industry and that the government did not have to purchase specialized equipment for the projects. The government, therefore, decided against sole-sourcing.

Equipment for manufacturing some weapon parts is so specialized that it is not readily available in the private sector. Officials also found that through competitive bidding among industries in the private sector the Army could purchase the rounds for about $32 each. Under the sole-source contract, the same rounds would have cost about $88 each, a difference of $56.

The presidential citation, presented at the Pentagon by Secretary of the Army John O. Marsh Jr., read in part: "My pledge to the American people at the beginning of this administration was to make government work efficiently and economically. By applying your considerable talents and abilities to this task, you have demonstrated that Federal employees can make the critical difference in how well and how economically government meets the defense needs of our country."

Grum, a mechanical engineer in ARDEC's Close Combat Armaments Center, has served more than 18 years with the federal government. Prior to transferring to Picatinny Arsenal in 1977, he worked at Johnsville Naval Air Development Center and Frankford Arsenal, both in the Philadelphia area.

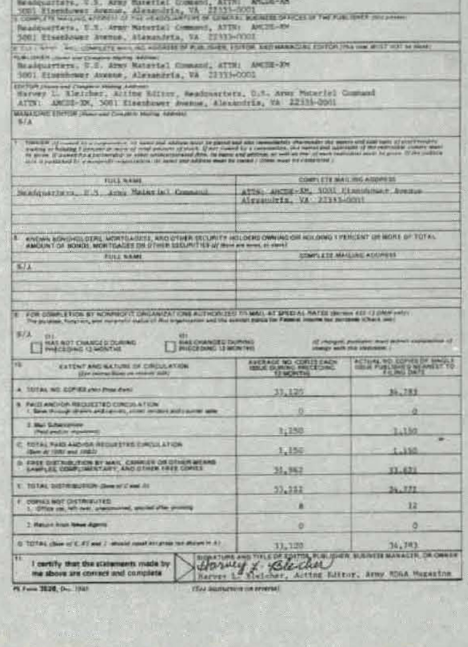
Boone, also a mechanical engineer in ARDEC's Close Combat Armaments Center, began his federal career in 1981 after working for 10 years with his family's tool and die business. Currently a project engineer, he is responsible for facility modernization projects relative to artillery metal parts manufacturing.

Ng, a general engineer has worked for the federal government since 1977. He serves as a central coordinator for product assurance and safety for production base modernization projects.

# Conferences & Symposia . . .

## Upcoming Conferences

- The U.S. Southern Command and the U.S. Army Materiel Command (AMC) are jointly sponsoring a symposium on Low Intensity Conflict in cooperation with the American Defense Preparedness Association. The symposium will be conducted March 4-5, 1987 at the Naval Training Center in Orlando, FL. For additional information, call AMC's Project Office for Low Intensity Conflict at the Belvoir Research, Development and Engineering Center on AV 354-6873 or commercial (703)664-6873.
- The Fifth Annual National Conference on Ada Technology will be held in conjunction with the Fourth Washington Ada Symposium on March 16-19, 1987 at the Marriott Crystal Gateway in Arlington, VA. The conference and symposium, hosted by Howard University, are sponsored jointly by the U.S. Army Communications-Electronics Command (CECOM), the U.S. Army Information Systems Engineering Command, and NASA Goddard Space Flight Center in cooperation with the DC Chapter ACM and SIGAda. For more information, contact Albert Rodriguez at CECOM on commercial (201)532-5846.



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