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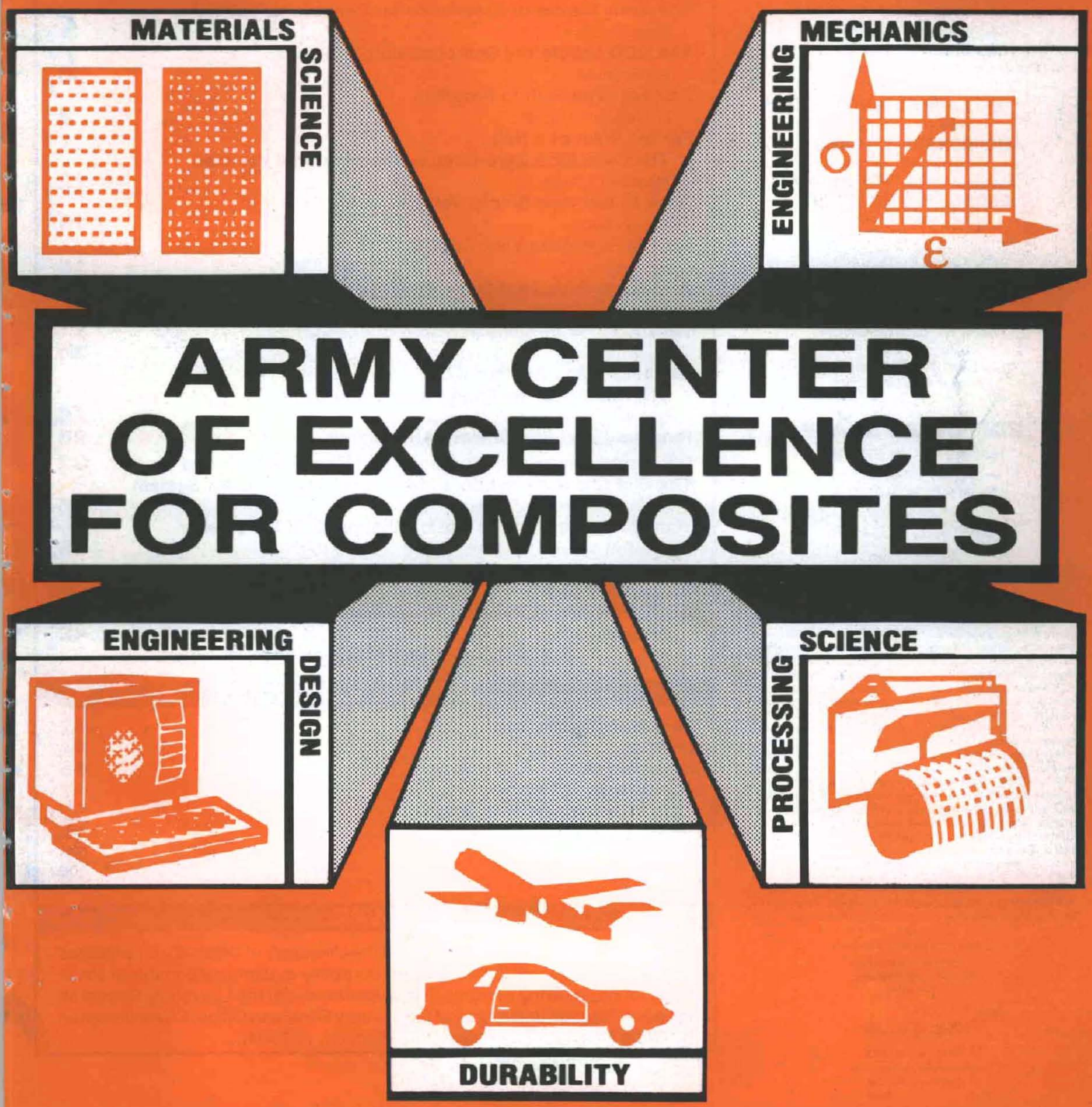
JULY - AUGUST 1992



ARMY CENTER OF EXCELLENCE FOR COMPOSITES

JULY-AUGUST 1992
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ARMY RD&A BULLETIN

Research Development Acquisition

Professional Bulletin of the RD&A Community

FEATURES

★ ★ **See Important Notice on Page 56** ★ ★

DEPARTMENTS

COVER

The Center for Composite Materials at the University of Delaware emphasizes quality, longevity, performance, and durability of composite material structures for future Army systems. It is associated with the University Research Initiative Program implemented by the Army Research Office. Cover designed by Chris Deavers, DOIM Graphics Section, HQ AMC.

THE ARMY CENTER OF EXCELLENCE FOR COMPOSITE MATERIALS

By Diane S. Kukich

Background

The Army has placed great emphasis on the criticality of reducing the cost of manufacturing in addition to designing and producing more reliable and durable systems. These concepts became part of the mission of the University Research Initiative (URI) program, implemented by the Army Research Office (ARO) in 1986. The Center for Composite Materials (CCM) at the University of Delaware, one of only a handful of academic institutions having developed a research program in the manufacturing science of composites at that time, was awarded a five-year grant to establish a Center of Excellence for Manufacturing Science, Reliability, and Maintainability Technology. CCM also brought to the ARO/URI program a well-established relationship with industry based on similar goals.

The program was set up with a strong emphasis on the quality, longevity, performance, and durability of composite material structures for future Army systems. In 1992, CCM was selected to receive a second five-year grant for a multidisciplinary program in the manufacturing science of polymeric composites, setting the stage for extending the fundamental work on process models to intelligent processing and manufacturing designed-in quality as cost effectively as possible.

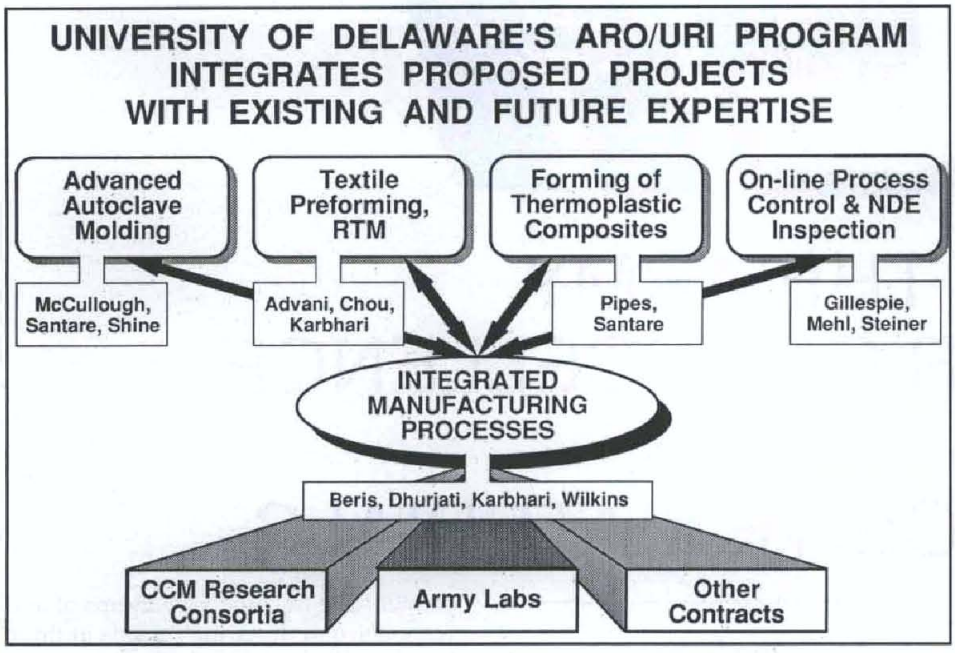
The Army's interest in composites remains high, due both to recent international political changes and to the inherent advantages of composite materials. A streamlined Army based largely in the United States will require easily mobilized troops and equipment to respond quickly to situations throughout the world. Composites can provide solutions to the need for lightweight, portable systems that can withstand a variety of environmental conditions. The new five-year ARO/URI program will ultimately help the Army to meet its materiel needs through a multi-faceted manufacturing science program.

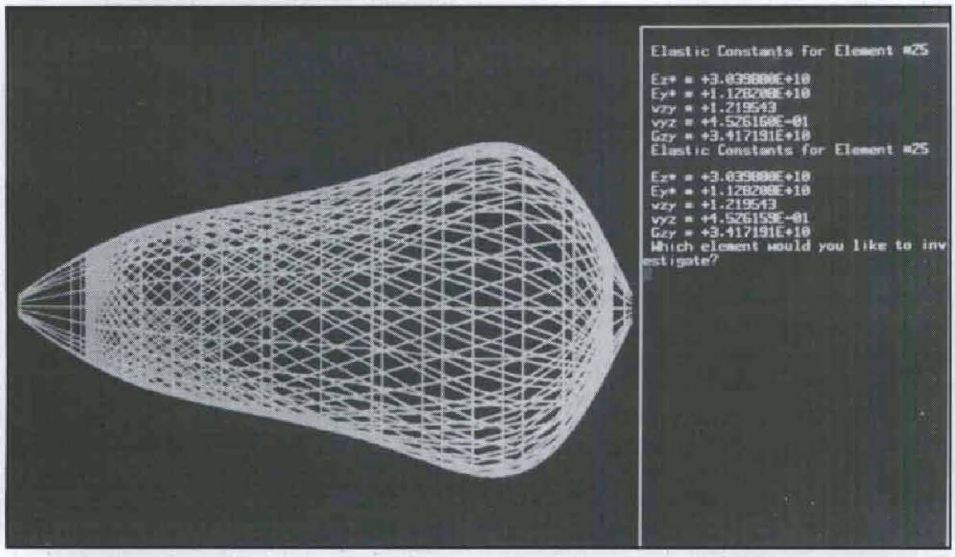
CCM's involvement with the Army goes beyond the ARO/URI program, however. The center is playing an important role in educating Army personnel and transferring the findings of its research programs not only to the ARO and individual laboratories but also to companies serving as Army subcontractors. Overall, center faculty and personnel have become very aware of and responsive to the Army's needs in three broad areas: research, education, and technology transfer.

Research

The center's research program is based on the integration of science and engineering disciplines through a focus on thrust areas that couple processing to performance through the development of process-induced microstructures. With the processing-performance-microstructure relationship as an underlying theme, the research leads to the development of products based on a fundamental understanding of the materials themselves. Composites can be tailored to specific applications by manipulating the microstructure through processing.

Fundamental work in processing science, materials science, engineering mechanics, durability, and design provides a base for the center's manufacturing science research. A variety of manufacturing areas are being investigated—nondestructive evaluation, online consolidation (including rapid fiber placement and pultrusion), sheet forming, liquid molding, and joining—which increases the program's potential pay-





Courtesy: Karl V. Steiner, Center for Composite Materials, University of Delaware

Interactive computer graphics software allows for microstructural analysis of filament-wound parts.

off to the Army. The following are brief descriptions of several center programs carried out with ARO/URI support during the past five years.

Cure Monitoring

One of the critical areas identified by the Army in 1986 was the determination of optimal cure cycles for polymer-composite resins and prepregs in thick sections, forecast to form the basis of future aircraft, missile, and bridging structures. Thick sections present special processing difficulties, including temporal and spatial gradients in temperature and extent of cure; nonisothermal cooling can lead to the development of internal stress and deformation, which ultimately lead to part failure. The center's initial research program successfully addressed those issues and developed models and software programs that are currently being applied both by DOD labs and by subcontractors in solving some of the Army's technological problems.

Specifically, the center's work in this area resulted in construction of a cure-simulation model that relates processing parameters to temporal and spatial gradients in temperature and extent of cure; development of coupled chemical and mechanical models to quantify the relationships between processing conditions and the development of a numerical simulation to calculate residual stress development during the nonuniform cooling of amorphous thermoplastic composites.

Design

In an effort to provide a discipline for design, center researchers developed Total Quality Design (TQD)—a design methodology that implements the principles of Total Quality Management to produce better products and processes. Through TQD, researchers can identify customer wants as well as quantifiable quality metrics that can be used to measure those wants. Concepts can then be developed and evaluated for use in providing the desired quality metrics. TQD also emphasizes the need for concurrent engineering in composites and provides the basis for a composites-specific design methodology incorporating the interactions among materials, configurations, and processes.

Although not directly supported by ARO/URI funds, a project on the design

of composite structures for low-velocity impact resistance grew out of the initial TQD work. In applying TQD to the project, MAJ Timothy C. Lindsay, assigned to the Army Materials Technology Laboratory (MTL) and a master's degree candidate in the Materials Science Program, focused on developing a design methodology for impact-resistant structures, in contrast to such traditional approaches as analyzing impact or attempting to increase impact resistance through material modification (for example, stitching or interleafing). The work was immediately used at MTL. In addition, the methodology was adopted by the U.S. Army Missile Command (MICOM) as part of its productivity enhancement program.

Interphase

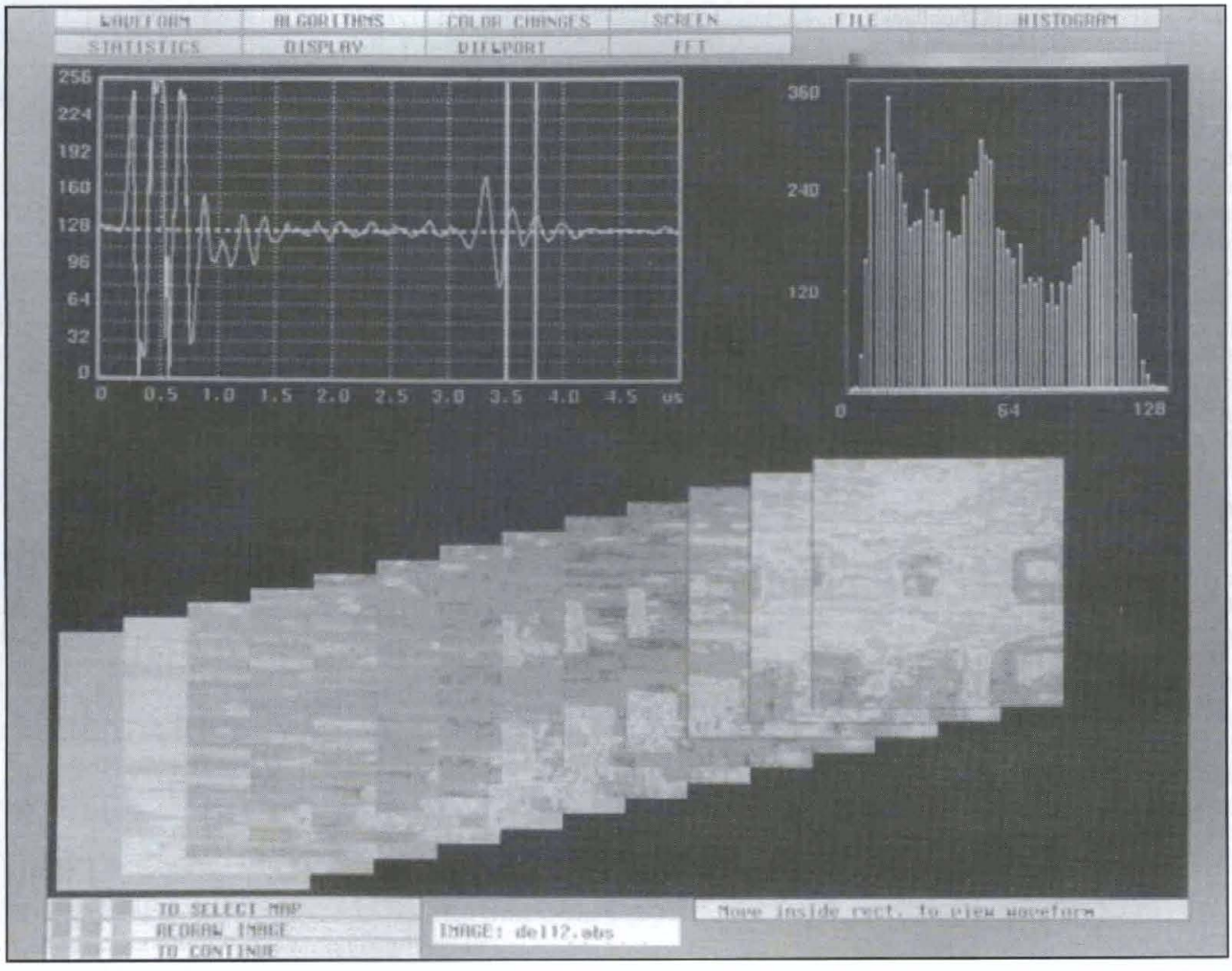
It is now well-recognized that the interface in composites is actually an interphase—a region that behaves in a way different from either the matrix or the fibers. Understanding of the interphase is critical to process optimization and ultimately to the development of application-specific materials and smart structures through tailoring of this region. Under the ARO/URI program, center researchers demonstrated that property gradients of the matrix exist in the vicinity of the fiber; developed models to relate property gradients to local states of residual stress; and determined the role of molecular mobility in the consolidation and bonding of thermoplastic composite materials.

Filament Winding

Filament winding enables on-line consolidation of complex-geometry shapes. In this area, researchers at CCM developed and experimentally verified analytical models for filament-wound shapes and then developed a computer-aided design methodology and structural mandrel optimization for filament-wound parts. Parallel efforts funded by industry in cooperation with the ARO/URI program supported development of an experimental facility for on-line consolidation of thermoplastic composites. In addition, a thermoplastic filament-winding head was designed and constructed to allow production of prototype complex-geometry shapes.

Textile Preforming/Resin Transfer Molding

Multi-directional textile composites offer a number of advantages over traditional laminates—fracture toughness, impact resistance, local tailoring of the architecture to achieve application-specific properties, near-net-shape manufacturing, cost savings, multifunctionality, and elimination of delamination, as the structure is three-dimensional rather than stacked. Center researchers are investigating woven, knitted, and braid-



Courtesy: Karl V. Steiner, Center for Composite Materials, University of Delaware

Full waveform analysis package processes 10 layers of pulse-echo data obtained from a 48-ply graphite epoxy specimen.

ed textile preforms for resin transfer molding (RTM), an increasingly popular alternative to autoclave curing.

Early work in this area focused on determining the effects of fabric architecture and material properties on the fracture resistance of thick-section textile composites, which yielded information about the effect of reinforcement geometry on the strength of composites.

More recently, the ARO/URI program supported a project resulting in design and construction of an automated track-and-column braider. Other researchers have investigated textile preform joining techniques for use in the RTM process; fabricated a variety of textile-reinforced RTM structural parts; and analyzed microstructure-property relationships for 3-D woven composites.

Induction Welding

Induction heating, one of several fusion bonding methods being investigated at the center, offers a number of advantages over adhesive and mechanical joints, including low part count and ease of manufacture. The heating mechanisms for this joining technology were poorly understood before the completion of pioneering research by Army CPT Bruce K. Fink, who completed a doctoral degree in the Materials Science Program. Focusing on induction welding of carbon-fiber-reinforced thermoplastics, the work demonstrated that the dominant mechanism of heat generation is due to dielectric heating of the matrix. The Army's interest in this technique lies in its potential for field repair of composites systems.

Technology Transfer

The University of Delaware is playing a major role in transitioning technology through the various steps of the Army's research and development process. This is being achieved through a program of "real-life" technology transfer based on close interactions between researchers at Delaware and those in the defense R&D community.

Center researchers view manufacturing science as the pacing technology for the application of composites to Army products. In fact, the development of the center's manufacturing science research agenda grew out of a similar realization with regard to industry in the mid-1970s, when CCM developed its University-Industry Research Consortium, *Applications of Composite Materials to Industrial Products.*

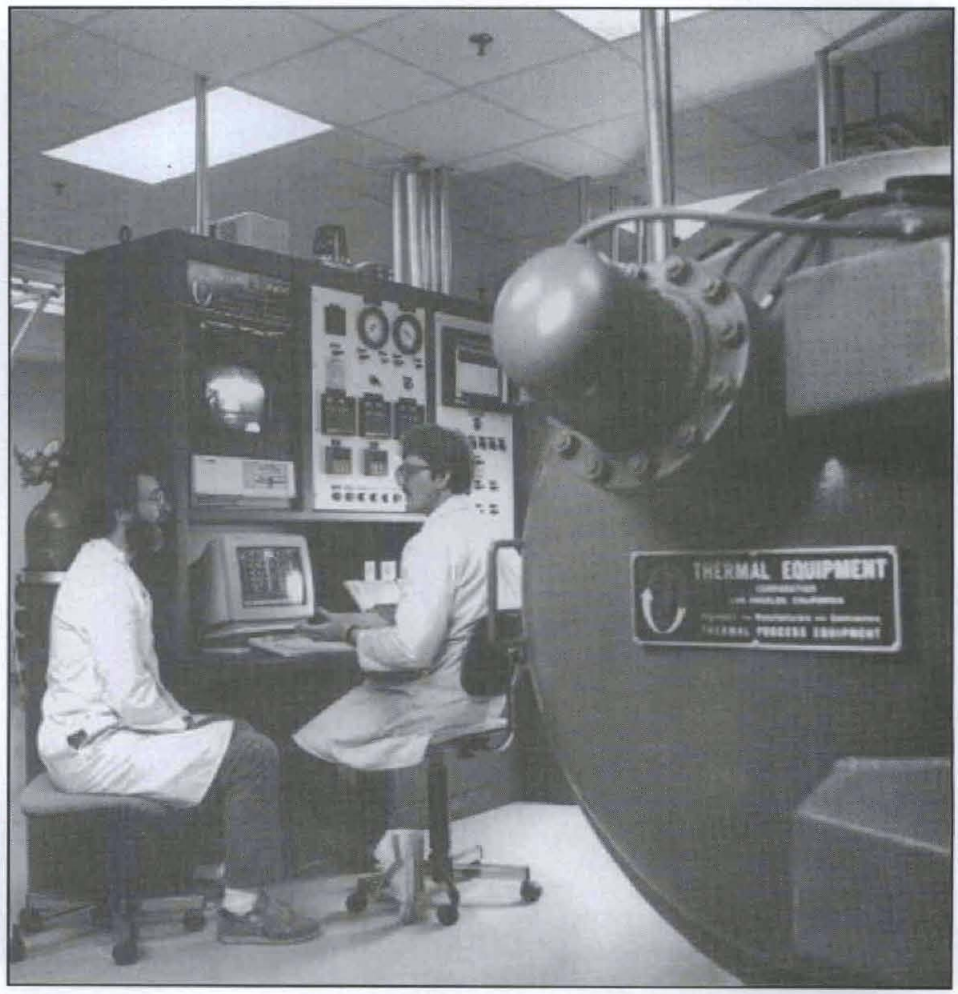
Part of the center's success in technology transfer to the Army can be attributed to this longstanding relationship with industry. With sponsors from both materials suppliers and end users in the automotive, aerospace, and consumer products industries, the center is in an ideal position to integrate the Army's needs with those of prime and sub-contractors from the private sector.

Because the effort to develop composites manufacturing science is of equal interest to the ARO and the center's automotive and aerospace sponsors, time and dollars have been leveraged as student and faculty researchers in both programs work toward many of the same goals. The center is poised to leverage industrial efforts to ensure that composites provide cost effective solutions to Army needs.

During the past several years, the center has begun to develop extensive interactions with Army laboratories and centers, including the Army Tank-Automotive Command (TACOM), MTL, MICOM, the Belvoir RD&E Center (BRDEC), and the Ballistic Research Laboratory (BRL). A program has been developed with TACOM to investigate the use of composites for improved survivability under impact threat. Center researchers have also been involved with the Defense Advanced Research Projects Agency (DARPA)-funded organizations working towards the use of composites for naval and ground applications, including those related to hulls and other vehicular structures.

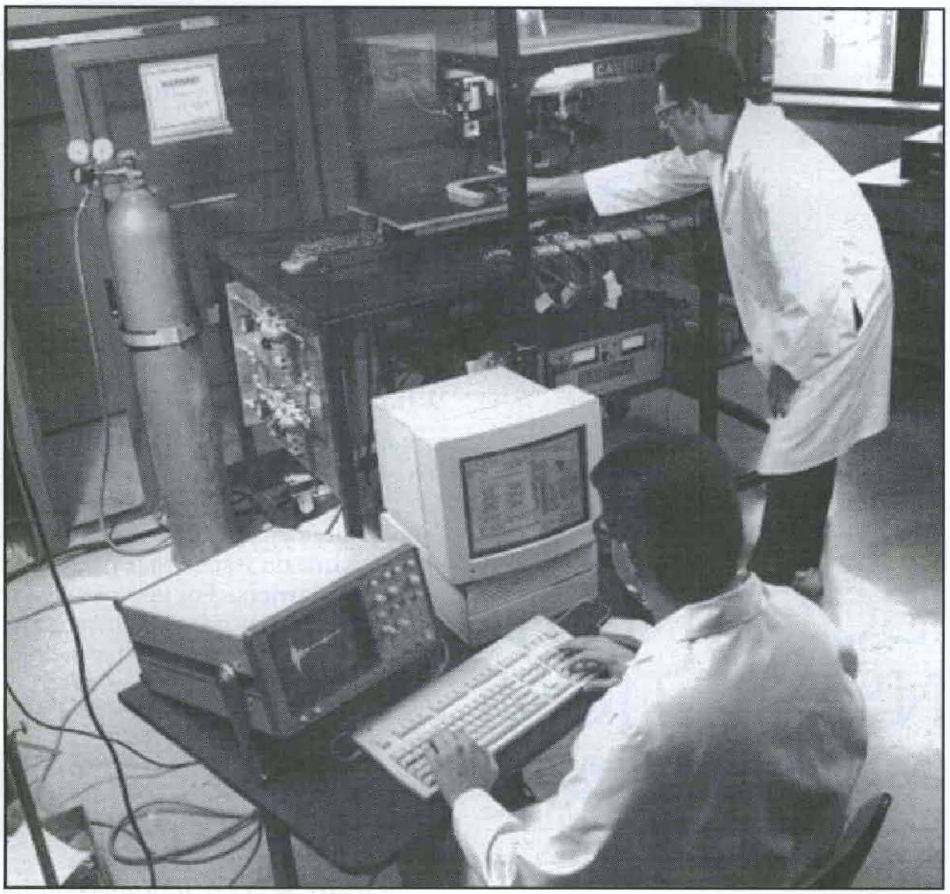
Education

An important objective of the ARO/URI grant to the university was to educate students in composites-related



Courtesy: Robert W. Snyder III, Center for Composite Materials, University of Delaware

A research autoclave acquired in 1991 extends the center's processing capabilities up to 1000 F and 500 psi. A video camera and monitor enable in-process monitoring through a quartz lens.



Courtesy: Robert W. Snyder III, Center for Composite Materials, University of Delaware

Acoustic emission techniques are applied to monitor the performance of the center's in-house-developed au tomated resistance welder. The welder enables sequential welding of large parts with reduced power requirements.

fields. During the five-year period, 15 graduate students were directly involved in the program as Army Fellows. All who have completed their degrees are now working in industry, as faculty members at other academic institutions, and at Army labs. Other students not directly supported by the ARO/URI have become civilian employees of the Army as well.

Delaware's continuing education programs have also proven highly valuable to the Army. Some 120 Army representatives attended the center's annual composites workshops and research symposia during the past five years, with additional interactions occurring on an informal basis throughout the year at both the center and Army labs. In addition, Army employees were offered access to the *Delaware Composites Design Encyclopedia,* an interactive videodisc course *(Experimental Mechanics of Composite Materials),* a professional development videotape series *(Introduction to Composites),* and the Center's many seminars, research reviews and poster sessions.

Future Directions

Based on the findings of the initial ARO/URI program and related research funded by industry, the new ARO/URI research program is aimed at improving the reliability and extending the useful life of structural components through optimization and control of potentially lower-cost manufacturing processes. The work will be coordinated through five major thrust areas: advanced autoclave molding, textile preforming/resin transfer molding, sheet and stretch forming of thermoplastic composites, on-line process control and non-destructive evaluation (NDE) inspection, and intelligent control of integrated control of integrated manufacturing processes.

The program's systematic and integrated approach, leveraged through collaborative efforts with industry, Army laboratories, the State of Delaware, and University of Delaware matching funds, will provide new insights for process automation and NDE field inspection. The overall effort will establish the foundation for integrated manufacturing systems within the concept of a unified-life-cycle approach to manufacturing.

DIANE S. KUKICH is an editor at the Center for Composite Materials at the University of Delaware. She prepared this article with input from the following faculty and staff researchers: Roy L. McCullough, CCM director, professor of chemical engineering, ARO/URI co-principal investigator; Tsu-Wei Chou, the Jerzy L. Nowinski professor of mechanical engineering, ARO/URI co-principal investigator; John W. Gillespie Jr., CCM associate director, research associate professor of mechanical engineering, ARO/URI co-investigator; Karen V. Steiner, CCM assistant director and associate scientist, ARO/URI co-investigator; and Vistasp M. Karbhari, CCM associate scientist, research assistant professor of civil engineering, ARO/URI co-investigator.

IMPORTANT NOTICE

The ***Army RD&A Bulletin*** office has relocated to Fort Belvoir, VA. All correspondence should now be addressed to: **Army RD&A Bulletin, Building 201, Stop 889, Fort Belvoir, VA 22060-5889.** Our new phone numbers, which were unavailable at press time, will be published in the September-October issue.

THE DOD LABORATORY DEMONSTRATION PROGRAM

By Robert Worral

Introduction

Army research scientists and engineers frequently express frustration and anger with the "bureaucratic" system. They feel their creative abilities are restricted by unresponsive controls that treat research like every other operation. These beliefs have been corroborated by more than 50 studies of in-house DOD research operations. The recommendations of these studies have had one common theme...Give the laboratory director the authority commensurate with the unique responsibility to create an atmosphere conducive to creativity!

What is being done to improve the situation for in-house laboratories? There is a lot being done. One of the most successful programs is the Department of Defense Laboratory Demonstration Program. This is a coordinated effort by Congress, the Office of the Secretary of Defense, all three Services and the Defense Nuclear Agency. The intent is to test ideas to improve the efficiency and effectiveness of in-house research institutes.

Background

On Nov. 20, 1989, Deputy Secretary of Defense Donald J. Atwood Jr. directed the Services to designate at least one demonstration laboratory and delegated substantive authorities to implement changes in personnel management, facilities refurbishment, management authority of the technical directors, and research-related contracting.

All three Services immediately saw the Lab Demo Program as a way to improve their in-house research environment. The Army took the opportunity very seriously and specifically named the following as demonstration sites: all the Army Laboratory Command labs, all the Medical Research and Development Command laboratories, the Corps of Engineers Waterways Experiment Station and the Missile Research, Development and Engineering Center.

Objectives of the program are being concurrently approached along three parallel lines. First, the Services and the Office of the Secretary of Defense (OSD) work together to eliminate any internally imposed constraints. Second, Department of Defense representatives work with other agencies, such as the Office of Personnel Management (OPM) and the Office of Management and Budget (OMB) to reshape overly restrictive directives. Finally, legislative proposals are being put before Congress to remedy impediments that are specifically embedded in law.

What Has Happened?

Significant progress has occurred in achieving increased efficiency and productivity at the demonstration labs. Each laboratory has used the opportunity to work on issues that presented significant barriers. For instance, many of the laboratories opted to bypass the service supply system. This has helped reduce the delivery time of small purchases from an average high of 120 days to less than 14 days.

What This Means for Army Research

There are several actions running simultaneously which, individually and collectively, will markedly improve the creative atmosphere of research operations. These include streamlining of contracting procedures, improving personnel systems, modernizing facilities, establishing a laboratory directed research fund, and extending the program to all Army research institutions. Below is a brief analysis of some of the changes laboratories should see soon.

Research-Related Contracting

This has been the most exciting and successful aspect of the program and offers the most promise for the immediate future. There have been several initiatives such as delegating the authority for approval of acquisition plans and bypassing the standard service supply system. These have cut the processing time at least in half. Current initiatives for increasing the "small purchase" limits and the implementation of a simplified contracting procedure offer even more opportunity for significant improvement.

The legislative package now before the Senate contains a provision to raise the limit for use of small purchase procedures from $25,000 to $100,000.

Thus, the acquisition of items from $25,000 to $100,000 could be accomplished by using much more expeditious small purchase procedures. Based on a survey of demonstration laboratories, small purchase procedures at most sites take less than two weeks!

The simplified contract procedure is now before the Defense Acquisition Regulatory (DAR) Council. When approved, it is expected to reduce the contracting administrative lead time by half.

Personnel Management

Many of the original Laboratory Demonstration Program personnel goals have been included in the Federal Employees Pay Comparability Act (FEPCA). This act assists the laboratory director in recruiting and retaining the highest quality scientists and engineers by permitting bonuses of up to 25 percent of an employee's annual salary.

The current Laboratory Demonstration goals include an automated classification system, delegation of authority for Scientific/Technical (ST) authorizations (see *Army RD&A Bulletin,* March-April 1992 pages 5-7) and additional direct hire authority.

Automated classification systems are being tested at several sites. When these systems are completed and fielded, the research supervisor will be able to type in the major functions of a position on his/her personal computer and get an immediate reading on the grade and series. This ability, with delegated classification authority, will reduce the time for getting a position classified. Additionally, the system automatically generates a position description, recruitment crediting plan and performance standards for the position.

The OSD Assistant Secretary (Force Management & Personnel) Christopher Jehn and Deputy Assistant Secretary of Defense for Civilian Personnel Policy/Equal Opportunity Sara Ratcliff are assiduously working with the Office of Personnel Management (OPM). One of their goals is to increase even further the number of scientific and technical authorizations to DOD.

The demonstration laboratory directors have been delegated limited direct hire authority to obtain GS-12 PhDs. In addition, the Office of Personnel Management has notified DOD that the demonstration laboratories can have any delegated examining authority they request. This will significantly speed up the process for extending offers of employment.

Facilities Refurbishment

There is a legislative proposal now before Congress that will give the Services and the demonstration laboratory directors more authority to improve research facilities. One of these provisions, if passed, will allow the laboratory director to use up to $1,000,000 of operating funds on any construction project. The new OSD Deputy Director of Defense Research and Engineering (S&T) Dr. Dominic Monetta is working with Congress to seek passage of this and other legislative initiatives during the current session.

Management Authority

There are two major initiatives in this area. The first is to have the major support offices, such as procurement, personnel, and supply, report to the technical director. The second is to establish a "laboratory directed research and development" fund of at least five percent of the total project funds.

Many of the demonstration laboratories have used the OSD directive as leverage to secure expeditious services from the major support offices, i.e. contracting, legal, personnel, and facilities engineers. The level of authority varies from site to site. The Missile Research, Development and Engineering Center has a very comprehensive effort. Contracting personnel are under the direct control of the technical director. The legal office and the facilities office have dedicated cells that are collocated with the laboratory. The civilian personnel office has a dedicated cell that has remained at the central personnel office. These dedicated operations have had a significant effect on the service and morale of all involved.

Scientists and engineers have found that working with the same contracting officers and lawyers has increased communication and understanding. In addition, support people are really enjoying the use of the increased laboratory demonstration authorities, and are getting to do what they joined their profession to do, support their customers!

Establishing a "laboratory directed research and development" fund has had some legal and administrative problems but progress is being made toward their resolution. This will allow the technical director to allocate funds to exploit critical technological breakthroughs without having to wait for the normal budgeting cycle.

Extension of The Program

The congressionally mandated Federal Advisory Commission on Consolidation and Conversion of Defense Research and Development Laboratories was impressed by the program and recommended in their September 1991 report: *The Secretary of Defense should direct the Services to implement all the provisions of the Laboratory Demonstration Program without delay, extend the program to all DoD laboratories, and seek legislative action required to complete the Laboratory Demonstration Program initiatives, including the personnel-related actions.*

Deputy Assistant Secretary of the Army for Research and Technology George T. Singley III is actively pressing for the extension of the program to all Army research institutions. The new organizations should have the additional authorities by the end of the current FY.

Summary

The Laboratory Demonstration Program has been in the implementation process now for two years at selected DOD in-house research institutions. There have been some areas of significant improvement, for example, reductions in procurement administrative lead time, development of a viable dual ladder career program for technical personnel and increased technical director authority. There are still significant improvements ahead. The DOD in-house laboratories will become an ever improving milieu for creative, exciting research!

ROBERT WORRAL is a doctoral candidate from Nova University, Fort Lauderdale, FL. He works for the U.S. Army Harry Diamond Laboratories as a special assistant for laboratory demonstration.

PROCESS: THE PATH TO PROGRESS

By LTC Kenneth H. Rose

Process makes the world go 'round. It is not a result. It is something far more important—it is the only means by which any result is achieved. Products and services, contrary to no small popular belief, do not spring from rules and regulations applied with great discipline and order, but from processes and their effectiveness with which they are carried out relative to each other.

Process is easily misunderstood. To see why, consider the diagram at Figure 1. This is a universal process model. It is similar to the traditional system model of input-process-output. But, only similar, not the same. A system view tends to be structure oriented, with the many parts seen as building blocks. A process view is action oriented, focusing on what gets done. The classic misstep is to view a process in traditional, familiar system terms and never get to the heart of what is really going on.

In the process model, the central block is the important one. The other two are only there for clarity. But, they can not be dismissed either, for the only reason that a process exists is to effect a transformation of something received from a supplier into something useful to and valued by a customer.

Why is this important? Because quality is determined by process, not results. This is not the view of conventional wisdom. This is not the view of traditional measurement or review and analysis. Management history is founded on results and reaction to results, not process measurement and evaluation.

An Army rifle range provides a good example of how to do things right. A drill sergeant takes a soldier to the range to qualify with the M-16 rifle. The soldier's first shot is high and to the right. A results-oriented response would be to make a sight correction to move the bullet strike down and to the left, but no drill sergeant would take such action. They all know that good marksmanship is a product of good equipment, good training—and, yes, process control.

Instead, the drill sergeant will have the soldier fire several shots. If they are widely scattered, the shooting process is not under control. He will examine the basic elements of the soldier's technique—the process elements—and take corrective action until the shots form a tight cluster of target hits. The target hits will always show some degree of variation. But, eventually that variation will be reduced to a level where it is not significant. Only then will he allow an adjustment to the sights on the rifle.

This is a common experience and one familiar to most soldiers. How can it be viewed in terms of the universal process model?

- Supplies: Rifle, bullets, soldier.
- Process: Soldier loads rifle and holds it.
- Customer: Soldier receives a "stable platform" (level rifle, good body position, good balance). This is supplied to the next process.

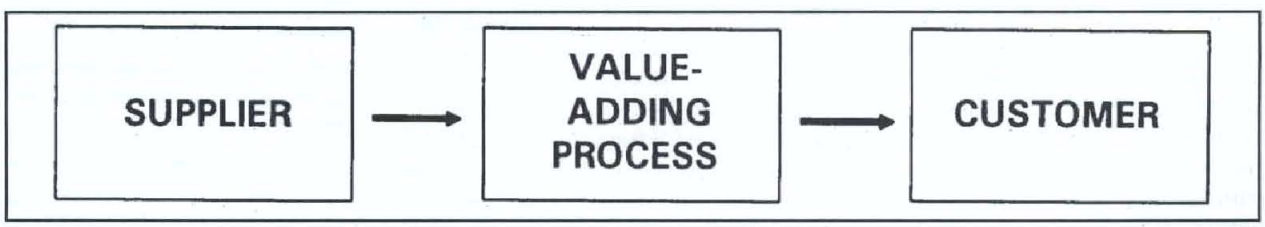


Figure 1.
The Universial Process Model.

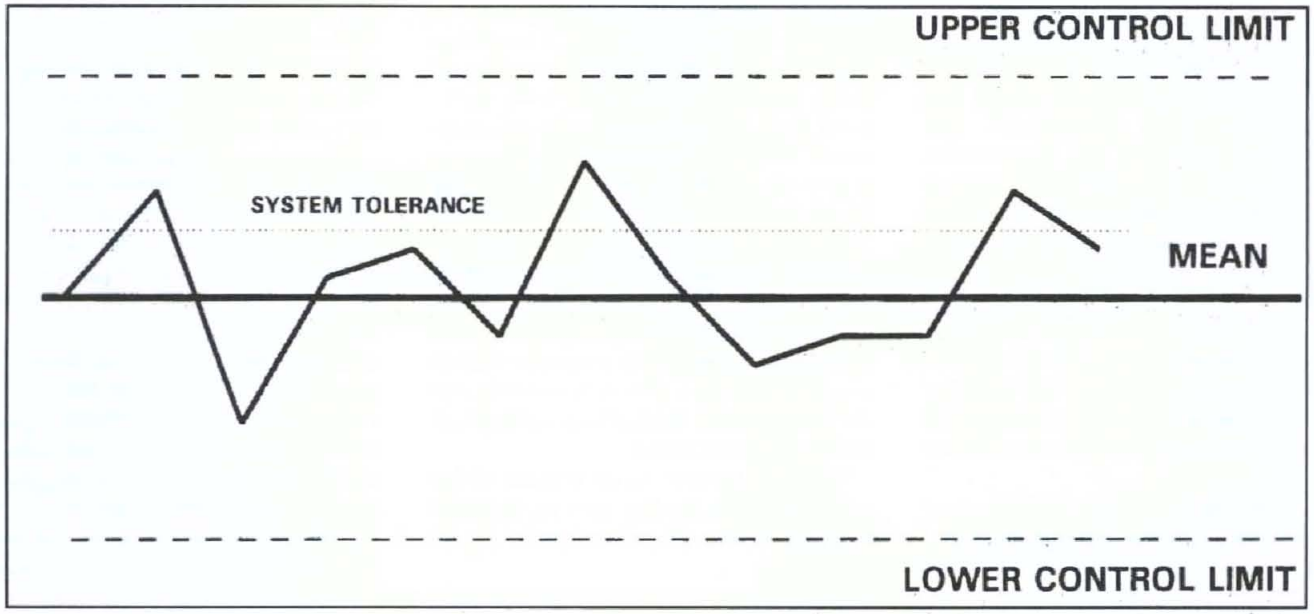


Figure 2.
Control Chart.

• Process: Soldier aligns front and rear sights.

• Customer: Soldier receives a "calibrated" rifle—one that will put the bullet where it is aimed. This is supplied to the next process.

• Process: Soldier aligns the target with the rifle sights.

• Customer: Soldier receives an executable condition. This is supplied to the next process.

• Process: Soldier squeezes the trigger.

• Customer: Target receives a bullet strike.

This may seem unnecessarily complex, and maybe even downright silly, but the point is that quality improvement on the rifle range lies not in whacking the soldier on the helmet with a pointer and shouting, "Shoot straight, soldier," or in changing the rifle sights after every shot, but rather in measurement, evaluation and control of the shooting process. It is so familiar to us that we do it without even thinking about it.

The difficulty is that, off the rifle range, we face things that are not so familiar—things that we do have to think about. The role of Total Quality Management is to provide illumination in such cases and to provide tools that will aid improvement actions without resort to results-oriented responses that often have little beneficial effect or even make things worse.

The following is based on fact, but augmented with enough fiction to make it a complete and illustrative example.

First, a little background information as a foundation. This is a matter of contracts and payments. When the government purchases goods or services through contract, it agrees to pay for those goods or services within a reasonable time after delivery—let's say 30 days for the purpose of this discussion. If payment is not made within that time, the government is obligated to pay interest on the outstanding debt as if it were a loan. This penalty for late payment is not a programmed expense and should be unnecessary, except in extreme and unusual cases. It is wasted resources.

Recently, an Army installation was experiencing rather large interest penalty payments each month. This became a matter of particular concern to the installation commander and finance officer. The chosen solution was rather traditional. Every two weeks, at the installation commanders and staff meeting, the finance officer distributed a list of interest payments, grouped by the commands and staff offices that received the goods or services. The commander then admonished the commanders and staff to "do better." Nobody wanted to waste public funds on unnecessary interest payments, but nobody was too sure about what the real problem was. To make matters worse, the data was always 30 days old, so recent improvements made by the commanders and staff went unrecognized as the new criticism was heaped upon them.

Off-line, the finance officer provided commanders with another list—this one showing all contract actions that appeared to be either over or approaching the 30-day limit. He suggested that commanders were at fault for not providing a "receiving report"—the official document that notifies the finance office of delivery of the contracted goods or services and authorizes payment—in a timely manner. The commanders took personal action, as did their senior, immediate subordinates. A great deal of executive time was spent running down each action.

Some interesting things came to the surface. First, a number of receiving reports were, in fact, late. These were cleaned up in short order. The commanders also discovered some "worst case" examples; that is, several instances where all the paperwork had been properly completed and closed out, yet an erroneous interest penalty payment had been made to the contractor. In other cases, papers had been mislaid or misfiled in the finance office, causing a delay that exceeded the 30-day deadline. But, most frequently, the problem was caused by the overwhelming workload in the finance office. There was just too much work for the available time, so actions slipped

beyond the 30-day mark.

Well, in the end, the results were different. Receiving reports were collected and filed. Lost papers were found and late actions were completed. The results were different, but the process was the same. And, with the best of intentions, all players marched down the same road, waiting for the next explosion.

The quality leadership philosophy and the tools of Total Quality Management offer a different solution method. They all focus on the process, not just the results. Here is a description of what the finance officer could have done.

The foundation of any effective process analysis is a process action team. This is a cross-functional collection of all the players in the process. It is critical that this team be complete—that all those involved in the process be represented, to include customers and suppliers. It is also essential that the team leader be someone who has both the responsibility for the process and the authority to make changes within that process, sometimes called the "process owner." So, a process action team is formed, with the finance officer as team leader. If this group is properly constituted, it will be a true action team and not just another subordinate committee with a different name.

The first step is to determine if the process is in control, just as the drill sergeant makes sure the shooter is producing a close shot group before he starts adjusting the sights. A good tool for this is the Control Chart (Figure 2.) There are several ways to apply this tool; what follows is just one.

The team collects data on processing time over a 12-week period. They compute the mean processing time—that's the heavy line down the middle. Using some statistical techniques, they then compute the upper control limit and lower control limit values. These describe the range within which almost all processing times will fall, if the process is performing normally. (We just made a giant leap here, but take it on faith. This discussion is about quality; it is not a mathematics or statistics tutorial.) The processing times within the control limits are subject to "common cause" variation; that is, variation that is part of the process, not something that an individual commander can influence. If a number of processing times fall outside the control limits, the process is not in control. These "outside values" are a matter of "special cause" variation; that is, variation that is not explained by the peculiarities of the process. The source of this kind of variation lies with the commanders. All special cause variation must be identified and eliminated before process improvements are attempted. (On the rifle range, common cause variation might result from a loose barrel; special cause variation might result from the shooter occasionally jerking the trigger.)

Figure 2 shows that the team has plotted weekly averages on the control chart. There is some variation indicated, but all is within the control limits. However, some exceed the 30-day limit, shown as the dotted line marked "system tolerance." So, there is a problem. The process is in control, but it is not "capable." It does not meet the demands—30-day payments—placed upon it.

Next, the team determines why processing time exceeds 30 days. They select all late actions and prepare a Pareto Chart (Figure 3). This is similar to a histogram or bar chart, except that the bars have been rearranged in descending order, highest to lowest. This makes the main causes visually apparent—they are the first ones on the left. Another scale has been added on the right that shows the percentage of total observations considered in the chart. A line graph indicating how the total accumulates has been added, as well. The pur-

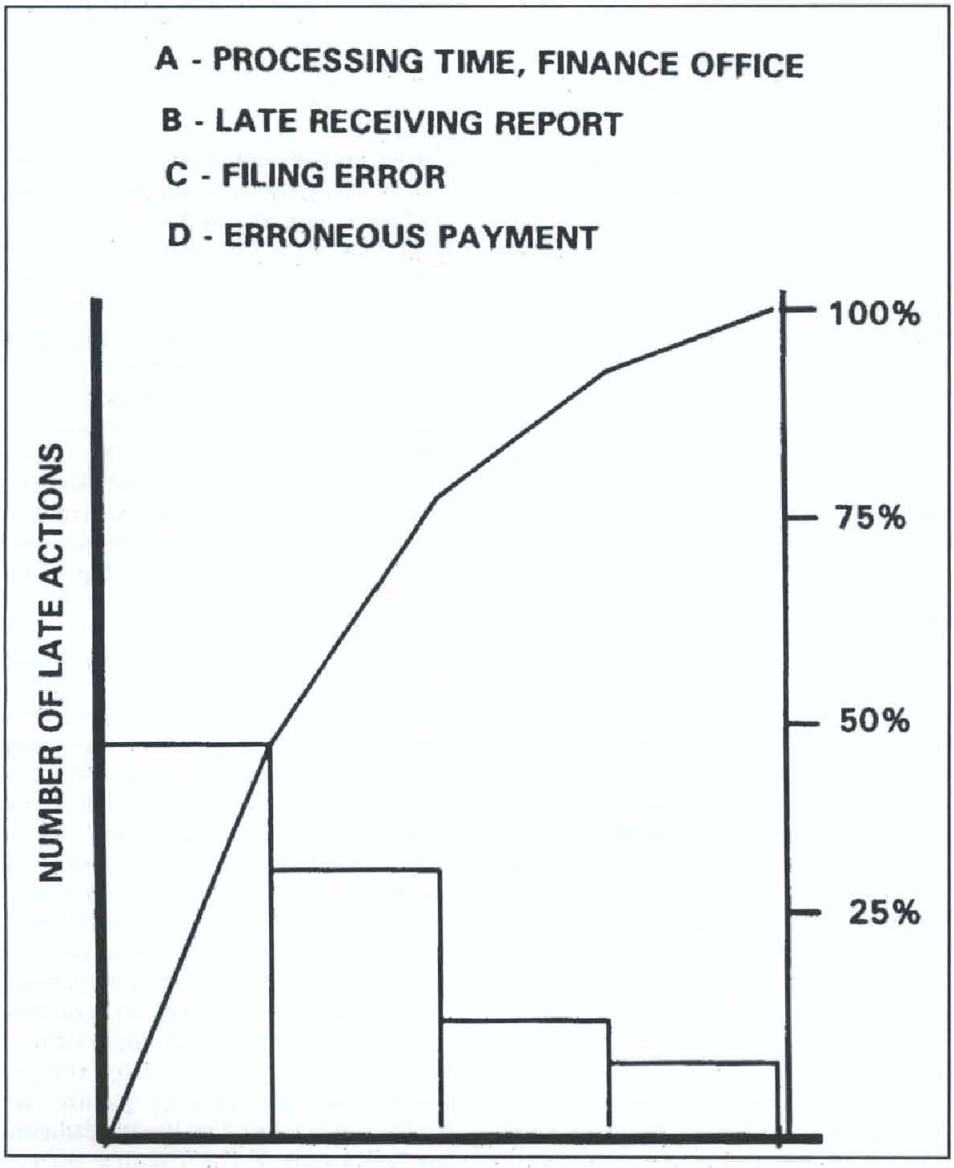


Figure 3.
Pareto Chart.

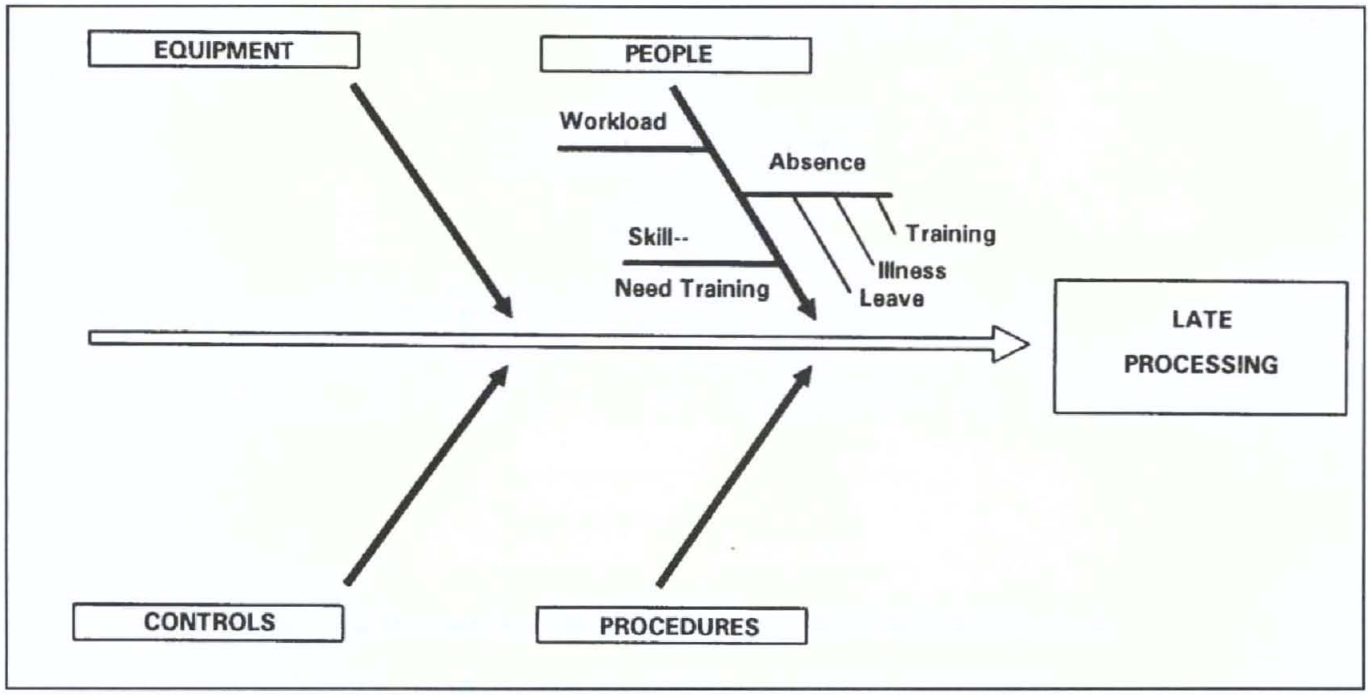


Figure 4.
Cause and Effect Diagram.

pose of the Pareto Chart is to separate the important causes from the trivial causes. This has been described as the difference between the important few and the trivial many because experience shows that usually about 20 percent of the reasons will account for 80 percent of the problems—the so-called "80/20 rule." In this case, the first two reasons (50 percent) account for 80 percent of the late payments.

From this analysis, the team has learned that the biggest problem is processing time in the finance office. A close second is late receiving reports. The remaining two causes are relatively minor. They may be addressed later.

Finally, the team prepares a Cause-and-Effect Diagram (Figure 4), sometimes called an "Ishikawa Diagram" after the Japanese quality expert who developed it. There are several types of these diagrams and all get rather complex. A complete discussion is not possible here, but the basics will be covered.

A Cause-and-Effect diagram is a useful tool for sorting out the causes of variation by examining relationships. The first step is to identify the basic elements of a process, then the parts of the elements, then the parts of the parts, and so on, all in a cause-effect relationship. For example, the team begins by establishing the problem being examined in a goal block (shown at the right side of the chart). They then add an arrow leading to that block. They identify four elements of the process as being the major influences of late processing time: people, procedures, equipment and control. These are added to the chart as arrows to the center arrow. The team then examines each of these individually to determine subelements down to the level where no more causes exist.

To examine just one area, consider "People." The team determines that late processing might be caused by the following "people" reasons:

- Absence: illness, leave, or training.
- Excessive workload (related to "procedures")
- Skill - Need training.

All of these are added to the diagram. The other basic elements are analyzed in the same way. When the diagram is completed, it is examined as a whole to gain insight into the relationships between the many causes and their single and combined effects. The result is suggested actions that will reduce variation and, therefore, reduce the problem shown in the goal block.

The happy conclusion to all of this is that the finance officer has not just changed results for the moment, but rather changed the process in the future for the better. This is real improvement, not just the appearance of improvement.

To summarize:

- The key to performance improvement lies not in unsatisfactory results, but rather "upstream" in the processes that cause those results.
- A cross-functional process action team that includes representation from all participating and affected elements—people who do things—is a sure way of getting a complete review of the process under study.
- A variety of process analysis tools are available and should be applied. Action should be based on data and knowledge, not intuition or gut feelings.

As we saw on the rifle range, this is not a new technique. But, as we saw in the finance office, it is not well-known either. Process does make the world go 'round. Process is the path to progress.

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For The Want Of A Nail. . .

THE CASE FOR A GYRO-COMPASS FOR ARMORED VEHICLES

By MAJ John F. Antal

"For the want of a nail, a shoe was lost,
For the want of a shoe, a horse was lost,

For the want of a horse, a rider was lost,
For the want of a rider, a message was lost,

For the want of a message, a battle was lost,
For the want of a battle, a kingdom was lost.

All for the want of a nail!"
— William Shakespeare

Introduction

The U.S. Army has spent considerable time and treasure to develop the best armored fighting forces in the world. Recent events in the Persian Gulf prove the value of this effort. Tanks can now shoot accurately out to 3,000 meters in day or night conditions. Engagements at extended ranges and difficult flat desert terrain, however, brought forward some serious problems that must be resolved before the next war.

In October 1991, a gyro-compass was demonstrated during a unit rotation to the National Training Center. The gyro-compass assisted tank and Bradley gunners in navigation, fire distribution and fratricide prevention. The gyro-compasses were mounted on a tank platoon and on task force level command and control vehicles. Reports from observer/controllers and the users were extremely positive.

How can armored forces navigate in deserts when the Global Positioning System (GPS) is not working due to malfunction or lack of satellites? How do armored forces distribute and mass fires effectively in the offense, especially when fighting on a featureless desert? How do armored forces quickly assign sectors of fire in both offense and defense without an azimuth indicator to depict relative direction? Can we apply a fire control solution to reduce battlefield fratricide? This article proposes that the answer to these questions can be found by adding a gyro-compass to armored vehicles.

Navigation

During Desert Storm, the U.S. Army used the sophisticated Global Positioning System (GPS) to navigate across the difficult desert terrain of Southwest Asia. GPS is an excellent system that provides an accurate grid coordinate of the user's position. The system is passive, highly reliable and easy to use. The only requirement is that the satellites that communicate with the GPS device on the ground be in the correct position, or window, at the right time.

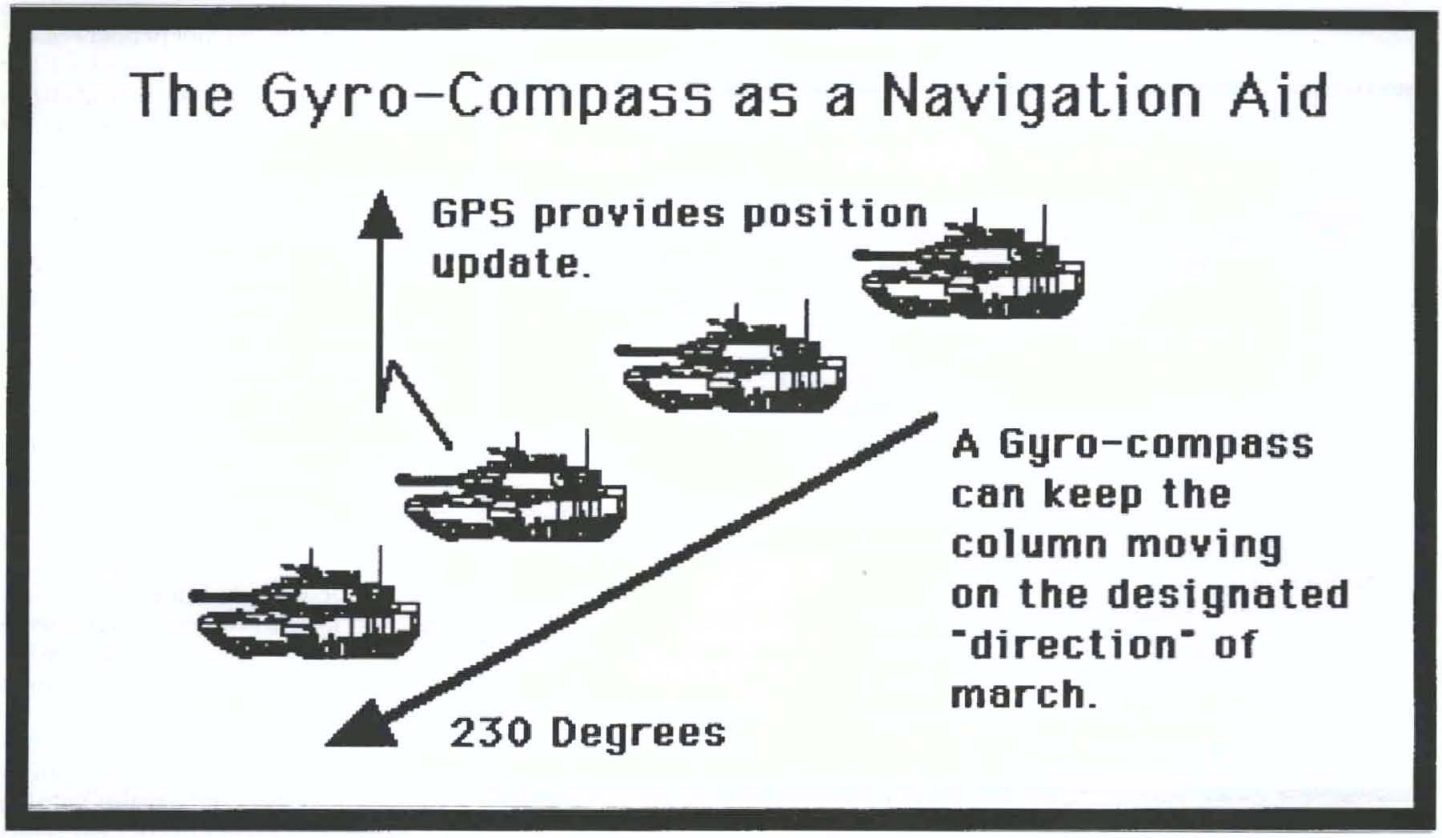

Figure 1.

The GPS solution, however, is not the ultimate navigation device. *It is only part of the solution.* Without the ability to navigate outside GPS satellite "windows" the U.S. Army may be counting on a system that may not always be available. In addition, the GPS cannot tell you the azimuth that you are travelling. If you set a far point on the GPS, the device will give you an azimuth from your current location to the far point. The only way to stay on this azimuth, however, is to move and take position readings along the line of march. In short, the GPS does not act like a compass for the armored vehicle. To maintain a strict direction of march, a constant azimuth is required.

A gyro-compass, backed up by GPS, is the simplest solution to this navigation problem. Armored formations on the move need the ability to follow a prescribed azimuth of movement. This ability will allow armored formations to navigate across any type of terrain. It will allow a commander to direct a "line of attack" for combat operations and quickly shift to alternate "lines of attack" based on the current situation. The capability to do this, on the move, while inside an armored vehicle, does not exist today. An armored vehicle gyro-compass is one simple solution. Figure 1 depicts how a tank gyro-compass can aid an armored formation in land navigation.

Fire Distribution

The greatest advantage of an armored vehicle gyro-compass lies in the area of fire distribution. Fire distribution is defined as the ability to designate and allocate fires to destroy enemy targets in the most effective manner with the minimum amount of time possible. An armored vehicle gyro-compass could accomplish this for both offensive and defensive operations.

The U.S. Army used "azimuth indicators" successfully for years on the older M48, M60 and M60A3 tanks. The purpose of this "azimuth indicator" was to give the tank gunner the relative position of the gun to the hull of the tank. Knowing the position of the gun in relation to the hull, targets could be identified by degrees on the "azimuth indicator." The "azimuth indicator" became the primary means of distributing fires in the defense from range-card positions on the non-thermal optic-equipped tanks.

A gyro-compass would apply the same concept to assist fire distribution in the defense. In addition, the gyro-compass would provide vehicle commanders, platoon leaders and company commanders the magnetic azimuth to their targets. This has the added bene-

With a common azimuth, a platoon leader or company commander can designate sectors of fire on the move, without the designation of recognizable target reference points.

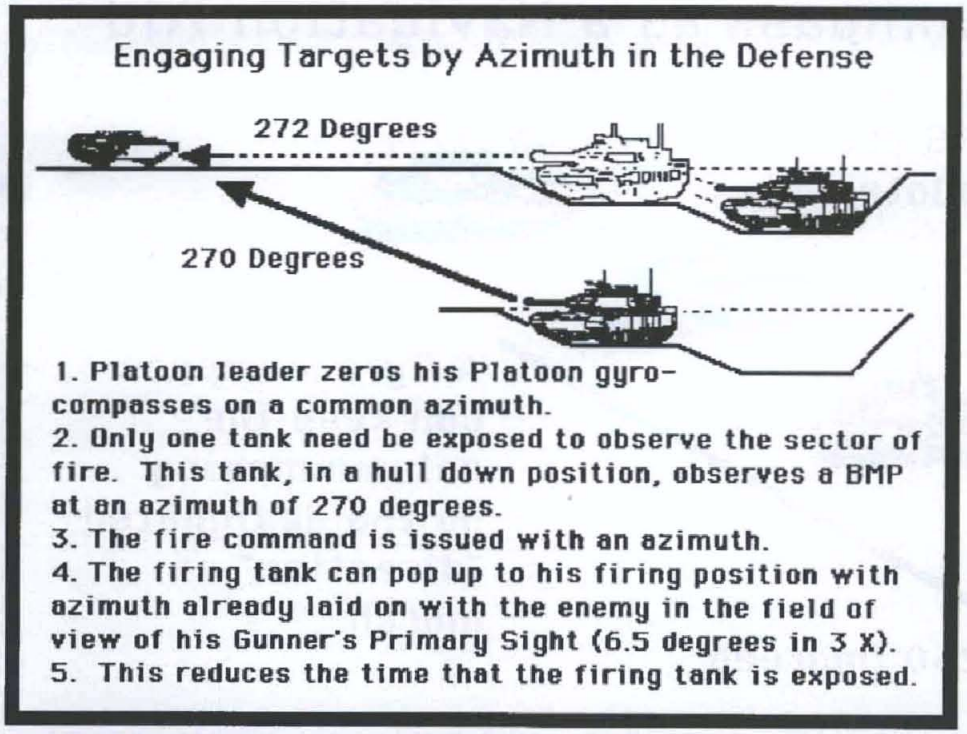

Figure 2.

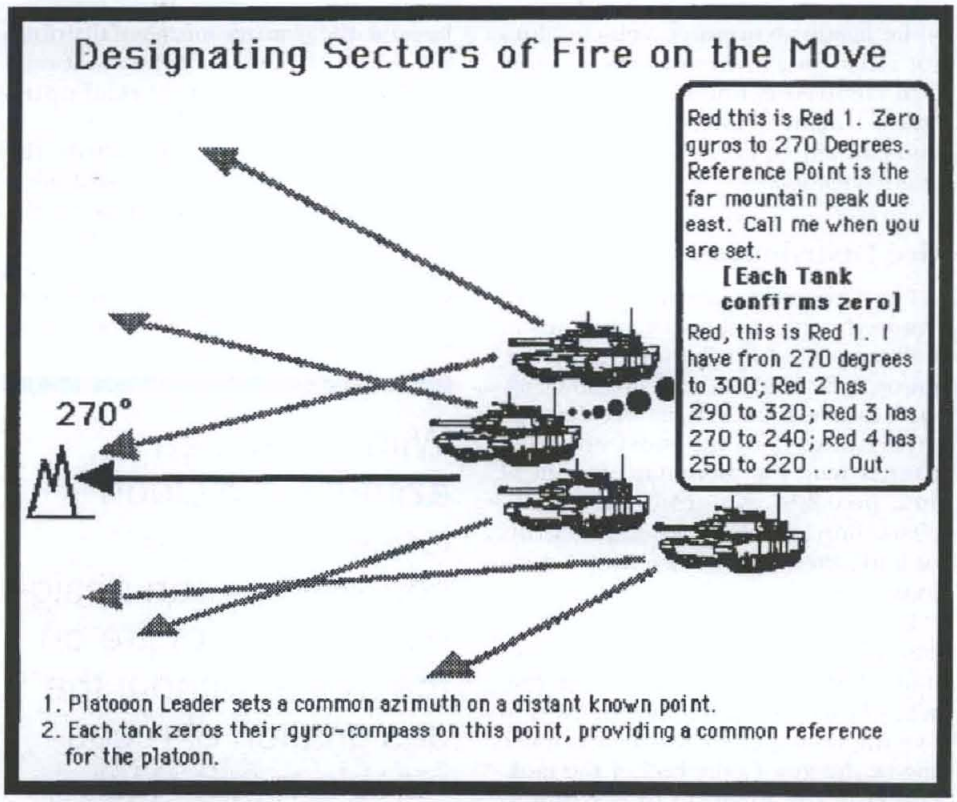

Figure 3.

fit of making the range card positions easier to create and independent of the exact positioning of the hull of the tank. A gyro-compass, therefore, becomes much better than an "azimuth indicator" for engaging targets during defensive operations. This ability can also decrease exposure time to enemy fires as fighting vehicles move from hide to firing positions, already focussed on the azimuth of the target. Figure 2 depicts the ability of a tank platoon leader to use a gyro-compass in the defense.

In the offense, a gyro-compass has many advantages for fire distribution and fire control. With a common azimuth, a platoon leader or company commander can designate sectors of fire on the move, without the designation of recognizable target reference points (TRPs). In addition, the ability to designate direct fire against targets by using an azimuth can speed up target acquisition.

This capability increases the night fighting capability of tanks, infantry fighting vehicles, and cavalry fighting vehicles. The excellent thermal sights on the current armored fighting vehicle fleet provides U.S. forces with a significant advantage. The ability to see a target at long range, however, is restricted to the field of view of the gunner's primary sight. The Gunner's Primary Sight on an M1 Tank has two settings, each with a different field of view. The 10-power setting field offers a 6.5 degree field of view. The three power setting offers a 20 degree field of view.

A gyro-compass can also speed up unit fire commands. A platoon fire command has six major elements: alert; weapon/ammunition; description; location; control; and execution. Often, the location element of the fire command takes the most time to describe. A Target Reference Point (TRP) solves this problem by establishing a common reference point within the platoon. The target is described as being right or left of the designated TRP. Right and left, however, are relative directions.

In the offense it is difficult to designate TRPs. This is especially true if the terrain lacks distinguishing features, as in the Iraqi desert. All of these problems can be solved by a device that allows the gun to be laid by azimuth. Figure 4 depicts a tank platoon leader

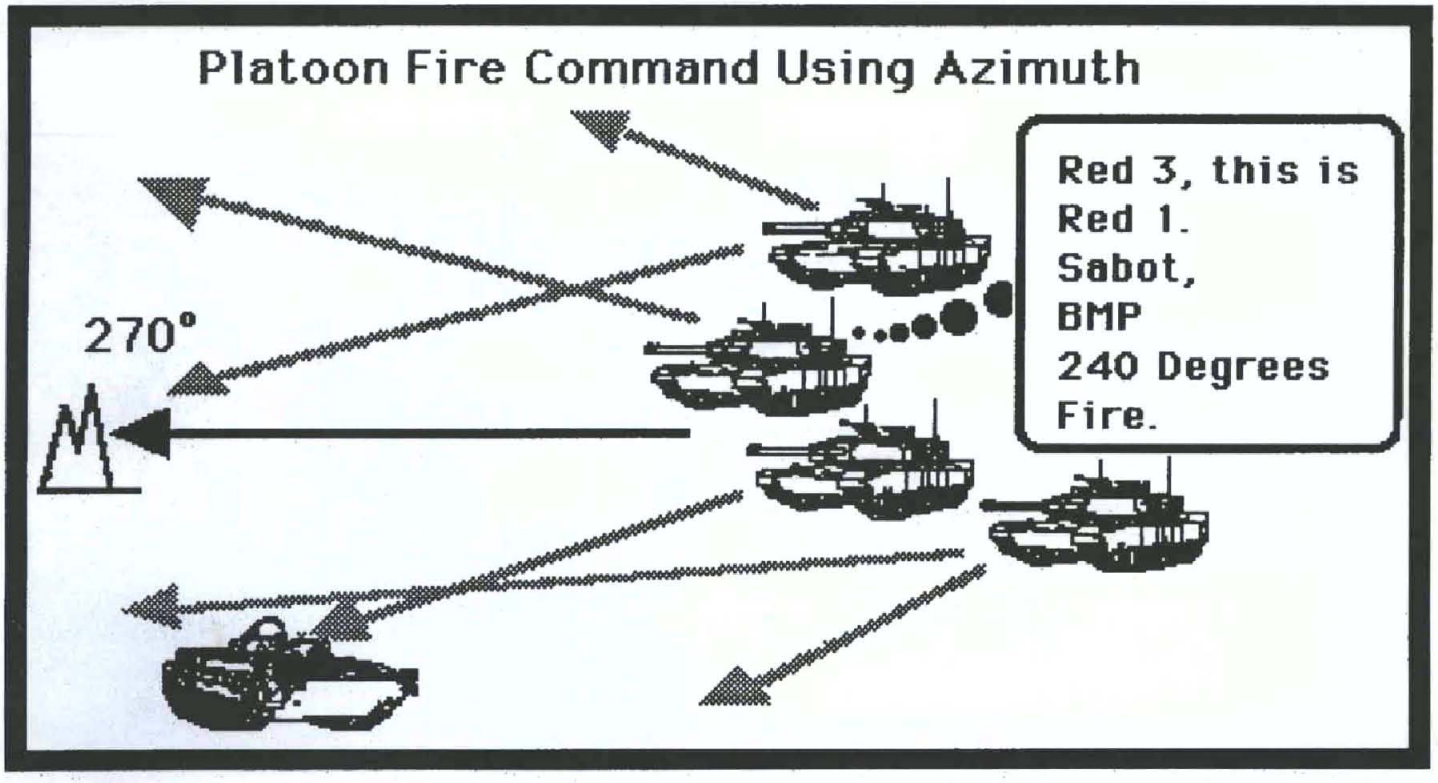

Figure 4.

issuing fire commands using an azimuth for target location.

Fratricide Prevention

Fratricide was a major issue in the recent Gulf War. Nearly a quarter of the casualties that American forces experienced during the Persian Gulf War were the result of friendly fire. Thirty-five of the 148 Americans killed (21 soldiers and 14 Marines) were officially listed as killed by friendly fire in Operation Desert Shield and Desert Storm.

Of the 467 wounded in action, 72 were officially reported as wounded by accidental fire from their own side. Some officials say that the actual tally could be twice as high as the "official" figure. In addition, many firing incidents occurred that did not produce casualties and were not reported.

Many of these firing incidents are the result of disorientation on the battlefield. In the swirling maelstrom of combat it is easy for an armored vehicle crew to lose the direction of the battle. This is particularly true because of the excellent thermal sights on the M1 Tank and Bradley Fighting Vehicles. These sights act like magnets to draw the vehicle commander down inside the turret to see the battlefield. With the narrow field of view of the gun sights, it is easy to find gun tubes pointing in the wrong direction. If these gun tubes become oriented on friendly targets, identification problems can occur. At 2500 meters, it is often impossible to distinguish a "hot spot" as friend or foe.

A simple gyro-compass could help solve this problem. The platoon leader or company commander could designate the primary azimuth range of enemy targets. This arc of fire could be accurately registered by each tank or Bradley gunner. Targets that appeared outside this arc could only be engaged on order once properly identified. Veterans of Desert Storm, who used the gyro-compass at the NTC, remarked that such a device could have been a major factor in reducing fratricide.

Conclusion

Tanks and other armored fighting vehicles are weapons of firepower and maneuver. To maximize their firepower, armored vehicles must maneuver rapidly and mass fires effectively. In spite of the tremendous upgrade in tank and infantry fighting vehicle navigation and fire control systems, the U.S. Army still does not have a simple device that gives gunners an azimuth to their targets.

The U.S. Army should procure a tank compass for every M1, M1A1 and Bradley in the current armored vehicle fleet. The Israeli army and several other armies are already looking at a rugged gyro-compass like device, to upgrade their navigation and fire distribution capability. With all the advantages of the M1A1 Tank and the M2 Infantry Fighting Vehicle, it would be criminal to waste this tremendous combat capability "for the want of a nail."

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ARMY TO GET NEW SMOKE VEHICLE

An Improved Mobile System to Help Troops Hide from the Enemy

By George Taylor

The LAMPSS Carrier

The U.S. Army Tank-Automotive Command (TACOM), Warren, MI, and the Red River Army Depot in Texas, are playing a key support role in developing an improved mobile smoke-generating system that will enable troops to conceal their movements from enemy detection by generating smoke screens.

The smoke generator program is a joint effort involving the U.S. Army Armament, Munitions, and Chemical Command's Project Manager (PM), Smoke and Obscurants, Aberdeen Proving Ground, MD, and the M113 Product Manager's Office. Also providing technical support to the effort is the U.S. Army Missile Command in Huntsville, AL.

According to Michael P. Anderson, the M113 PM Office's assistant program manager for new derivative vehicles, the Design and Manufacturing Technology Directorate in TACOM's RDE Center is designing an experimental smoke generator carrier vehicle, and Red River is using the design to fabricate a vehicle demonstrator.

The new carrier will partially replace the M1059 smoke generator carrier. This is an M113A1 armored personnel carrier that has been modified in the cargo compartment and top deck for integration of a smoke-generating system. The M1059 smoke system, which is remotely controlled from inside the vehicle, uses two roof mounted smoke generators and associated equipment.

Each generator uses a gasoline-powered pulse-jet engine to produce smoke by combining the engine's hot exhaust with "fog oil," which causes the oil to vaporize. This vaporized mixture is then expelled into the atmosphere, where it recondenses to produce the desired smoke screen. A 120-gallon fog-oil tank inside the vehicle holds enough oil to keep the system operating for approximately one hour.

The Army's Chemical Corps has used smoke units for many years to screen river crossings and other concentrations of troops, as well as to deceive or "blind" opposing forces. These units, however, included only stationary emplacements until the M1059 made its debut in 1988, giving the Army the capability to produce "smoke on the move" for the first time.

Though the M1059 has proved to be an important asset in the Army's vehicle fleet, it has some limitations in smoke-making technology. "The smoke-generating apparatus we have on the M1059 is literally 1940s technology and is unable to meet battlefield requirements of the 1990s," said Anderson.

The new system, referred to as the LAMPSS (Large Area Mobile Projected Smoke System), will be able to maneuver with Abrams- and Bradley-equipped elements of the force and will provide dramatically improved smoke-screen protection for troops.

Like the M1059, the LAMPSS carrier

The new LAMPSS will be able to maneuver with Abrams- and Bradley-equipped elements of the force and will provide dramatically improved smoke-screen protection for troops.

will carry a three-man crew—a driver, commander and smoke-generator operator. Its features will include a smoke generator that not only protects against visual detection but also defeats night-vision, thermal and other image-intensifying equipment. It does this by injecting carbon-based particles to create a large-area cloud that prevents infrared detection. The carbon may be disseminated with the fog oil to produce a bi-spectral screen. A material change to produce millimeter-wave-defeating obscurant is planned.

It also operates more efficiently; it includes a 95-gallon oil tank but still operates for more than one hour between refills.

Another feature will be a turret-mounted rocket launcher that will allow the crew to fire smoke-producing rockets capable of projecting a smoke screen out to a distance of six kilometers.

The proposed LAMPSS carrier is a modified M901A1 Improved TOW Vehicle, a derivative of the M113-series armored personnel carrier family of vehicles. Modifications include replacing the M901A1's turret-mounted TOW missile launching hardware with a smoke-rocket launcher, adding a land navigation and turret-positioning modular azimuth positioning system and computer module, and mounting the smoke generator and related hardware in the rear of the crew compartment. Moreover, improved versions of the vehicle's engine and transmission are being installed that will increase the horsepower from the standard 212 to 300 and significantly improve vehicle mobility.

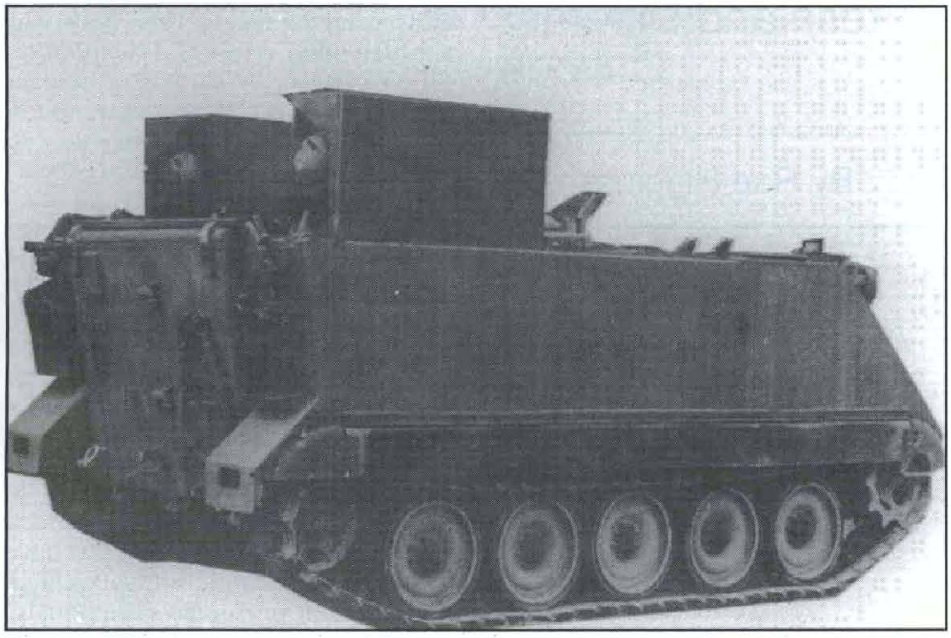
"We are not calling this vehicle a prototype," said Anderson, who heads the development of the LAMPSS carrier. "We are calling it a working mock-up or demonstrator because it may be a lot different from what the final vehicle design winds up looking like.

"The purpose of this demonstrator," he added, "is to show the Milestone I decision makers the feasibility of combining smoke-generating and smoke-projection capabilities on a tracked vehicle like the M901A1. These are the people who will decide if this concept is to be pursued into full-scale engineering."

Anderson said the LAMPSS was completed in 45 days. In March it was sent to Fort Polk, LA, where it underwent mobility, smoke generation and rocket-firing trials. He said the vehicle then went to Aberdeen Proving Ground, MD, where it helped to support a decision to proceed with LAMPSS requirement documentation and a Milestone I In-Process Review.

Anderson also said the LAMPSS was shown at the 11th Worldwide Chemical Conference, the Armor Conference, War College, and the Aberdeen Proving Ground Armed Forces Day earlier this year.

He added that the LAMPSS is expected to be shown at a customer show in Warren, MI, on Sept. 16, 1992.



Carrier, Smoke Generator, M1059.

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TACOM SCIENTISTS VISIT RUSSIA

An Opportunity to Establish New Relationships and Get A Fresh and Different Outlook

By Rae Higgins

Two U.S. Army Tank-Automotive Command (TACOM) engineers recently returned from Suzdal, Russia, where they represented the United States at the First International Russian Symposium on Terramechanics.

Dr. Ronald R. Beck, chief of the TACOM RDE Center's System Simulation and Technology Division and Zoltan J. Janosi, chief of the division's Analytical and Physical Simulation Branch, attended the meeting earlier this year. The purpose of the meeting was to establish contact with Russian engineers and scientists engaged in terrain-vehicle interaction research and development.

During an international conference hosted by the International Society for Terrain-Vehicle Systems (ISTVS) in Budapest, Hungary last year, two Russian scientists invited Beck and Janosi to attend the 1992 conference.

The technical conference was held in Suzdal (120 miles east of Moscow), and dealt mainly with the research and development of off-road and military vehicles, terrain-vehicle relationships, and how such vehicles perform on terrain. Another American, Dr. Boris Volfson of the John Deere Company, as well as representatives from Germany, Sweden, Japan and delegations from other newly formed Russian republics were also in attendance.

"It was a privilege and an honor to attend this conference. It was a pleasure to interact with these Russian scientists and engineers. Everybody was very friendly, warm and hospitable. They're sincere in wanting to interact with the West, and they're eager to foster data exchanges even though they do not know quite yet how to proceed," said Beck.

The technical sessions were conducted in Russian, but the visitors were able to follow the proceedings via translators. Beck said that although a bit was lost in the translation, he and Janosi have the Russian language proceedings of the conference and will have the most interesting papers translated into English.

Commenting on the country's cross-country vehicle R&D activities, Beck and Janosi said that the Russians have been investigating the soft soil-vehicle relationship problem. Previously, TACOM studied this problem, but abandoned it years ago due to the finding of adequate solutions. Very little was presented on vehicle dynamics, simulation

Dr. Ronald Beck (front, 4th from left) and Zoltan Janosi (front, 2nd from right) pose with their foreign colleagues in Russia.

and modeling—the focus of TACOM engineers.

However, Janosi, a member of the board of editors for the official journal of the ISTVS, asked M. P. Chistov, a Russian engineer, to send him an English translation of his presentation on vehicle performance modeling for publication in the *Journal of Terramechanics.*

"He seemed to have some interesting ideas about the subject," said Janosi.

Janosi also indicated that he and Beck saw videotapes of special Russian off-road vehicles and that their developers are interested in working with the U.S. to further pursue these concepts. They include: a 6x6 amphibious high mobility cargo vehicle with 23,400 pounds of cargo capacity and a 5.6 mph swimming speed; a 6x6 amphibious truck with a cargo capacity of 11,000 pounds and a 5 mph swimming speed; an experimental vehicle with an articulated frame and six conical wheels intended for lunar or planetary exploration; and a heavy two-unit articulated tracked vehicle with positive pitch control, a 30-ton carrying capability and good swimming ability.

Janosi said he does not think the Russians will be in the market anytime soon to buy any U.S. vehicles, however, because of the unfavorable exchange rate between the ruble and the dollar.

"I think the Russians are more eager to sell their cross-country vehicles to the West because of the reduced demand for them by the Soviet military," said Janosi.

On the other hand, Janosi added, former Communist bloc countries such as Hungary, which had used Soviet-built military vehicles exclusively, will be looking to purchase vehicles from the United States or other sources as a result of the political changes in Central and Eastern Europe. "Now they have a choice, and they're looking into the possibility of buying from the U.S.," Janosi said.

Beck and Janosi said one of the highlights of their trip was receiving yet another invitation to Russia to visit the Russian Mobile Vehicle Engineering Institute from its chief, Dr. Valery Gromov. Formerly a classified laboratory, the St. Petersburg facility is now "open" due to the dramatic changes within the nation. Gromov's complex includes a dynamic simulation laboratory which is supposedly similar to TACOM's Motion Base Simulation Facility. According to Beck and Janosi, Gromov is very interested in "comparing notes" and discussing mutual technical problems with his American counterparts.

Beck and Janosi said that Dr. Anatoly Miroshnichenko, the organizer of the symposium and their Russian host, is looking forward to participating in the next international ISTVS conference, which will be held in South Lake Tahoe in September, 1993. He may even visit TACOM in conjunction with the trip.

Both TACOMers believe the trip was successful and are hopeful for additional positive contacts with the Russians in the future. "It was a 'First Encounter of the Third Kind'," Janosi quipped. "Hopefully there will be more contacts, and we can go into technical details and not just listen to some papers and presentations."

Beck agreed, "It's an opportunity to establish new relationships and get a completely fresh and different outlook on how to do things. However, the degree of future cooperation will depend on Russian political and policy developments."

Fortunately for Beck and Janosi, they did not spend their entire time in Russia cooped up in conference rooms. They went sightseeing and spent some time among the Russian people. They toured the Kremlin, visited Red Square, saw Moscow University and even dined in the home of Miroshnichenko and his family.

"I would call this the trip of my career with the government. I've been to many places, but never once did I dream that I would be traveling to Russia and meeting with many of their engineers and scientists," Beck said.

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A WARTIME EXPEDIENT LASER PROTECTION DEVICE

By John Brand,
LTC Walt Probka
and Joseph Spellman

When the recent war broke out in the Persian Gulf the Army program for protection against lasers was well underway, but for some systems it had not yet been completely implemented. The Army research, development, and acquisition community immediately began a successful effort to ensure the forces committed to battle were protected against laser effects. For most systems, this involved acceleration of existing programs.

For two vehicles, the M901A1 Improved TOW Vehicle and the M981 Fire Support Team Vehicle, there were insufficient time and assets to apply the product improvement that had already been developed. The U.S. Army Laboratory Command's Survivability Management Office (SMO) and several other organizations teamed to devise and produce an expedient laser filter applique based on the filter used in the M22 binocular. Kits were fabricated and sent to the theater of operations to protect the crews of those combat vehicles.

Laser Protection Programs

Protecting personnel from lasers is of critical importance. Every time a tank or anti-tank engagement or long-range laser homing munition engagement occurs, a laser duel also occurs. This duel may be one-sided, as when a tank establishes the range to a target or an artillery observer designates a target for a Copperhead artillery shell. It may be two-sided, as well, as when the target finds the range for counterfire. In either case, a gunner or observer viewing a laser—even a rangefinder or target designator—through magnifying optics is at grave risk of eye damage that can vary in magnitude from temporary visual upset (such as flash blinding from a visible laser) to serious, permanent incapacitation from retinal burns. Lasers can cause serious physical damage and psychological injuries, dramatically affecting combat power in battle.

Lasers can cause serious physical damage and psychological injuries, dramatically affecting combat power in battle.

The U.S. Army has an aggressive policy for laser protection of eyes, magnifying optics, and electro-optics. This includes the following programs:

- Personnel protection items, such as the laser protection outsert for the Ballistic/Laser Eye Protection System, managed by the project manager—soldier,
- Unity vision blocks, under the purview of the Army Tank- Automotive Command's Survivability Office,
- Coated optical components for night vision image intensification devices, managed by the project manager for night vision and electro-optics, and
- The retrofit program for the principal tank/anti-tank systems currently in use or in production (the Optical Improvement Program) (OIP).

The OIP has been managed by LABCOM's Survivability Management Office at the direction of the under secretary of the Army. Management of the OIP originally involved total responsibility at the beginning of the program, with responsibility for execution later decentralized to the respective program managers once the technical problems were resolved and the implementation began. The SMO has since retained a technical oversight responsibility.

When Desert Shield began in August 1990, the SMO reviewed the laser protection status of major items of equipment. Most of those items of equipment were either in the process of accelerated retrofit or enough assets had been modified for needs in that theater. However, there were two systems for which the approved product improvement program (PIP) had never been funded due to fiscal constraints. The funding was never approved because the items were intended for eventual replacement and the PIP was costly—about $54 million, including unity vision blocks and periscopes. These two systems were the M901A1

Improved TOW Vehicle (ITV) and the M981 Fire Support Team Vehicle (FISTV).

The ITV and FISTV Optical Systems

Both the ITV and the FISTV use an erectable "hammerhead." In both the ITV and the FISTV the hammerhead contains a night sight and a day panoramic surveillance periscope to perform target acquisition. The ITV hammerhead includes two missiles and the tracker to guide them. The FISTV hammerhead contains an AN/TVQ-2 laser designator to designate targets for laser homing munitions or to mark targets with a laser beam for missile-firing aircraft. The FISTV is shown is Figure 1.

The hammerhead on both systems contains an optical device that combines the image from the missile tracker or laser designator, the thermal night sight, and the low magnification, wide field of view surveillance periscope. The surveillance periscope on the hammerhead is protected by an armor blister. The squad leader, who sits behind the driver on the left side of the vehicle, also has a surveillance periscope. These are shown in Figure 1. Although the squad leader's periscope in the FISTV has some laser protection, none of the four surveillance periscopes has protection equal to the OIP standard.

This lack of protection creates a dilemma for the crew. At best, the squad leader is partially protected (FISTV) or, at worst, completely unprotected (ITV). The gunner, who uses the hammerhead, has a dangerous mix of protected and unprotected optical channels. The laser designator and TOW tracker have full built-in laser protection. The night sight is, of course, immune to the effects of lasers that would damage the eye. The surveillance periscope, which is totally unprotected, exposes the gunner to levels of eye damage ranging from temporary flash-blinding (mission kill) to serious permanent eye damage. The squad leader is subject to the same kinds of injury.

Protection of the surveillance periscopes was originally part of the PIP, but requires manufacture of new filters and depot level installation. Due to the uncertainty of when battle would be joined in Operation Desert Shield, speed in providing the fix was of the essence. If the crews (and the combat power of the systems) were to be pro-

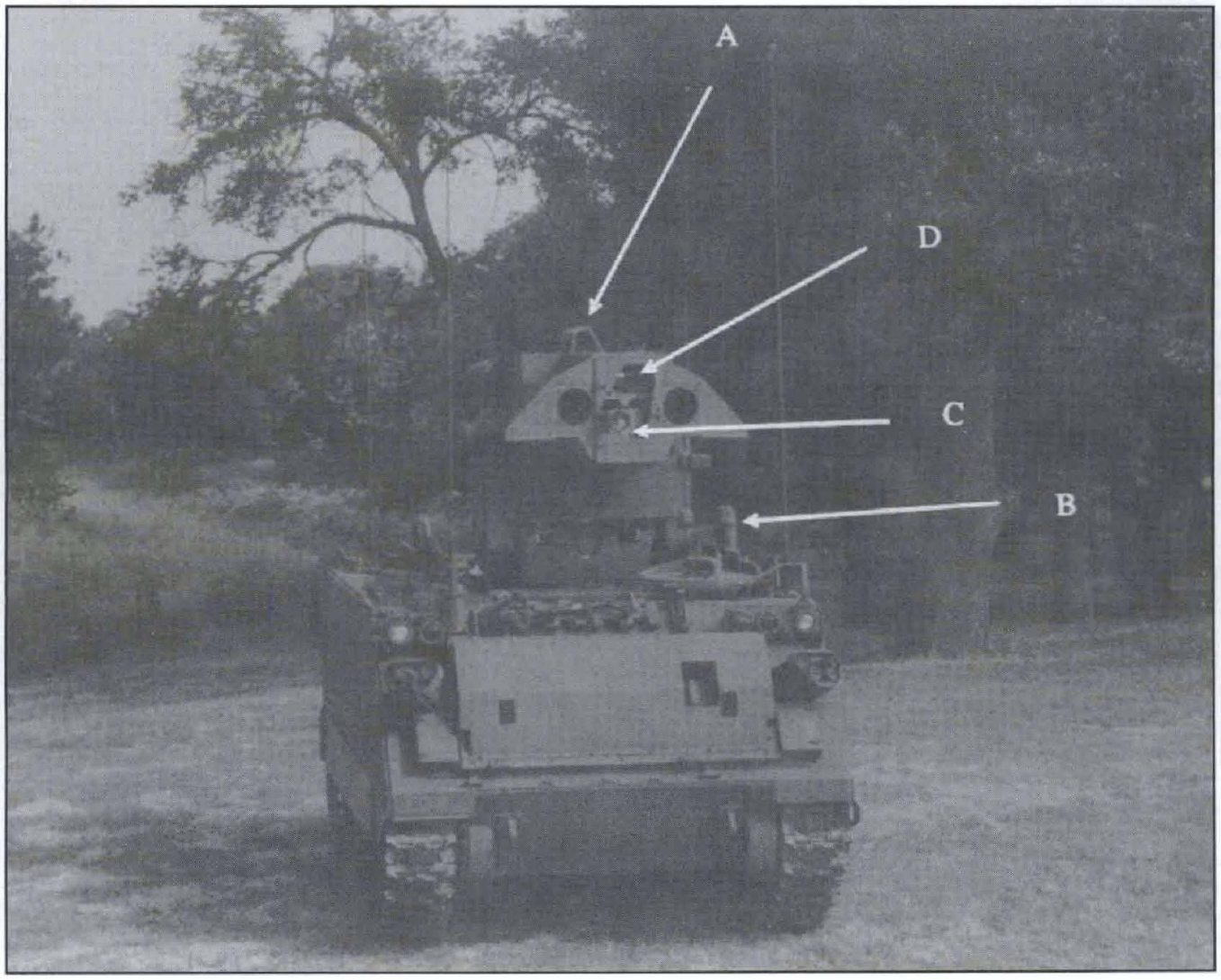

Figure 1.
The M981 Fire Support Team Vehicle. The surveillance periscope head, under an armor blister, is shown at A. The squad leader's periscope is shown at B. The laser designator is at C and the night sight at D.

tected, an existing item would have to be adapted.

Laser Protective Filter for M22 Binoculars

The existing item chosen for adaption was the laser protective filter for the M22 binoculars. This extremely capable filter was in high volume production—more than 144,000 were made in the first production buy. An interference filter, this device is made up of alternating thin layers of transparent materials deposited on a substrate. For some wavelengths, light is transmitted, and for undesirable wavelengths reflected and prevented from entering the optics and, ultimately, the eye. Interference filters provide excellent protection and still provide high light transmission from the scene being viewed, but for light striking the filter beyond a certain angle protection falls off essentially to nothing.

For the M22 binocular, the filter was designed for an optical system with a seven degree field of view. That is, light hitting the filter at angles of 3.5 degrees or less from the perpendicular has the unwanted laser wavelengths filtered out. The filter was adaptable to optical systems with a 25 degree field of view because the design actually provided protection over an angular range much greater than the minimum required angle of 3.5 degrees. It therefore was a candidate for adaption since it provided an adequate protection level, an adequate protection angle, and was in high volume production.

The SMO therefore began to investigate and design a "quickfix" applique filter kit for the M901A1 and M981 fighting vehicles.

Fielding Kits

A number of things must be done to field even a small kit. To begin with, data were obtained from the filter manufacturer to determine whether the filter would indeed provide protection over the field of view in the new application. Samples of the filter, provided by the Army Armament Research, Development, and Engineering Center (ARDEC), were also independently tested by the Army Environmental Hygiene Agency to confirm the manufacturer's data.

The proposed installation sites on the M901A1 and M981 were checked during a trip to the Ordnance Center and School at Aberdeen Proving Ground. The Ordnance School also loaned periscopes from their vehicles for form-fit-function verification. An initial design sketch was quickly done and an Ordnance School instructor then modified the design to make it more rugged. The next day he and a student made prototype clamps to hold the filters in place. In the meantime, ARDEC had investigated the concept and determined that the applique should work. They advised that the filter coating should be potted in a glass sandwich for environmental stability.

In the interest of quick fielding, the Harry Diamond Laboratories (HDL) Mechanical Technologies Branch was asked to manufacture the kits. The chief of the branch improved the design yet again and made ready to produce a still undetermined number of kits. The final kit, shown in Figure 2, consisted of a filter and clamp for each periscope and wrenches, nuts, and screws. Lens cleaning tissues and a small bottle of locking compound to keep the applique from vibrating loose were also provided.

Installation was straightforward. Using the enclosed directions, a soldier applied both kits in less than an hour. The appliques installed on the two periscopes are shown in Figure 3. After a short vibration test on a vehicle (it stayed on) and a session with a hose (it didn't leak) the kit was considered adequate for its purpose. (The original kit design was left on the test vehicle, which was parked outside, over the winter into June, with no evidence of leakage or even condensation. The filters showed no visible degradation, but will of course be tested).

Up to this time, no "real" money had been spent and the user community had not been approached. With feasibility and costs established and a prototype kit available, that time had now arrived.

The director of the SMO approached HQDA, the PM, M113 Family of Vehicles, and the science advisor of Central Command (CENTCOM). After a

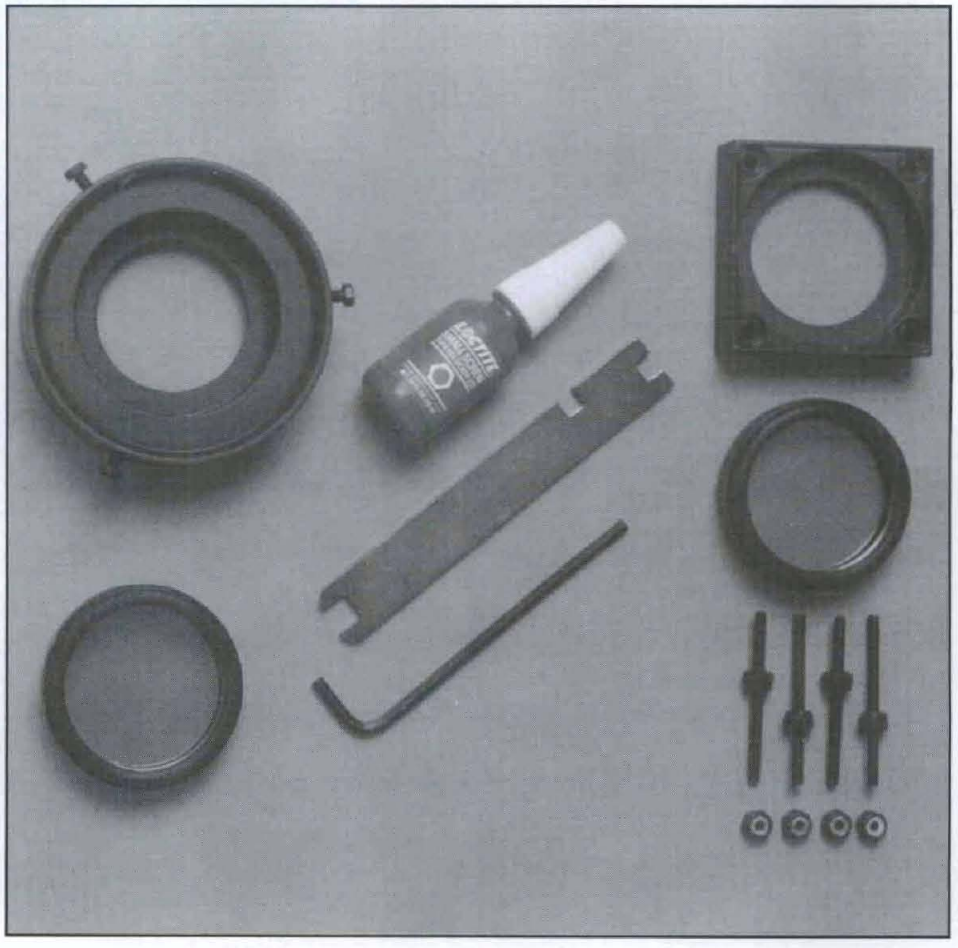

Figure 2.
The kit, with laser filters and mounting hardware.

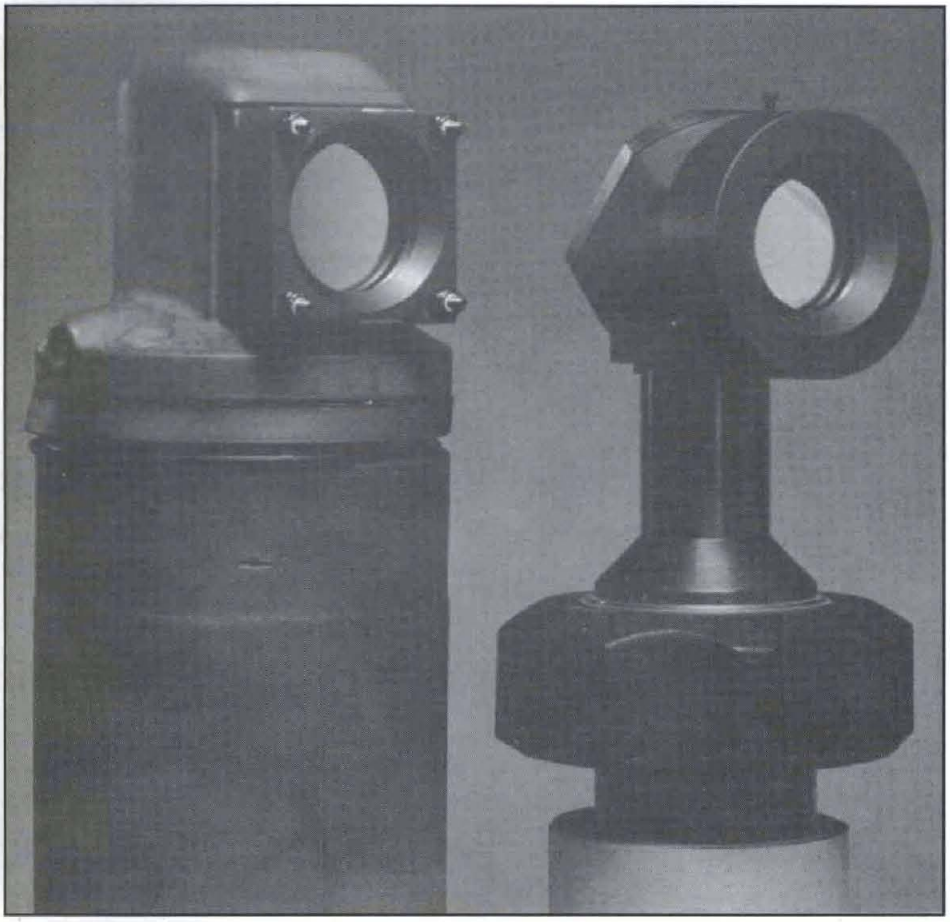

Figure 3.
The kit installed on the periscopes.

series of discussions and briefings, CENTCOM requested that the kits be provided as soon as possible. The action officers from the Office of the Deputy Chief of Staff for Operations and Plans and the Office of the Assistant Secretary of the Army for Research, Development and Acquisition determined the number of kits required.

The PM M113 assigned a temporary part number for the interim kit and took responsibility for funding for shipping directions, and in-theater matters. The HDL shops went into high gear. Interested parties decided that the immediate wartime requirement number of kits would be fabricated and shipped as fast as possible with minimal testing, and that further kits would be more carefully tested and, if necesssary, redesigned by ARDEC. SMO provided installation instructions and technical assistance as needed, and acted to keep all parties informed of progress.

Enough filters were made available by the Armament, Munitions and Chemical Command (AMCCOM) from spare M22 filters to expedite the manufacture of enough kits for in-theater assets. The kits were fabricated and shipped and installed according to theater priority before the start of the ground war.

A later portion of the total number of kits was put into theater reserve. After theater needs were filled, some kits were sent to ARDEC at Picatinny Arsenal for evaluation and re-design as needed, and the rest to a CONUS depot for storage. Additionally, the HDL shops are now working with the PM M113 to draw up a technical data package for production of more kits if the contingency should arise.

Conclusions

Several lessons can be extracted from this successful attempt at fixing a vulnerability under the conditions of unexpected war:

- The responsible technical manager must know the actual performance of his assigned material as well as the specified values.
- Team work is key. This effort depended on motivating disparate elements of the community and forming a team, any member of which could fall back on "not my job" and kill the effort. In fact, every one concerned rejected that minimalist philosophy and got involved with verve and enthusiasm.
- There's always a way to overcome or get around an obstacle.
- The expedited purchasing policies newly put in place before the war were essential. For instance, the laser filter encapsulation and marking were paid for with a government credit card—otherwise they probably couldn't have been made.
- In-house manufacturing in government shops is priceless when time is crucial. A government shop can make things fast, be responsive to change, and is not encumbered by contractual limits and delays.
- If you tell people what the objective is and why they are important to it, they will do anything to support the troops.
- Never give up.

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LTC WALTER PROBKA is currently the attack helicopter test project manager in the Joint Over the Horizon Targeting Program Office, OSD. He has served as director, Survivability Management Office, in a variety of other R&D assignments in AMC. He is a rated aviator and has a B.S. in aerospace engineering from Northrop Institute of Technology.

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The preceding article was edited by Ellen Jones, who works in LABCOM's Technical Publications Branch.

WRAIR STUDY ON CELLS IN SPACE SUCCEEDS

By Chuck Dasey

The U.S. Army Medical Research and Development Command's (USAMRDC) first venture into space was very successful, according to COL William Wiesmann, director, Division of Surgery and Trauma Research, Walter Reed Army Institute of Research (WRAIR), coordinator of the project. "We got some exquisite data," he said, including both anticipated and unanticipated observations of the effects of weightlessness on cells.

Researchers from the WRAIR collaborated with scientists from the National Aeronautics and Space Administration (NASA), the University of Louisville, the University of California at San Francisco, and the Hospital for Special Surgery in New York City.

The Space Tissue Loss Model is a self-contained cell culture system designed to travel in the space shuttle's mid-deck locker. It is an important research tool that will help determine the effects of weightlessness on bone, muscle, heart and immune system cells. It is carried in an automated module that maintains a constant temperature of 37 degrees Celsius, and provides air and nutrients to, and removes waste from, the cells, and allows injection of drugs and collection of samples under zero gravity conditions. The system is fully computer-controlled, and requires no monitoring in-flight by the crew. The project is expected to yield important new information about the health effects of long-term space flight. It is also expected to provide important new combat casualty

The project is expected to yield important new information about the health effects of long-term space flight.

The elegantly simple idea of flying cell cultures in zero gravity has been in development for a long time.

care information about immune system compromise and tissue loss following trauma and treatment. The high potential for application of findings to the improved healing of combat wounds indicates the experiment's value to Army medicine.

As in the best of projects that are exhaustively planned and adroitly executed, there was a flurry of last-minute activity to get the Space Tissue Loss Model aboard the space shuttle Atlantis for the March 24 lift-off.

Mark Arnold and Ted Delaplaine, engineers assigned to the U.S. Army Biomedical Research and Development Laboratory (USABRDL), and Walter Franz, a machinist from WRAIR's Instrumentation Division, spent two weeks at the Kennedy Space Center at Cape Canaveral, FL, for the final preparation of the module.

Final preparations included plumbing the module's cell culture cartridges with tubing to deliver nutrients and drugs, collect samples, and remove wastes; sterilizing the plumbing, leak testing, pump calibration, heater installation and heat sinking, heat sensor calibration, vibration-proofing the internal wiring, and installation and final programming of the module's internal electronics.

In Florida for launch preparation from WRAIR's Division of Surgery were Wiesmann, Dr. George Kearney, the principal investigator; Diane Elgin, laboratory technician; project manager Tom Cannon, and Dr. Bill Bass of the Instrumentation Division. The module was handed off to the NASA ground crew at 3:30 p.m., Sunday, March 22, 1992.

After a 24-hour delay, the Atlantis finally lifted off on Tuesday, with USABRDL and WRAIR personnel watching, relieved that they had made their deadline, and excited by the spectacle of the launch.

Upon retrieval of the module from NASA after the shuttle's return nine days later, the cell system appeared to have operated as planned. Laboratory analysis of the effects of the journey on the cell cultures began immediately.

"Fourteen of 16 cell culture cartridges produced data," said Kearney. "All software, environmental controls and mechanics functioned perfectly. The system design was fully vindicated. Everything worked."

"NASA is very happy about this, too. Eighty percent of secondary experiments—the ones carried in the mid-deck area of the shuttle—don't work," added Wiesmann.

The elegantly simple idea of flying cell cultures in zero gravity has been in development for a long time. The USAMRDC first suggested the idea in 1985, when, at the visionary urging of then Vice Chief of Staff GEN Max Thurman, various Army commands devised projects to use the space shuttle as a research platform to solve Army problems.

LTC Marc Howell, currently assigned to USAMRDC's Pentagon Liaison Office, was assigned in January 1985 as USAMRDC's space project officer. He was responsible for eliciting project ideas from the command.

"As usual, Thurman was way ahead of the rest of the Army," he said, indicating the initial reluctance of the command to embrace the idea of research in space. Each research program director and laboratory commander had more mainstream projects on which to spend time and money. The U.S. Army Institute of Dental Research (USAIDR) submitted the first project concept, which was briefed to Howell by Dr. Jean Setterstrom, currently assigned as the deputy for science, and COL Harold Plank, then USAIDR commander, in June 1985. Their project, Microencapsulation of Drugs in Zero Gravity, is scheduled to fly in October 1992. The WRAIR Division of Surgery project was first proposed by LTC Geoff Graeber, CPT Paul Paustian, and CPT George Kearney, then assigned to the Armed Forces Institute of Pathology, in October 1985.

Coaxing space research proposals out of laboratories was half the job for Howell. The other half was marketing the proposals to the Army leadership, and establishing the process and pathway for getting an Army medical research project on the shuttle.

"The USAMRDC jumped far into the lead by designing good space experiments," Howell said, "and this led other R&D organizations to develop experiments. The requirement to integrate the USAMRDC experiments into the space shuttle manifest pushed the Air Force to exercise DOD sponsorship of other service projects, such as our own, through the Space Test Program process."

The tragic loss of the Challenger shuttle in January 1986 threatened the Army Space Initiative by moving back the timetable. "However," Howell explained, "the delay caused by the accident allowed the experiments to mature, and allowed the command to improve its ability to maneuver them through the system." These experiments survived the Challenger accident because they were based on good science, but they also appealed to non-scientists. They were marketed to the Army, DOD and NASA based on these virtues. They captured the Army's interest because they were directly related to Army problems."

CHUCK 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. Dasey also holds an M.B.A. degree from Mount Saint Mary's College in Maryland.

MULTILEVEL SECURITY (Part II). . . STAYING INSIDE THE ENEMY'S DECISION CYCLE

By COL W.H. Freestone

Introduction

In January 1990, the Joint Staff requested that the Defense Communications Agency (now the Defense Information Systems Agency) establish a program to move emerging multilevel security products from U. S. industry to the field—beginning with the commanders of the unified and specified commands. The program was given the name Multilevel Security Technology Insertion Program (MLS-TIP).

American industry, during the previous 10 to 15 years, had worked to develop products that would provide commanders and their staffs the means to automate the process of simultaneous transfer of classified data between two different classification levels. The Joint Staff believed decisions involving military missions could be reached more quickly if MLS could be achieved in the CINC command center environment, even in limited form. Rather than waiting until a complete MLS capability was available, the thrust of this new program was to insert available off-the-shelf MLS products into real command and control environments.

Testbeds

In order to support the overall MLS technology insertion effort and to evaluate the usefulness of newly available MLS products, two defense-wide MLS testbeds were designated for the purpose of product testing in real environments. The first MLS testbed was established at the Military Airlift Command (Scott Air Force Base). The second was at the U.S. Central Command (MacDill Air Force Base). The operational environments at these two locations were conducive to the transition of lessons learned to other joint commands as well as to the individual military services. MLS testbeds continue to operate today, providing a valuable source of information concerning operational use of MLS products.

MLS Products

MLS products are based on what is known as "trusted system technology." That is, the hardware and software that comprise an MLS system are subject to rigid scrutiny in order to insure all events occurring within a computer operating system, for example, are clearly understood. The intent here is to

Now that the Cold War is over, and the Defense Department is moving toward increased levels of efficiency, multilevel security technology is becoming a high interest item.

insure that there are no unauthorized activities occurring within a given system. The intent also is that a computer's operating system and other components within a trusted information system perform in accordance with manufacturer claims.

The concept of "trust" therefore, means that an MLS product will be trusted within certain parameters to perform a repetitive automated function that an operator had previously performed manually. MLS products today fall into five categories: Gateway/Guard, Trusted Workstation, MLS Local Area Network (LAN), Trusted Database Management System (DBMS), and Trusted Host.

MLS products known as Gateway/Guards are relatively easy to understand. They perform very focused and defined tasks, generally between two networks or between two data sources. Acting as a filter for the transfer of information (high to low or low to high) or simply as a routing device, the Guard/Gateway performs rule based (expert system) tasks that can save commanders and their staffs valuable time.

A Trusted Workstation may be used to display two different data sources (Multilevel) on a single terminal screen. The two screens may derive from two different classified sources at the same level (i.e. compartments) or from two classified levels (i.e. Secret and Confidential). The operator would use a "mouse" to cut and paste between windows on the same screen to effect transfer of data electronically, rather than relying solely on manual/paper transfers. In some cases, the workstation is used as a "platform" to perform other tasks related to maintaining the security of a system.

An MLS Local Area Network, by itself, is used to enforce separation of two different levels of classified users. A great many terminals may be included in a single MLS LAN structure.

The MLS Trusted Data Base Management System insures separation of different levels of classified information within the database itself. Finally, a Trusted Host will accept different MLS software applications that will enable the host computer to process more than one level of classified information with other levels.

Fielding MLS Technology Products

For any military technology, the payoff occurs when the real user gets involved. The user environment is the mission area of the MLS Technology Insertion Program. The program was created to enhance information system environments that already exist, through the insertion of new MLS products into those environments.

The state-of-the-art for MLS products today is focused in the Guard/Gateway arena. Keep in mind that a Guard functions much the same way as any other expert system that operates on rule based logic. It performs tasks that humans do ordinarily. However, the guard contains very sophisticated software that allows the device to achieve a level of "trust" for the process that it is performing. Once installed, it takes over repetitive standard functions involved with transfer of classified operational data. The Guard process includes an option for human review, if desired.

The process of multilevel security technology insertion and development will be an evolutionary one.

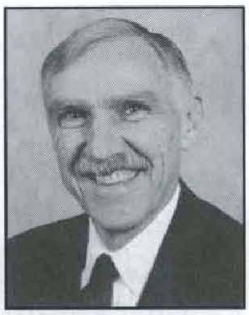
Conclusions

Now that the Cold War is over, and the Defense Department is moving toward increased levels of efficiency, multilevel security technology is becoming a high interest item. A new initiative from the Joint Chiefs of Staff-C4I for the Warrior-is a strategic concept that all of DOD will hear more about in the near future. One of the elements of this new JCS thrust is improved interoperability.

Multilevel security technology will provide a significant contribution to this effort in helping the JCS achieve that goal. The process of multilevel security technology insertion and development will be an evolutionary one. Ever since we entered the island of Grenada with our Caribbean partners back in 1983, there has been continued interest in improving our joint fighting capability worldwide. That movement is continuing with multilevel security expected to play an increasingly important role. The next article in this series will discuss a companion program to the MLS Technology Insertion Program—the Defense Information System Security Program.

COL W.H. FREESTONE is manager of the Joint Multilevel Security Technology Insertion Program at the Defense Information Systems Agency. He is also a member of the Army Acquisition Corps.

PEO-AR



Dale G. Adams

Dale G. Adams holds a B.S. degree in chemical engineering from Lafayette College in Easton, PA, and a master's degree in electrical engineering from the New Jersey Institute of Technology. Since 1990, Adams has served as the program executive officer for armaments (PEO-AR) at Picatinny Arsenal, NJ. He also served previously at ARRADCOM as: director of product assurance; chief of the Armament Division, Fire Control and Small Caliber Weapons System Laboratory; and as the deputy director of the Small Caliber Weapons Systems Laboratory. From 1985 until his 1990 appointment as PEO-AR, Adams worked at Aerojet Ordnance, Downey, CA, first as vice-president of quality assurance and later as vice-president of the Ammunition Division.

Adams' management philosophy is in line with the fundamental PEO management concept of monitoring project management adherence to program baselines. His involvement in day-to-day project management activities is limited to considerations relevant to those baselines, and he prefers to delegate managerial authority to his project and product managers to conduct their programs. Periodic formal management reviews conducted by senior PEO staff members, including Adams, with the program offices and appropriate industry contractors are the primary mechanism for program baseline oversight.

Missions and Organization

PEO-AR's mission is to exercise the full line authority of the Army Acquisition Executive for the overall management, direction and control of tasks and designated associated resources for a major portion of the ground combat armament mission for the Department of the Army. PEO-AR, including assigned project and product managers, has an authorized staff of 168, comprised of military and civilians. Mission areas supported are:

- **Sense and Destroy Armor (SADARM)** - sub-munitions are being developed for integration into the Multiple Launch Rocket System (MLRS) and 155mm Cannon Artillery Projectiles;
- **Tank Main Armament Systems (TMAS)** - the 120mm Tank Main Armament and the Advanced Tank Cannon (ATAC) Systems, with complementary ammunition, are being developed for support of current and future tank systems;
- **Mines, Countermines and Demolitions (MCD)** - intensive management of mine, countermine and demolitions programs from development through initial production, fielding and product improvement;
- **Paladin (M109A6)** - major development of the M109 self-propelled Howitzer with primary emphasis in the areas of RAM, terminal effects, survivability and responsiveness; and
- **9mm Pistol Program** - current production of U.S. designated M9, the new standard pistol for the Department of Defense, and for "NATO" qualified parabellum ammunition, high pressure test ammunition, designated ancillary items, and support equipment for the Army, Navy, Marine Corps, Air Force and Coast Guard.

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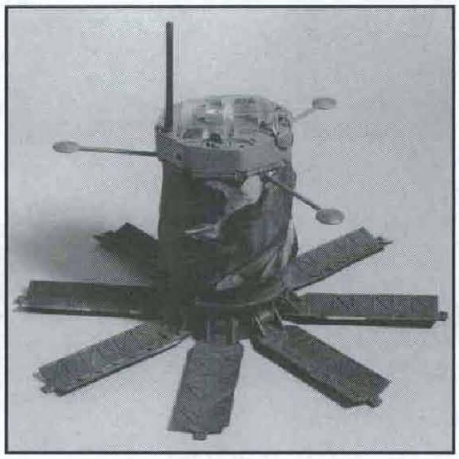
PM TMAS	COL Franklin V. Hartline	Picatinny Arsenal, NJ Comm. (201)724-5307; DSN 880-5307
PM MCD	COL Richard H. Johnson	Picatinny Arsenal, NJ Comm. (201)724-7041; DSN 880-7041
PM PALADIN	LTC William R. Hertel	Picatinny Arsenal, NJ Comm. (201)724-2572; DSN 880-2572
PM 9MM	LTC Howard M. Lane, Jr.	Rock Island, IL Comm. (309)782-3895; DSN 793 3895

MINES, COUNTERMINES AND DEMOLITIONS (MCD)

Wide Area Mine (WAM)

The WAM is a radically new, intelligent mine, which is effective over a 100 meter radius. WAM's seismic and acoustic sensors monitor the environment and provide information to an onboard microcomputer which identifies the target, computes an intercept path and launches a skeet over the target. The skeet's onboard IR sensor locates the target and fires an explosively formed projectile at the top of the target. WAM will incorporate other radically new features, including command, control and two-way communication, and on/off command capabilities. WAM will be both hand emplaced and mass scattered. The hand emplaced version is scheduled for fielding in FY97.



Stand Off Minefield Detection System (STAMIDS)

Photo Not Available

The Stand Off Minefield Detection System (STAMIDS) is an aerial mine detection system which will provide field commanders with advance warning of the existence of minefields. STAMIDS will be able to detect a full range of minefields from surface laid or buried pattern minefields to scatterable minefields. STAMIDS will consist of a sensing system and data preprocessing system mounted upon an airborne carrier, such as a short range UAV and helicopter, telemetry to a ground processing station, and a ground station data processing system which will provide the data analysis in a user-friendly format. STAMIDS will enter Proof of Principle in FY93.

Time Delay Firing Device (TDFD)

The TDFD is a cigarette pack-sized, field-settable, battery-operated, single shot, explosives-initiating device, which will be used as a replacement for the M1 Delay Firing Device. the device incorporates a number of new features, such as an arming delay with visual countdown, and resetability during the arming cycle which provide additional options and enhance safety. TDFD will be used in a variety of different conventional and unconventional demolition missions. TDFD contains an electronic timer, which can be programed incrementally from five minutes up to 30 days, an integral power source and a self-contained explosive timer, which can be attached to an M7 blasting cap. TDFD will be fielded in FY93.

PROGRAM EXECUTIVE OFFICER — ARMAMENTS

9MM PISTOL PROGRAM (M9 PISTOL)

The M9 is the replacement for the M1911A1 .45 caliber pistol and the 4-inch barrel .38 caliber revolvers currently used by the Department of Defense. The M9 is a semi-automatic double action pistol that is more lethal, lighter, and safer than the M1911A1. The M9 is carried by service members who are not issued rifles, and others who have a close quarter personal defense requirement, such as law enforcement personnel and aviators. Adoption of the M9 pistol and ammunition provides U.S. troops compatibility with NATO allies. The M9 is currently in the fifth year of fielding.

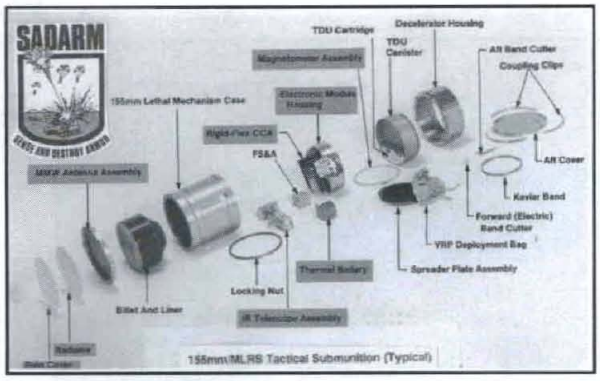
Right Front View of a Soldier Holding the M9.

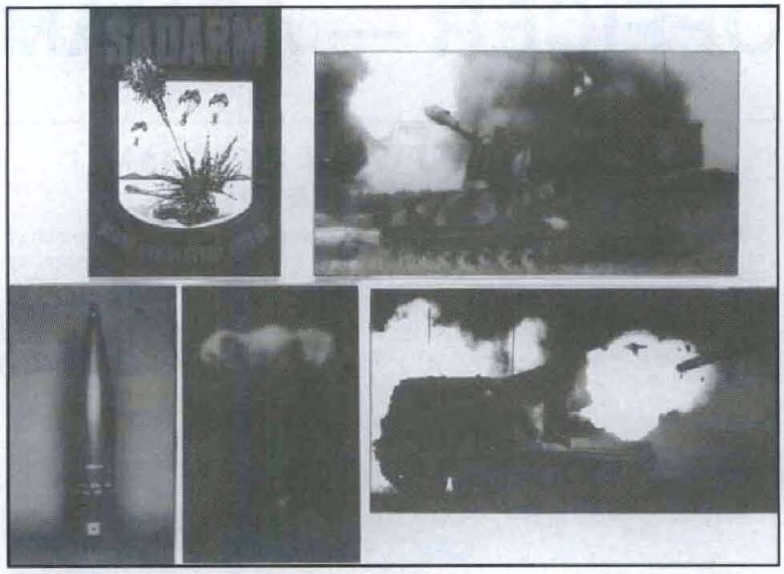
Left Side View of Pistol, M9, 9mm Semi-Automatic.

Right Side View of Pistol, M9, 9mm Semi-Automatic.

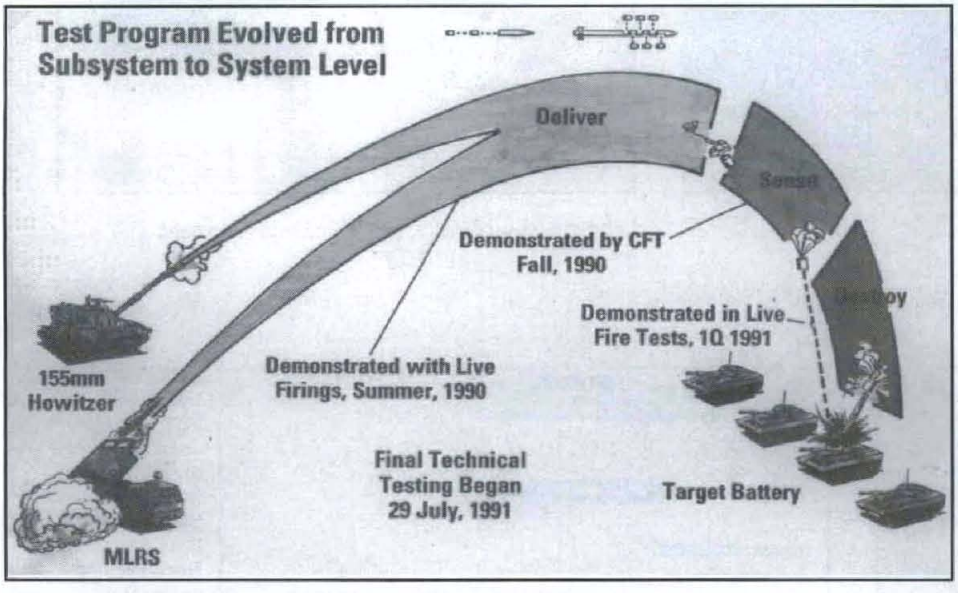
Left Side View of Pistol, M9, Field Strip. The Level of Disassembly of Components (top to bottom): Slide Assembly, Barrel Assembly, Recoil Spring Guide Rod Assembly, Receiver Assembly with Grips, Recoil Spring, and Magazine Assembly.

SENSE AND DESTROY ARMOR MUNITION (SADARM)

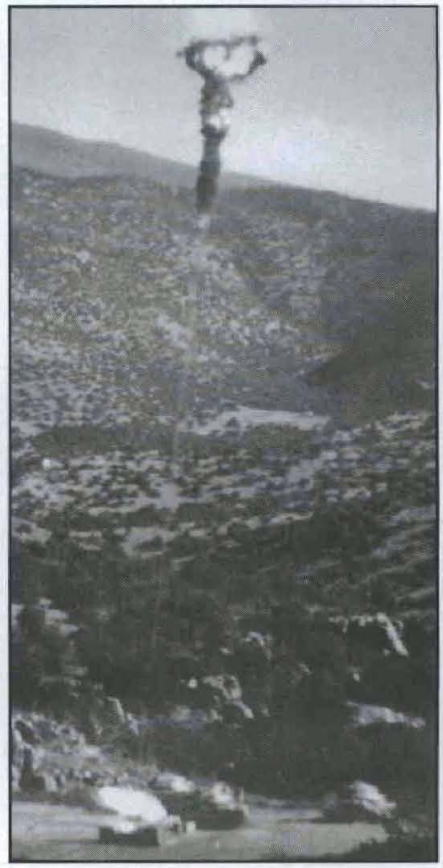




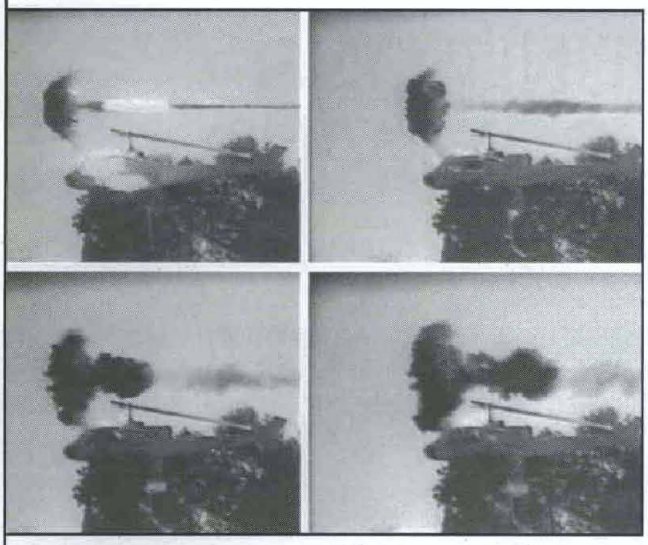
SADARM is a smart sub-munition which utilizes active and passive millimeter wave and infrared sensors to detect combat vehicle targets, then kills the target by firing an explosively formed penetrator through the top. It is delivered by either of two artillery carriers with two SADARM sub-munitions in the 155mm howitzer projectile, and six in the MLRS rocket. The principal mission of the SADARM munition is in the counterbattery role, destroying enemy artillery with the speed and efficiency necessary to limit friendly losses to opposing fire. A key attribute of SADARM is its resistance to countermeasures and ability to work in all weather conditions. SADARM is the Army's first fire and forget smart artillery munition.



The 155mm howitzer delivers a SADARM projectile to the target area where two SADARM sub-munitions are dispensed, and a decelerator parachute is deployed. The millimeter wave radar then senses altitude and, at the proper height, a second stage parachute is deployed and millimeter wave and infrared sensors then begin their scan. The combined sensor input identifies an appropriate armored combat vehicle; the warhead fires; the SADARM Explosively Formed Penetrator (EFP) then penetrates the top of the vehicle; and the vehicle is destroyed. The MLRS launcher delivers a rocket to the target area where six SADARM sub-munitions are dispensed and parachute decelerators are deployed. After parachute opening, the sequence of events is exactly the same as for the 155mm sub-munitions. Each projectile or rocket load carries the potential for multiple target kills.

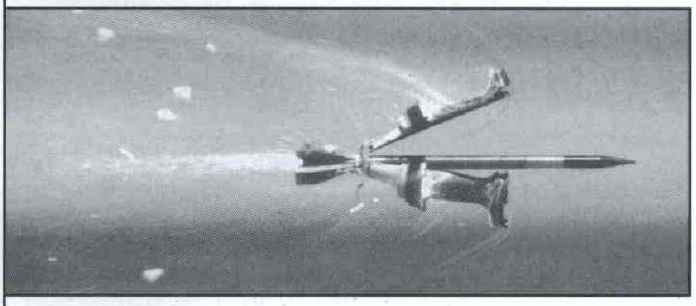


TANK MAIN ARMAMENTS SYSTEM (TMAS)



Cartridge, 120MM
HEAT-MP-T, M830A1

The M830A1 cartridge provides the M1A1 tank with a credible anti-helicopter self-defense capability. When used against ground targets, the cartridge uses a sub-caliber projectile which provides reduced drag and shorter time of flight and significantly increases the probability of a hit at longer ranges. Probability of incapacitation against buildings and bunkers is also increased by 25-35 percent over the standard M830. The M830A1 also utilizes an insulated primer and epoxy paint for the combustible cartridge case which will reduce accidents/damage during handling in the field.



Long Rod Depleted Uranium kinetic energy penetrators such as one used on the cartridge, 120mm, APFSDS-T, M829A1 were utilized with devastating effects in Operation Desert Storm. The M829A1 earned the nickname "Silver Bullet" by CENTCOM armor forces for its operational performance. This cartridge was developed and fielded on an accelerated schedule by the TMAS Program Management Office as part of its Armament Enhancement Initiatives program.

Future Armament Systems Technology (FAST)

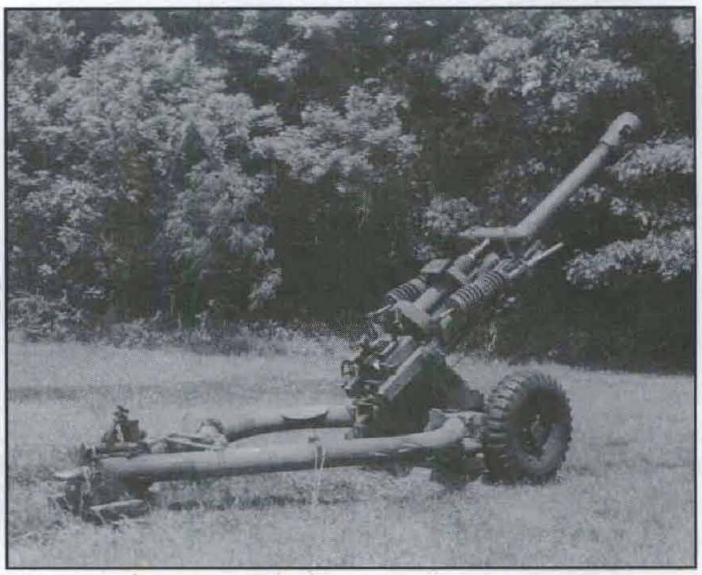
The FAST Program transitions promising technologies in the areas of lethality, fire control, target acquisition, and combat identification from the laboratories into the development stream. The latest implementation of FAST was the Advanced Tank Cannon System Proof of Principle Test which consisted of the XM291 120mm/140mm Gun, XM91 Autoloader and modified M1A1 Fire Control System. The XM291 120mm gun and fire control modifications are a potential lethality enhancement for an Abrams upgrade, with P3I to 140mm or electrothermal chemical options. Current FAST efforts are implementing a new SAVA based extended range fire control system, embedded training, autotracker and a sensor suite consisting of: a millimeter wave RADAR, a Second Generation FLIR and a combat protection system. Future thrusts will result in full sensor fusion and combat identification.

M109A6 SELF PROPELLED 155MM HOWITZER—PALADIN

Formerly known as the "HIP," the M109A6-PALADIN, is an armored, full-tracked howitzer carrying 39 complete rounds. With a crew of four, the Paladin is capable of firing, at greater ranges, all current and developmental U.S. conventional 155mm artillery projectiles. A new turret structure and enhanced survivability measures combine with an Automated Fire Control System (AFCS), permitting accurate position location, azimuth reference and on board ballistic solution. These improvements and the addition of the latest communication equipment enhance the flexibility, response time, rate of fire, and allow semi- autonomous tactical operations. The addition of a Low Heat Rejection Engine and numerous other automotive improvements serve to enhance the reliability and maintainability of the howitzer. The Paladin is currently in Low Rate Production and scheduled to be fielded to its first unit in mid-1993.

U.S. ARMY ARMAMENT, MUNITIONS AND CHEMICAL COMMAND (AMCCOM)

A Mason & Hangar-Silas Mason Co. Inc. employee packs a 120mm M829 tank round into a shipping container at Iowa Army Ammunition Plant, Burlington, IA. The round is used in the M1 Abrams tank.



The M119 105mm towed howitzer is intended for use in direct support field artillery battalions in the light infantry, airborne and air assault divisions. The lightweight howitzer was developed by the United Kingdom and is now manufactured at Rock Island Arsenal, Rock Island, IL.

Commanding General AMCCOM

MG Paul L. Greenberg

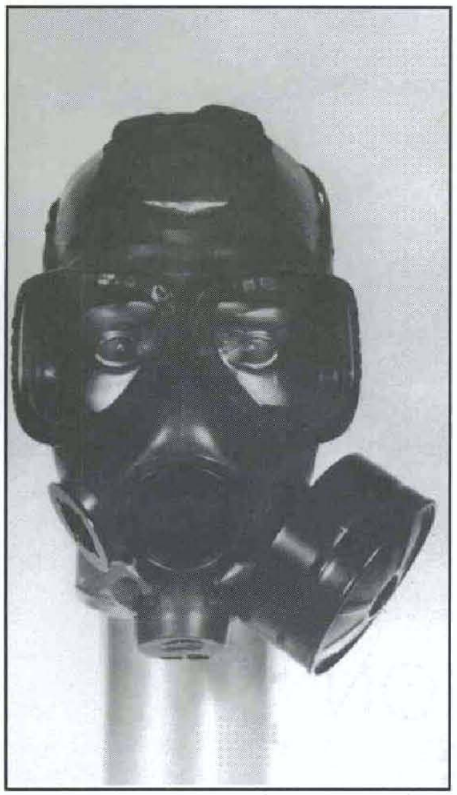
MG Paul L. Greenberg has served as commander of the U.S. Army Armament, Munitions and Chemical Command (AMCCOM) since June 5, 1990. He came to Rock Island, IL, from Headquarters, U.S. Army Materiel Command where he was the deputy chief of staff for ammunition. Commissioned a second lieutenant through the ROTC program upon graduation from Texas A&M University with a B.S. degree in chemistry, MG Greenberg holds an M.S. degree in systems management from the University of Southern California, and an M.B.A. from Shippensburg State University, PA. His military education includes the Infantry, Ordnance and Intelligence Schools; the U.S. Army Command and General Staff College; and the U.S. Army War College. MG Greenberg has filled many command and staff positions during his career. He served as deputy commanding general for procurement and readiness, AMCCOM, Rock Island, IL; project manager, ammunition logistics, U.S. Army Armament Research, Development and Engineering Center, Dover, NJ; commander, Rock Island Arsenal, Rock Island, IL; chief, Munitions Division, Office of the Deputy Chief of Staff for Research, Development and Acquisition, Department of the Army, Washington, DC; and commander, Longhorn Army Ammunition Plant, Marshall, TX. MG Greenberg has also served in Vietnam, Korea and Germany.

Missions and Organization

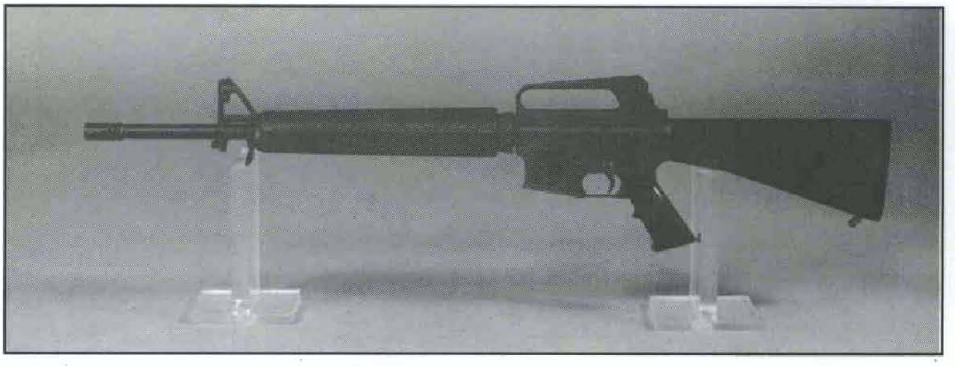
AMCCOM, headquartered at Rock Island Arsenal, Rock Island, IL, is the largest major subordinate command of the U.S. Army Materiel Command. Its primary missions are research, development, engineering and readiness.

AMCCOM has installations and activities throughout the United States, encompassing two research, development and engineering (RDE) centers, three arsenals and 26 Army ammunition plants and activities. With an annual budget of about five billion dollars and assets of 44 billion dollars, the command has the diversification and flexibility to produce a strong readiness capability.

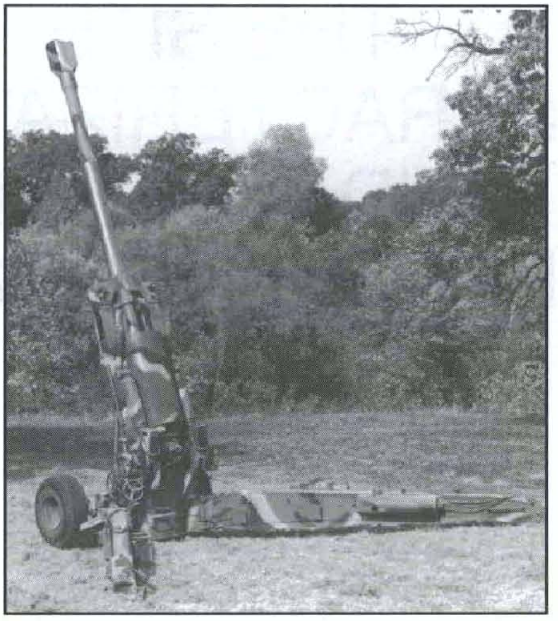
The U.S. Army Armament RDE Center (ARDEC), located in Dover, NJ, incorporates state-of-the-art technology into military equipment. It performs research, development and engineering on direct fire, close combat systems ranging from bayonets to tank cannons; and indirect fire support systems such as artillery, mortars, ammunition, mines, countermines and demolitions. The center is a leader in the development of precision and smart munitions and liquid propellant and electromag-



The M40 Nuclear, Biological and Chemical Protective Mask is fabricated from silicon rubber instead of natural rubber used in the M17A2 model. This provides better fit, improved comfort and improved performance in low temperatures. The M40 uses a NATO-compatible, easier to change, external C2 canister. The M40 has a front and side "voicemitter" and larger lenses for improved vision.



The M16A2 rifle is the standard rifle for the individual soldier. The rifle fires the 5.56mm round produced at AMCCOM's Lake City Army Ammunition Plant, Independence, MO. The M16A2 has a new muzzle compensator, new square front sight and more sophisticated rear sight, new interchangeable, cylindrical handguards and a three round burst control device.



The M198 155mm Howitzer is a helicopter transportable medium towed howitzer. It provides significant improvement over previous towed 155mm howitzers in lethality, range, reliability, availability, emplacement and movement. The cannon will fire a 98-pound, rocket-assisted projectile approximately 18 miles.

netic gun technology.

The U.S. Army Chemical RDE Center (CRDEC), located at Aberdeen Proving Ground, MD, is the DOD focal point for nuclear, biological and chemical defensive materiel. The center develops monitors and sensors to detect and identify chemical and biological agents, develops decontaminating systems, new protective masks and equipment, and smoke and other obscurant systems.

While these two centers develop new weapons and systems, other AMCCOM installations concentrate on sustaining the readiness of weapons already in the field.

AMCCOM has three government-owned and operated arsenals that perform a variety of missions to support the armed forces. Rock Island Arsenal, IL, the largest weapons manufacturing arsenal in the free world, produces recoil mechanisms and gun mounts for most of the howitzers and tanks now in the field. The arsenal also manufactures the carriages and performs complete assembly of the M119 and M198 howitzers.

Watervliet Arsenal, near Albany, NY, produces mortars, tank and howitzer gun tubes, recoilless rifles and associated breech mechanisms and spare parts. The arsenal is the center for the production and procurement of thick-walled cannons, including the 16-inch guns used on the Navy's battleships. Watervliet has the largest computerized flexible manufacturing system of its kind in America.

Pine Bluff Arsenal in Arkansas produces smoke, incendiary, and riot control munitions. It also produces and renovates various protective masks used by all branches of DOD.

As the single manager for conventional ammunition for DOD, AMCCOM is responsible for the procurement, production, shipment and maintenance of conventional ammunition. AMCCOM shipped more than 453,000 short tons of ammunition to our troops during Operation Desert Shield/Storm.

Ammunition production is largely accomplished by AMCCOM's 16 active ammunition plants. The various plants produce small arms ammunition, propellants and explosives, metal parts, and load, assemble and pack the rounds. AMCCOM also provides technical assistance and training in the field. Logistics assistance representatives are located worldwide and work directly with the troops to respond to readiness concerns. Quality assurance specialists assess the readiness and safety of ammunition stockpiles and assure that it is stored safely, maintained appropriately and demilitarized when necessary.

AMCCOM HEADQUARTERS GROUP

Commanding General	MG Paul L. Greenberg DSN: 793-5111 Comm.:(309)782-5111	Rock Island, IL
Deputy Commanding General for Procurement and Readiness	BG James W. Boddie Jr. DSN: 793-5944 Comm.:(309)782-5944	Rock Island, IL

THE SITE CHARACTERIZATION AND ANALYSIS PENETROMETER SYSTEM

A Breakthrough in Hazardous Waste Site Investigations

By Dr. Philip G. Malone and Landris T. Lee

Introduction

The Department of Defense is faced with the Herculean task of cleaning up military facilities across the nation. The Superfund Amendments and Reauthorization Act of 1986 provided continuing authority for the secretary of Defense to promote and coordinate efforts for evaluation and cleanup of DOD installations. The massive evaluation and cleanup effort involves 17,665 sites at 1,880 defense installations. Funding for this cleanup effort has risen to over $1 billion per year.

Contamination in the soil and groundwater is one of the major pollution problems being addressed in the cleanup program. Typically, the major pollutants involved are fuels, explosives and energetics, chlorinated solvents, and heavy metals. Soil and groundwater pollutants come from leaked, spilled or disposed fuels; industrial chemicals; and military materials.

Soil and groundwater pollution has traditionally been investigated by drilling and installing monitoring wells. Soil samples are taken as the monitoring wells are installed. Protocols currently in use call for using a stab sampler or split-spoon sampler to take samples every 5 feet or at every change in soil type. Unfortunately, this type of sampling results in an incomplete record that may omit thin contaminated layers that are extremely important in understanding and predicting the spread of contamination.

Water sampling is done after installing monitoring wells. The wells are installed to collect groundwater samples at discrete points and are constructed with the well screen installed at a selected horizon. Once installed, a monitoring well is usually integrated into a site sampling program and becomes the data point that represents that part of the site. Unfortunately, subsurface information needed to site a monitoring well is usually scarce prior to well drilling. Post-installation evaluations conducted by the Department of Energy have shown that approximately 50 percent of the wells are not appropriately placed to provide the necessary information to plan remedial action at a site.

With the large number of DOD sites that require investigation, it is obvious that substantial savings can be realized if a fast, inexpensive method of investigating soil and groundwater contamination prior to the installation of monitoring wells can be developed. The U.S. Army Toxic and Hazardous Materials

The SCAPS truck is completely self-contained with a separate instrumentation area in the back of the truck body and the penetrometer rod handling area in the front.

Agency (USATHAMA) directed the U.S. Army Engineer Waterways Experiment Station (WES) to develop the cone penetrometer as a supplementary technique for the investigation of subsurface contamination.

Large truck-mounted cone penetrometers, capable of pushing a penetrometer rod to depths of approximately 150 feet in normal soils, have been used for over 40 years in the investigation of the strength properties in foundations and road subgrades. By adding sensors that can detect the presence of contaminants in surrounding soil or groundwater, the cone penetrometer can become an invaluable tool in rapid reconnaissance of waste sites.

Under the direction of USATHAMA, the Site Characterization and Analysis Penetrometer System (SCAPS) program was initiated as a tri- service program in the Department of Defense. It has evolved into a cooperative program involving the Department of Energy. WES has developed a prototype penetrometer truck that is equipped to measure soil strength, electrical resistance and soil fluorescence. This type of equipment has proven to be especially useful in determining the type of soil and the level of contamination at sites where fuel leaks and/or spills have contaminated soil and groundwater.

Site Investigation Procedures

A typical site investigation begins with a surface geophysical survey conducted with direct current resistivity, conductance (induced electromagnetic) and magnetic field measuring equipment. The surface geophysical survey is designed to locate buried obstacles and buried utilities. The penetrometer rod, moving through the soil at 3 feet per minute, can push a hole through most underground piping and can severely damage buried cables and conduits. Maps generated from the geophysical survey and site utility plans are used to lay out the positions of the penetrometer survey holes.

SCAPS Penetrometer Survey Van

The SCAPS cone penetrometer consists of a set of hydraulic rams mounted on a 20-ton, all-wheel drive truck. The rams are designed to be used with the reaction mass of the truck to drive a steel rod into the soil. The hydraulic rams can force a 1.4-inch-diameter steel rod to a depth of approximately 100 feet in normally compacted fine-grained soils in less than an hour. One crew can push seven to 10 penetrometer holes in one day.

The SCAPS truck is specifically designed for use on hazardous waste site investigations. The rear van is divided into two compartments. The rod handling area is in the front of the van and is separated from the instrumentation section in the rear. Each compartment was built with its own air conditioning system. For safety, the rod handling compartment is constantly monitored during operation for toxic or combustible gasses.

The van body is finished inside and out with stainless steel panels to facilitate decontamination. A specially designed trailer carries grouting pumps to seal each hole. The trailer also has a water tank and a closed-loop steam cleaning system for decontaminating the rods as they are withdrawn from the ground.

SCAPS Sensor Options

The penetrometers are presently equipped with three different types of sensors. Strain gauges installed in the penetrometer tip can measure the force exerted on the conical tip of the penetrometer rod and the sidewall (or sleeve) friction developed on the rod directly above the tip. The pattern of forces on the rod sensors varies in a consistent way with the type of soil (sand or clay) being penetrated. The relationship between the tip resistance and the sleeve friction can be used to deduce the type of soil being penetrated.

Electrical resistivity sensors have been built into some penetrometer rods to permit the DC resistivity to be measured continuously as the rod is forced into the soil. Any contamination from dissolved salts (electrolytes) can

be mapped based on resistivity changes.

On other SCAPS penetrometer units, a unique fiber-optic sensor, a fluorometer, has been installed to measure the concentration of fluorescent compounds in soil. The penetrometer units equipped with the fluorometer have been especially successful in locating soil contaminated with petroleum, oil or lubricants.

All penetrometer sensors read out in real time in the instrumentation section of the van. The site investigation can be altered as the work progresses, and data and samples can be added to cover unexplored areas that computer-based extrapolation indicates are contaminated.

The SCAPS penetrometer can be used with sampling equipment to obtain soil or groundwater samples at depths where contamination is thought to have occurred. While penetrometer samples are typically smaller than those obtained by drilling and sampling, penetrometer samples can be carefully targeted on soil horizons where monitoring well screens will be placed or where "hits" from the sensors indicate significant contamination that should be investigated in detail. The SCAPS penetrometer samples are also considered to be of superior quality since they are not contaminated by drilling fluid.

Data Analysis

When the data collection is complete, the readout from the sensors can be visualized for an entire site using large scale three-dimensional data contouring programs. The irregularly spaced data set from the penetrometer sensor system is mathematically gridded to produce a synthetic data set. The volumes of contaminated soils are represented as concentric shells with increasing levels of contamination.

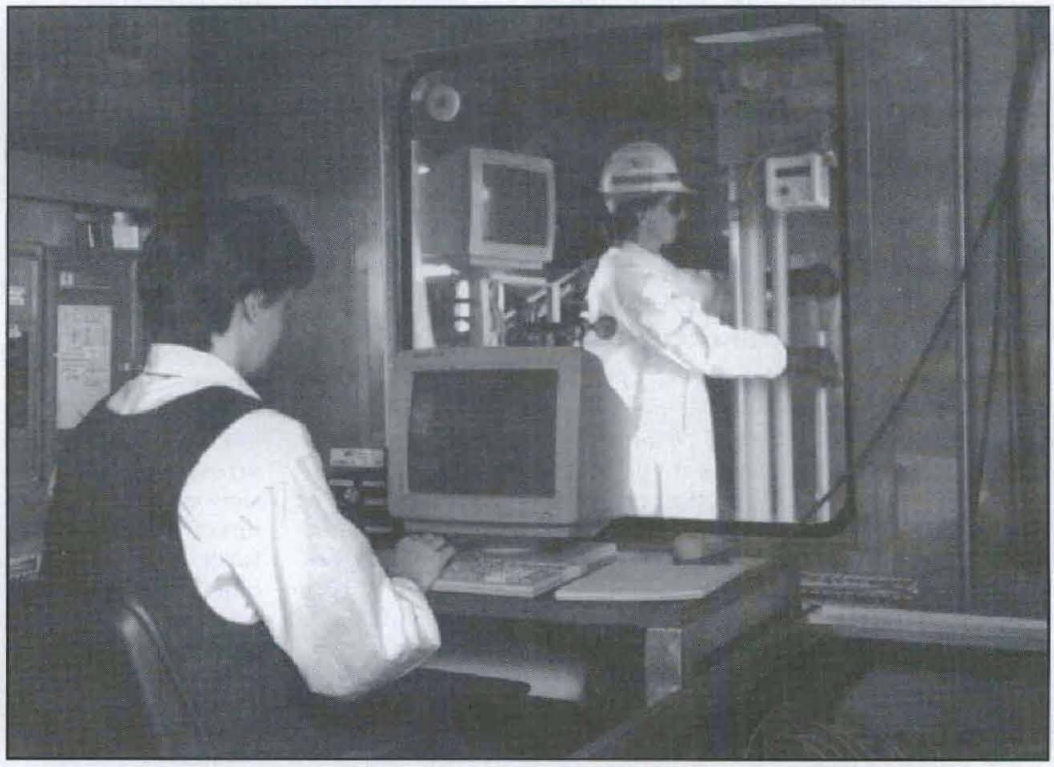
By using the visualization program running on a computer workstation, the three-dimensional representation of the shells, or plumes, can be rotated so that the soil volume having a specific level of contamination can be viewed from any angle. The visualization data can be converted into a series of maps or cross-sections showing the different levels of soil contamination across a site. The three-dimensional representations are especially useful in planning remedial action, such as waste extraction or excavation of the contaminated soil mass where the volumes of waste or soil are critical questions for decision-makers.

After a SCAPS investigation, long-term monitoring can be done with a relatively few monitoring wells installed in critical locations with the well screens set in soil units that are the most likely conduits for contaminant movement. Laboratory analytical data from water and soil samples obtained from monitoring wells serve to confirm the level of contamination noted from the penetrometer sensors and satisfy the requirement for standard laboratory analyses where questions of litigation or regulatory compliance arise.

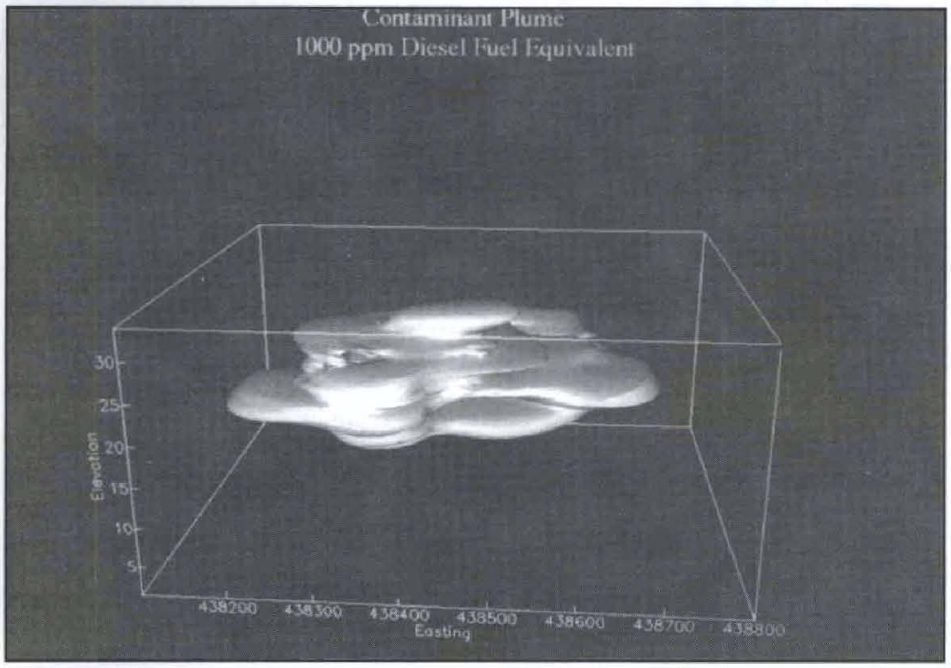
Cost Effectiveness

Because SCAPS penetrometer data results in fewer but optimally placed monitoring wells, the use of the cone penetrometer can offer substantial cost savings in completing the investigation of a contaminated site.

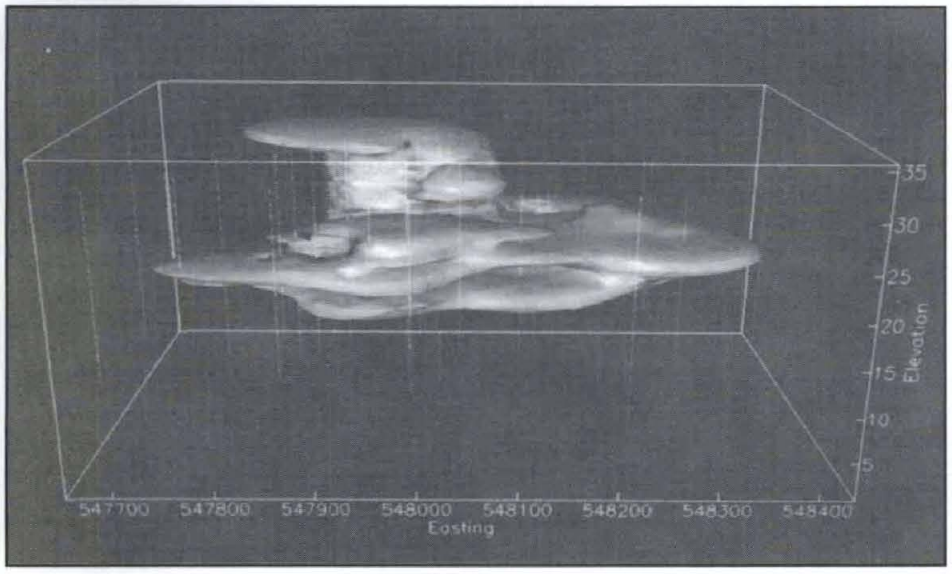
A typical monitoring well at a haz-



Data appears in real time on the instrumentation in the truck as the SCAPS penetrometer is pushed into the ground. Instrumentation personnel can monitor the rod area visually through the glass and by instrumentation sensors to ensure the safety of personnel. Both compartments have separate air-conditioning units for safety.



A black-and-white SCAPS three-dimensional visualization showing a contaminant plume of diesel fuel. A color version would show the contaminant concentrations by various shades of color.



A black-and-white SCAPS three-dimensional visualization showing a contaminant plume. A color version would show the contaminant concentrations by various shades of color. The light vertical lines around the plume represent locations where the SCAPS penetrometer was pushed into the ground.

ardous waste site can cost between $5,000 and $10,000 depending on the depth and type of material specified for construction. The number of monitoring wells on a Department of Defense site may vary from less than 10 to hundreds of wells. A recent Department of Energy study showed that by using SCAPS the number of monitoring wells installed was reduced by 50 percent. This reduced the cost of the investigation by 25 to 36 percent over conventional drilling methods.

The SCAPS system also helps to site each monitoring well so that the groundwater analyses (another expensive operation) have the maximum usefulness.

Additional indirect savings are realized in the reduced stress on the work crew and the increased safety that the enclosed air-conditioned van provides. Site cleanup is simplified and less costly because the penetrometer does not generate contaminated cuttings or drill fluid that must be drummed and shipped to a suitable waste disposal site.

The SCAPS system, with its unique cone penetrometer, allows site cleanup operation with safer, cleaner and less expensive methods than we are presently using. Current plans call for building three more SCAPS trucks and putting them on Department of Defense and Department of Energy sites within the next two years. The new fluorometer sensor technology is being offered for licensing to interested private firms.

DR. PHILIP G. MALONE is a geophysicist in the Geotechnical Laboratory at WES. His master's and doctorate degrees are in geology from Indiana and Case Western Reserve Universities, respectively. He also has completed a year of postdoctoral work as a National Academy of Science/National Research Council associate at the Smithsonian.

LANDRIS T. LEE is a civil engineer with the Geotechnical Laboratory at WES. He received his bachelor's degree in civil engineering from Mississippi State University and his master's in geotechnical engineering from the University of Colorado.

YUMA INITIATIVE EXTENDS LIFE OF ABRAMS TANK AIR CLEANER

By Chuck Wullenjohn

As we look back on the first anniversary of last year's overwhelming victory resulting in the collapse of Iraq's military and the liberation of Kuwait, thoughts turn to activities at the Army's primary desert test center that supported the effort—Yuma Proving Ground, located in Southwestern Arizona. Thousands of overtime hours were worked last year at the proving ground as Desert Shield and Desert Storm tests received priority over the installation's normal heavy workload.

Almost immediately after the Iraqi invasion of Kuwait in August, 1990, many Yuma Proving Ground employees came forward with suggestions of how equipment performance could be maximized in the harsh desert environment of the Persian Gulf. One such suggestion came from test engineer David Horn, working in the proving ground's Combat Systems Engineering Branch. His suggestion dealt with lengthening the life of air cleaners on the M1 Abrams Main Battle Tank, of which nearly 7,000 were deployed.

Before coming to Yuma Proving Ground in 1985, Horn worked in Minnesota as an air cleaner designer. This experience gave him a thorough understanding of the strengths and weaknesses of air filtration systems. He first became familiar with the M1's air filtration system in 1978, when it was undergoing development.

The M1 is one of only two main battle tanks in the world equipped with turbine engines. The other is the Soviet T-80, which didn't see service in the Gulf. The turbine engine, used mainly in jets, offers great speed, power and agility, but at the same time has a voracious appetite for air. The M1's $400 thousand AGT 1500 turbine gulps approximately 10 times more air than its American predecessor main battle tank—the diesel powered M60A3. The engine air intake is located atop the left rear sponson of the M1. Three filters, costing approximately $100 apiece, purify air drawn into the engine.

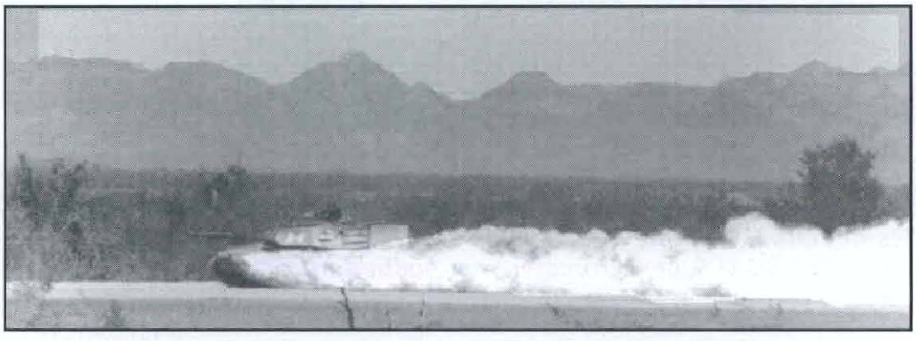
The air inlet is located in an area of the tank that gets extremely dusty from dry sand and dust thrown up by the tank's tracks. Operating in a desert environment, a "worse case" condition, air filter elements clog quickly.

"While viewing the tank time and time again as it traversed the proving ground's dust course," said Horn, "I observed an area located about three feet above the intake—about on a level with the top of the turret—that remained almost free of dust. This led to my idea of constructing an 'air induction tower' that would allow the engine to breathe cleaner air."

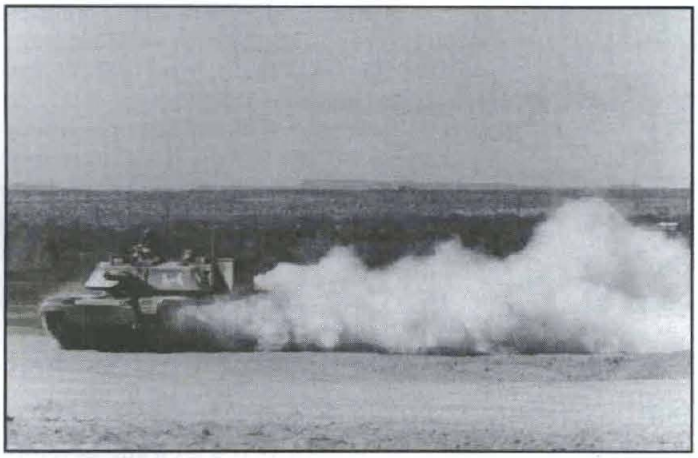
Using the official suggestion program, Horn documented his idea. The suggestion package was forwarded from Yuma to Test and Evaluation Command headquarters at Aberdeen Proving Ground, MD, where Horn's idea was shown and supported at even higher levels. Eventually, his idea went to the Tank-Automotive Command in Warren, MI, where a prototype was developed and sent to Yuma Proving Ground for testing.

"Unfortunately, the Warren, MI, design didn't work," said Horn, "for they made the throat of the tower too small. It was like forcing the M1's turbine to breath through a straw."

Horn telephoned the Tank-Auto-



An M1 Abrams Main Battle Tank, with the experimental plywood air induction tower mounted over the air intake, traverses Yuma Proving Ground's dust course.



Huge quantities of sand and dust can be drawn into the air cleaner of the Abrams tank. The air induction tower, when it underwent testing at Yuma Proving Ground, extended the lives of the three air filters by four times.

Positioned over the air intake on the left rear sponson of the Abrams, the air induction tower allows clean air to be drawn into the engine.

motive Command and requested permission to design and build a new tower at the proving ground using easily available plywood. His request was immediately granted and he set to work.

The reason he chose to build the unit out of plywood was that he felt it would take too long to fabricate steel units and transport them to the Gulf in time for use. With a simple plywood unit, drawings could be sent to the tank crews who could build the towers themselves.

"I wasn't worried about the towers getting damaged in battle, because their only objective was to get the M1 tanks to the site of the battle free of air cleaner problems," he said.

Horn came up with a simple tower design that mounted directly to the turret instead of the tank's hull. This allowed the turret to rotate 360 degrees without interference. With the turret positioned with the tower directly over the engine air intake, air pulled into the air cleaner comes from the less dusty area near the roof of the turret.

As directed by the Tank-Automotive Command, several months of intense testing amid swirling clouds of thick, powdery dust took place on Yuma Proving Ground's unique dust course. Over 700 grueling miles were put on the tower-mounted M1 during that time. In fact, during the course of testing, the plywood tower had to be repainted three times due to the sandblasting it took from sand and dust thrown up by the tank's tracks.

Horn's tower design significantly improved the operating performance of M1 tanks operating on the dust course. By the time testing was completed, tower-equipped tanks were logging mileage four to five times greater than a standard M1 tank.

In addition to the performance gains, Horn estimated that a huge cost savings would be realized if filter usage rates were reduced by 75 percent.

The brief four day ground war in the Gulf was over by the time the tests were concluded. As a result of the tests, however, the Army funded the construction of 10 steel versions of the final design and is currently testing them at the Army's National Training Center at Fort Irwin, CA.

"We tested and proved the engineering aspects here at Yuma Proving Ground," said Horn, "and the Army feels the concept is important enough to explore further. At Fort Irwin they're evaluating the soldier/machine interface of the units under actual operating conditions. If the tests are successful, the units might become a critical component of a special M1 "desert kit."

Though Horn's air induction tower never made it to the Persian Gulf in time to play a role in the Desert Storm victory, he has great memories of the testing effort and the dedication of everyone involved with it. "It was extremely rewarding to develop and submit an idea like this, then to go out and test it to prove it works like I said it would," said Horn. "In essence, we at Yuma Proving Ground were able to beat out other expensive "high tech" air filtration solutions, some of which had been under development for almost 10 years, with about $25 dollars worth of plywood."

"Everyone here was totally committed to the project while testing was taking place. At one point, a rain storm was going to interrupt our testing schedule and everyone gave 110 percent to get as much done as possible before the drops began falling."

Now working in the proving ground's Engineering Services Division, Horn handles the evaluation of YPG reliability data as chief of the Analysis Services Branch. He now enjoys a regular five-day-per-week work schedule, but has fond memories of his former life as a test director.

"Operations Desert Shield and Desert Storm were particularly challenging, for we operated on the very cutting edge of what was happening. We maintained close contact with the Tank-Automotive Command which notified us of problems soldiers in the Gulf were having with equipment. We developed numerous fixes and recommendations. Yes, it was an exciting time."

Horn feels a sense of pride for his idea and, naturally, hopes it's adapted by the Army. Within a few months, the testing results will be tabulated, analyzed and decided upon, and his original suggestion will have an answer.

CHUCK WULLENJOHN is chief of the Public Affairs Office at the U.S. Army Yuma Proving Ground. He is a graduate of Humboldt State Universtiy in California.

ARMY AGAIN EXCEEDS BLACK/MINORITY COLLEGE GOALS

By George T. Singley III
and Dr. Paul L. Marinkas

Introduction

Studies have indicated that in order to meet the expected demand in the year 2000 for new scientists and engineers, the nation will need to attract and retain more students in degree completion activities in science, mathematics, and engineering. Historically Black Colleges and Universitites (HBCUs) and Minority Institutions (MIs) must play a vital role in meeting this demand.

In recognition of this, Congress established the goal that 5 percent of DOD contracts be awarded to Small and Disadvantaged Businesses (SDBs), HBCUs and MIs.

The Army's program for achieving the HBCU/MI aspect of this goal is based on three key approaches: to increase support to the HBCUs/MIs already receiving funding; to increase the number of HBCUs/MIs receiving support; and to develop contract provisions which will encourage prime contractors (including major research institutions) to consider HBCUs/MIs for subcontracting opportunities.

Army Policies Support HBCUs/MIs

As a first step, the Army leadership instructed the Army Research Office (ARO) in Research Triangle Park, NC, to plan for HBCU/MI funding of at least 3 percent, 4 percent, and 5 percent in successive fiscal years. This goal was subsequently expanded to all Army organizations funding programs with higher educational institutions. Additionally, the Army established policy pursuant to a DOD-wide policy to encourage major prime contractors to include HBCUs/MIs as subcontractors. The policy was implemented by making this teaming/subcontracting arrangement an evaluation factor in source selection.

As a result of these policies, the number of HBCUs/MIs successfully competing for research and development awards increased from 19 to 39 between fiscal years 1989 and 1991. In addition, research and development awards to HBCUs/MIs have increased from $9.2 million (4.5 percent in fiscal year 1989), to $22.2 million (8.79 percent in fiscal year 1990), and to $22.6 million (9.62 percent in fiscal year 1991). Thus, the Army has more than doubled the share of awards going to HBCUs/MIs, and has exceeded the Congressional goal by a wide margin in the last two fiscal years.

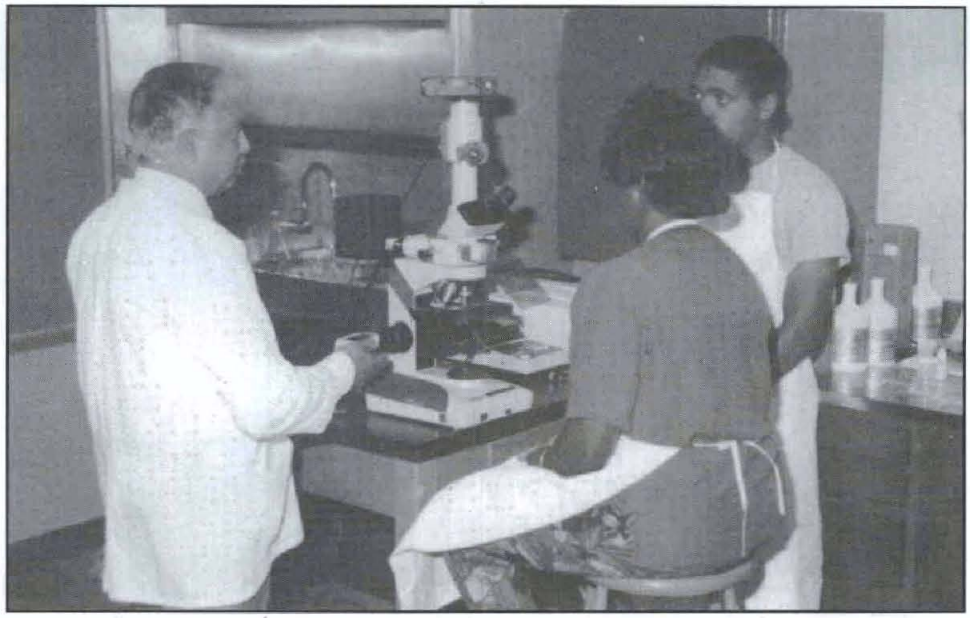
The increase in research and development awards won by certain HBCUs/MIs during this period is particularly noteworthy. For example, awards to Hampton University increased from $60,000 to $461,960; Howard University from $191,000 to $1,708,297; Jackson State University from $139,000 to $632,479; Alabama A&M University from $57,255 to $510,829; Jarvis Christian College from $0 to $125,236; Morris Brown College from $0 to $194,223; and the University of Puerto Rico from $79,000 to $373,379.

Diverse HBCU/MI R&D Supports Army

The diversity of disciplines in which HBCUs/MIs support Army research and development is impressive. Howard and Jackson State Universities are part of a team headed by the University of Minnesota which operates the Army High-Performance Computing Research Center (AHPCRC). Howard University, with its new Computational Science and Engineering Research Center (ComSERC), was the first HBCU to be selected as an affiliate of AHPCRC. The collaboration allows these universities to become involved in the nation's most advanced computer science research, and to investigate areas of super computing that are of special interest to the Army. Among the special initiatives offered by the AHPCRC is its summer program at the University of Minnestoa which provides both hands-on instruction and motivation to both undergraduates and graduate students from other institutions.

Jarvis Christian College, a small private institution in Hawkins, TX, conducts research in kidney function and mathematics. Southern University,

Dr. Franklyn Jennifer (left), president, Howard University and Walter Hollis, deputy under secretary of the Army (operations research) at the opening of Howard University Computational Science and Engineering Research Center.



Dr. Abdul J. Mia (left) conducts research with two students, Pamber Thompson (center) and Haile F. Yancy at Jarvis Christian College.

Florida A&M University, North Carolina A&T University, Tuskegee University, Alabama A&M University, and Clark Atlanta University perform research for the Strategic Defense Command on adaptive tracking of missiles, vibration reduction, high-temperature superconductivity, composite materials, and radiation-hard fluorescent materials. Central State University supports the Army Research Institute for the Behavioral Sciences. North Carolina A&T University supports the Army's Natick Research, Development and Engineering Center in production systems for institutional food packaging

The Future: Strengthening HBCU/MI Infrastructure

To help attain the goal of 5 percent HBCU/MI participation, Congress directed the Defense Department to disseminate knowledge of the program, DOD procurement procedures, and instruction in the preparation of proposals in response to DOD solicitations. While the HBCUs/MIs found this assistance useful, it did not address a fundamental problem, i.e. that many HBCUs/MIs simply did not yet have the capacity or resources to develop a competitive edge in the DOD procurement system.

To help correct this lack of infrastructure, Congress authorized the DOD to provide capacity-building assistance in the form of equipment and renovation of research laboratories, faculty and student development programs, and loans of DOD personnel to assist school faculty, teach, or perform defense research. Also authorized were the award of scholarships and fellowships, the establishment of cooperative work-education programs, and the establishment of partnerships with defense laboratories to instruct students.

The Department of Defense and the Army are in the process of developing policies and programs to implement infrastructure support to the nation's HBCUs/MIs. As an example, Army Centers of Excellence support specific technologies such as rotorcraft, optics, electronics, and high-performance computers. In the future, all new Army Centers of Excellence will have an HBCU/MI member. The Army Research Office will issue a Broad Agency Announcement (BAA) soliciting proposals from HBCUs/MIs to join Army Centers of Excellence and to significantly participate in their research programs.

Additionally, the Army will competitively establish two new Centers of Excellence headed by HBCUs; one in information sciences and another in training research. Interested institutions have submitted proposals and the evaluations have been completed; awards are expected this summer.

Army policy also directs that each Army research, development and engineering center (RDEC) or laboratory will pursue an agreement with an appropriate HBCU/MI for association. The intent of this is to improve the linkage between HBCUs/MIs and Army RDECs/laboratories and to foster collaborative relationships.

The Army leadership feels that its approach and success fully meets the intent of Congress and will contribute significantly to meeting the increasing demand for scientists, engineers and mathematicians.

GEORGE T. SINGLEY is deputy assistant secretary for research and technology in the Office of the Assistant Secretary of the Army for Research, Development and Acquisition.

DR. PAUL L. MARINKAS is chief of the Technical Support Office, Armament Engineering Directorate, U.S. Army Armament Research, Development, and Engineering Center (ARDEC), Picatinny Arsenal, NJ. He is currently on temporary assignment at the Pentagon in the Office of the Director of Research and Laboratory Management, Office of the Deputy Assistant Secretary for Research and Technology.

Dr. Thomas E. Davidson...

ARDEC TECHNICAL DIRECTOR VALUES EXCELLENCE

By Bill Harris

Background

Appointed as the Army Armament Research, Development and Engineering Center's (ARDEC's) technical director at Picatinny Arsenal, NJ, on March 12, 1989, Dr. Thomas E. Davidson has more than 36 years of research, development and acquisition experience. He was appointed to the Senior Executive Service (SES) in 1985 while serving as the deputy director of ARDEC's Fire Support Armaments Center (FSAC).

The Chicago native came to Picatinny in 1982 from Watervliet Arsenal, NY, where he had served as both an Army officer and civil servant since 1956. His last position there was chief of research. His most recent previous position at Picatinny was as FSAC's deputy director.

Davidson is one of the world's leading authorities on armaments and has published more than 30 papers in national and international journals. He was recently named a 1991 winner of the Presidential Meritorious Rank Award, the second highest accolade an SES employee can earn.

He is listed in *American Men of Science* and *Who's Who in the East.* He has received the Outstanding Technical Achievement Award with Presidential Citation, was the co-recipient of two U.S. Army Research and Development Achievement Awards, earned the Alfred H. Geisler Memorial Award for Outstanding Metallurgical Achievement, the American Society for Metals Presidents' Award and numerous other recognitions.

He was awarded a bachelor's degree in metallurgical engineering from Lehigh University, Bethlehem, PA, in 1954. In 1959 he earned a master's degree in metallurgical engineering and in 1968 he obtained a Ph.D. in materials engineering, both from Rensselaer Polytechnic Institute, Troy, NY.

Responsible for all technical operations at ARDEC, he manages an annual budget of more than $1 billion and a technical staff of more than 2,000 scientists and engineers with approximately 2,000 support personnel.

When he entered the Army in 1955, only a year after graduating from college, he didn't know what was in store for him. The young engineer arrived at Watervliet Arsenal, NY, a major weapons research and development facility, with little experience in either soldiering or hands-on engineering. There he learned both, setting his course for the future.

Author's Note: When interviewed for this article, Davidson talked about the challenges that lie ahead for ARDEC, and how he sees the world's largest armaments research and development center meeting those challenges.

"As a lieutenant, I was given an assignment by the arsenal commander to develop a whole new process for manufacturing cannons. This introduced me to the concept of developing and bringing along technology, and of establishing and managing programs and people," he said.

The technical director there was Bob Weigle, who would later become the technical director at Picatinny Arsenal. It was his mentorship that pointed Davidson in the direction he's taken. "He emphasized technological achievement, recognizing those

who achieved it, and pursuit of advanced education." From those early years in his career, Davidson's life work had become clear—technical management and the pursuit of excellence.

Some 37 years later, Davidson is still pursuing those goals. He's still relentlessly dedicated to helping others and their organizations to be the best that they can be.

As he assumed positions of higher and higher authority, he learned more and more about how to achieve, about how someone can make his or her mark in the Army's R&D community.

His plan of attack is something he advises all new employees to adopt.

Four Points

"I call them my four points. They're not revolutionary, mostly common sense.

"First, achieve excellence in your chosen profession. If you're a chemist, be a good chemist. Being recognized is important because when you lead people you need to have their respect, their technical respect.

"Second, decide your future direction. Management? Technical leader? Would you rather manage others or become a technical expert in your chosen field?

"Third, focus. Dedicate yourself to whatever direction you've chosen—through work, through training. Achieve visibility.

"Last—have fortitude and patience. Be willing to stick to your goals. Don't get distracted or go on divergent paths."

Davidson points out that it was Weigle's mentoring that pointed him in the right direction, and so he provides these suggestions for young people interested in engineering and science.

Challenges

"These disciplines are very difficult to pursue, but having the best capabilities in these areas are basic to the survival of this country," he somberly noted. "We are in a worldwide technology battle over a variety of fronts. Although our challenge is no greater than in many other areas of competition, we can't afford to be second best in defense. Peace will be maintained only through our strength and superiority. Other areas in the world are emerging very rapidly, and we have to be smarter and more aggressive in getting new technology into the field.

"So the challenge to excel in these disciplines is greater than at any time in the past because of both the complexity of the tasks and the demand for rapid and responsive technological solutions."

Davidson sees these challenges as more difficult for yet another reason, one which up to a few years ago hadn't been as critical. With the end of the cold war, the competition for program dollars has become keen both inside and outside the defense establishment. Money to fund ARDEC's programs is still available, but Davidson said that the center is now looking to do what it's required to do more economically.

He said that will equate to a 15 to 20 percent drop in ARDEC manpower over the next five years. "We are already consolidating operations, closing some buildings. We're in a competitive market for defense dollars even within the defense establishment itself.

"We're looking at the marketplace much more determinedly, and where we can we're buying non-developmental items. The M119 lightweight 105mm howitzer is a good example. The British had an existing weapon system that met our needs, so we bought it."

Curt L. Dunham, chief of technology development, electric armaments (right) shows Dr. Davidson the incoming power lines of the cartridge plasma injector of the electrothermal chemical gun located at Picatinny Arsenal, NJ.

Maintaining The Technological Edge

Exchanging technology with other nations has its advantages, and Davidson highly encourages cooperation. But he cautions that that can lead to complacency. "We have to watch for that. It will be more difficult in the future to maintain that edge, and we must have a top-notch in-house capability to develop new systems. Maintaining the technological edge is one of my primary thrusts, along with educating our work force."

Leading the technical effort of an organization that consists of almost all civilians (4,000 versus less than 200 military), Davidson isn't overly concerned that some ARDEC employees will opt to leave government service for more financially lucrative positions in related industry.

"It happens in industry. Good people are always in demand and we can't live in fear of that. All we can do is train them to be the best. We should look with pride that industry wants our people. The reason why so many stay is that we give them the best education and much greater responsibilities than industry. And those that do leave go mainly to the defense industry, so it helps maintain our national expertise. And we will always be a manpower source for our program executive officers and product/project managers."

As part of that manpower at Watervliet during the '50s, the young engineer couldn't have dreamed how far armament technology would come. He said, "I'm amazed at our ability today to pack guidance and control electronics in a cannon projectile that's fired at 1,000 meters per second—and have it work reliably.

"The use of artificial intelligence to help tank and artillery crews make better fire control decisions is also something I never would have dreamed of. And although the concept of launching a projectile with electrical energy is not new—being able to make a system small enough to use it in a tactical vehicle is. If all we had to do is defend Niagara Falls, we could have made an electric gun years ago to accomplish that task."

Although electric guns won't be fielded until the 21st Century,

PEOPLE IN PERSPECTIVE

Davidson's responsibilities entail the short and near term too. After all, he's quick to emphasize, "Our job...is to get items in the hands of soldiers.

"In the short term, through 1995, ARDEC's customers will get in their hands 81mm and 120mm mortars with greater range that will deliver twice the lethality; 105mm and 120mm tank ammunition with significantly greater penetration capability (some made their mark in Saudi Arabia, he said); new mine systems capable of being laid from the ground or air (the Volcano); the M119 howitzer, which has a 50 percent increase in range over its predecessor, and a new 155mm howitzer round that can fly 20 percent farther," Davidson projected.

Smart Weapons

From 1996 to the turn of the century will mark the emergence of smart weapons. "The SADARM (Sense and Destroy Armor Munition) for the 155mm howitzer and Multiple Launch Rocket System, the WAM (Wide Area Mine), controllable mine fields and the STAFF (Smart Target Activated Fire and Forget) round (a tank-launched top attack anti-tank round) will all be fielded.

Davidson has an eye on Army downsizing. He said, "Smart munitions and dumb munitions have the same purpose, but it takes fewer smart ones to get the job done, so you need fewer planes and ships. They're a force multiplier because they decrease both the logistics tail and the number of platforms needed to use them. They're especially important for our light divisions, which have minimal transportation requirements but still must be able to survive."

Beyond 2000

Beyond the year 2000 Davidson sees great promise for electric guns, for liquid propellants and for three-dimensional minefields. "With electricity we can fire faster, almost eliminate battle trace (muzzle flash and noise), double energy on target and significantly reduce catastrophic events inside vehicles. Liquid propellants will provide greater range, quicker firing rates and decrease the logistics burden and cost of artillery systems." Davidson said that enemy helicopters won't be safe on the turn-of-the century battlefield laced with mines capable of seeing, hearing, acquiring and firing on both ground *and* air targets.

With a sense of great satisfaction, Davidson pointed to Operation Desert Storm, where soldiers used the weaponry developed by ARDEC with overwhelming success.

Shortly after his appointment as technical director he was asked how he felt about it. "Anyone who works in the R&D community would aspire to a position like this because we are the largest R&D center in the Army, and I am certainly excited about the challenge.

Job Perspective

"I see the job as being the outside face of ARDEC in the technical community. My job is basically to guarantee where we are going and to assure that we have the resources to get there. It's my job to see that we are responsive as a technical community to our user, whoever he or she may be, whether it's the person in the field or the person solving a problem in the production plant. All of that is our overall life cycle responsibility.

"So it's making sure of our needs today, and also concentrating particularly externally on getting the challenging work and meeting the challenging work tomorrow. It's exciting!"

BILL HARRIS is the media relations officer for the U.S. Army Armament RD&E Center. He holds a B.S. degree in mechanical engineering from Tufts University and an M.B.A. from Lehigh University. He is a graduate of the Army Advanced Public Affairs Course (University of South Carolina) and the U.S. Army War College. A U.S. Army Reserve lieutenant colonel, he served a one-year active duty tour as the Army's deputy chief of community relations during Operation Desert Storm.

LETTERS

Dear Sir:

The RD&A Newsbrief (MTL Invention Measures Projectile Velocity) in the March-April 1992 issue is a good example of overkill with computers and subsequent waste of time and manpower. I was approached by the Flash X-ray group at Yuma Proving Ground in January, 1984 and asked to solve the same problem using a computer to calculate the velocity. Based upon previous experience in using digital techniques to measure time intervals for synchronization, I built a simple bi-directional counter that did the job splendidly.

Two piezo-electric pressure transducers were placed near the muzzle exit of the gun tube, 12 inches apart, to detect the pressure behind the projectile as it passed. The pulse from the first transducer started the counter to counting in the up direction. The pulse from the second transducer reversed the direction of counting. The counter, at that point, contained a number that was an accurate measurement of the time that it took that particular round to travel one foot. Thus, if you want to trigger the flash X-ray at six feet from the muzzle exit, you divide the clock frequency by six at the same time that you reverse the direction of the counter. When the counter gets back to zero, trigger the flash X-ray and, "Bingo," you catch the round right where it is supposed to be because the delay time translated into intervals of distance, as well as time, for each individual round without doing any fancy calculations. You really don't need to know the velocity of the projectile in order to get a picture of it. If you want to take the picture at ten feet, then divide the clock frequency by ten for reverse count.

I built this circuit in about three days from spare parts that we had in the lab. I presented a paper on the device and its capabilities at the 33rd Defense Conference on Non-Destructive Testing at Morristown, NJ on 27-29 Nov 84, and at the Hewlett-Packard Flash X-ray Course at Portland, OR on 31 Jul 86.

I also hold patent # 4,685,330, dated 11 Aug 87 for a Position Selectable Delay Generator for Mechanism Trigger, so I question why the U.S. Patent Office issued a second patent which accomplishes the same thing. I am enclosing a copy of said patent.

Sincerely,
Lindy R. Ford

Army RD&A Bulletin Responds:

Thank you for your correspondence. A copy has been passed on to the Army Materials Technology Laboratory.

SPEAKING OUT

What Incentives, in Addition to Those Currently Offered, Should the Department of the Army Provide in Order to Attract and Retain the Best Available Scientists and Engineers?

Dr. Charles L. Vincent
Senior Research Scientist
for Coastal Hydrodynamics
Coastal Engineering Research Center
U.S. Army Waterways Experiment Station
Vicksburg, MS

The very best scientists and engineers with whom I have had the good fortune to work are seduced by the technical problems with which they become consumed. More than anything else the opportunity to perform challenging, fascinating work in a stable and supportive work environment is the key to attracting and retaining top flight scientists. Certainly salary, benefits, and physical working conditions are of concern if they fall below a reasonable level or if other opportunities to perform similarly engaging work are offered at a more interesting location at a significantly higher pay.

Over the next few years I think that the Army may have difficulty both in recruiting and retaining the types of scientists it wants. The problem will be a lack of stability in the work environment due to changes in orientation and focus of research, reduction of staff and programs, and consolidation and coordination of efforts. Unfortunately, this undermines the scientist's or engineer's sense of security that the resources, support, facilities, and interest will be there. Given the external forces that are causing these changes, the Army may have difficulty countering this instability.

Whether it is an incentive or not, the provision of a stable, supportive work environment is probably more important than any other factor the Army can provide at this time.

Dr. Joel M. Dalrymple
Senior Research Scientist
U.S. Army Medical Research Institute of Infectious Diseases
Fort Detrick
Frederick, MD

Unfortunately, the best and brightest young scientists and engineers are not naturally attracted to careers with the Department of the Army. Many of the government's financial or scientific incentives are simply not competitive with those available in private industry. The fact is that the Army has some exciting scientific and engineering challenges for talented professionals but such opportunities cannot be appreciated without appropriate publicity. Our inability to provide an overview of the scope, magnitude, and complexities of Army opportunities restricts recruiting. Providing lucrative and exciting post-graduate fellowships in Army laboratories would be an excellent way to entice recently trained professionals. Such exposure might pique their interest in a career with the Department of the Army. Such fellowships could include participation in research rotations with collaborating universities and government contractors and travel monies to attend scientific meetings and seminars. Researchers at Army laboratories would enjoy the opportunity to interact with bright young scientists and engineers and would be expected to provide them with an intellectually stimulating environment. Department of the Army fellowships would provide ways to show bright young scientists and engineers how exciting a career in one of our laboratories can be. Let's try to make their time with us an intellectual challenge touched with the sense of purpose that comes from contributing to our nation's defense and world health. They can always make money later.

Dr. Herbert L. Meiselman
Senior Research Scientist
(Behavior and Performance)
U.S. Army Natick RDE Center
Natick, MA

During this period of change in DOD, the Army has increased its attention to science and engineering in order to maintain its technological edge. This has led to a desire to enhance the quality of the S&E's. It is my opinion that R&D in the Army needs basic changes which go beyond the addition of a few incentives for its S&E's—the Army needs short term changes and a long term culture change. We need to replace overmanagement with more autonomy, replace a burdensome procurement system with easier alternatives, replace territoriality with teamwork, and replace supervision with mentoring.

At present, science is overmanaged in the Army at all levels, producing too much paperwork for the scientists and their managers. We need local managers and experts to help focus Army R&D and to help prioritize the program. Basic science needs long term stable funding (five years?) with about 20 percent of this for independent research. This independent research should emphasize risk-taking. Scientists should need to show progress annually, but should not be required to respond weekly and monthly to repeated administrative pseudo-crises.

Scientists and engineers need a procurement system designed for them; small purchases should be possible with supervisory approval. For example, we could accomplish this by extending credit card purchase limits to $10,000.

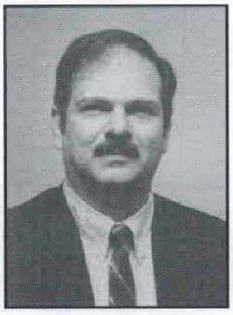
In addition to recognition for science and engineering, our professionals should be recognized for teamwork with other organizations inside and external to DOD, to overcome territoriality. We need to abolish administrative obstacles in order to extend

exchanges with other DOD labs, and with universities and industry, both nationally and internationally. In line with exchange and communication, scientists and engineers should be given the time to, and understand the importance of, technical interchange. By encouraging participation at national and international meetings of broader communities than just our military colleagues, we can attract others to our work and to our special resources. Our goal must be total outreach and genuine collaboration between Army S&E's and other groups of professionals. In order to attract both new and advanced scientists and engineers and communicate with others, we should talk the language of technology instead of acronym-laden babble (ALB).

The mentoring of young scientists and engineers is often talked about but rarely done. With the realization of a true dual career ladder in R&D (GM to SES, GS to ST) the senior non-management scientists up to and including the senior scientists (STs) can provide this mentoring. This advice process can improve the quality of work, provide information to avoid costly duplication of work, and provide guidance on how to get the job done more easily. The focus of mentoring should be technical and practical, not administrative.

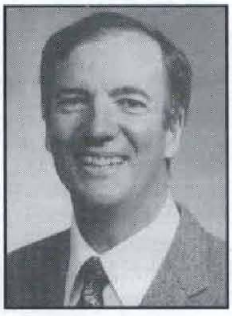
The solutions to some of these problems are local, and to others at a higher level. Natick RD&E Center defined these and other factors needed to create a healthy R&D environment with the help of a Quality Circle chaired by Dr. Irwin Taub, a fellow senior research scientist. Making real progress in attracting and retaining scientists and engineers requires a healthier research environment, which means rethinking and revising how we do science and engineering.

Dr. Michael A. Stroscio
Senior Research Scientist
U.S. Army Research Office
Research Triangle Park, NC



To recruit and maintain world-class scientists and engineers, the U.S. Army should place enhanced emphasis on more frequent international travel to scientific and technical meetings dealing with topics important to the future Army.

Dr. Joseph P. Sattler
Chief Scientist
U.S. Army Harry Diamond Laboratories
Adelphi, MD



My ideas for personnel incentives for scientists and engineers are:

• Improve marketing. There is room for improvement in marketing our present opportunities. Individuals not associated with the Army are unfamiliar with the scope of world-wide career opportunities and challenges that the Army has to offer an S&E. Many are also unaware of the existing educational benefits and incentive programs available to S&E's working for the Army. Strengthening our marketing approach would result in more individuals seeking Army career opportunities.

• Give agencies direct-hire authority for S&E's at all grade levels.

• Obtain a blanket exception from the hiring freeze for all S&E's.

• Broader use of recruitment, retention, and relocation bonuses.

Dr. Gary L. Hagnauer
Senior Research Scientist
U.S. Army Materials Technology Laboratory
Watertown, MA

Special programs and opportunities for government service, training, career enhancement, and active participation in research and development may attract scientists and engineers to seek employment in Army RD&A. However, the best scientists and engineers are attracted by prominence of the organization and the quality of the research and development facilities. An opportunity to work with experts in a technical field on the cutting edge of science and technology and with the best available equipment is the primary attraction for the most talented and dedicated scientists and engineers. Army laboratories and RD&E centers with prominent reputations, renowned staff members and world class facilities have no problem attracting top quality scientists and engineers.

Opportunities for advancement, good working environment, fair treatment, competitive salaries, and job stability are incentives for retaining any employee. As an employer demanding the highest level of competency, it is essential that the Army provides an environment in which scientists and engineers are actively encouraged and offered opportunities, as part of their jobs and career development, to continually develop and expand their areas of expertise. Indeed, as a measure of success, the training and experience scientists and engineers gain by working for the Army should result in attractive job offers from employers in other government agencies and the private sector. While the loss of an experienced scientist or engineer may be viewed negatively, a certain amount of turnover of technical staff is healthy, especially in an R&D organization. Where special incentives need to be employed carefully and with discretion is in the retention of scientists and engineers with special talents and with unique and critical skills—such individuals often serve as mentors for other scientists and engineers and as the corporate memory for an RD&A organization.

To retain the best available scientists and engineers, the Army must provide state-of-the-art research facilities and a work environment which challenges them technically and enables them to perform their jobs unencumbered by constant and ill-advised bureaucratic demands. The mission and specific role of the scientist or engineer must be clearly understood, supported and appreciated by both the employee and employer. Resources and a critical mass of expertise must be provided and readily accessible to meet mission demands and facilitate RD&A implementation. TQM and its meaningful application should in itself be a major incentive by helping develop a collaborative work environment and allowing non-supervisory scientists and engineers to participate more fully not only in technical, but also in non-technical decision-making processes which directly impact their productivity and well-being. Depending upon the individual, expanded leadership/supervisory responsibilities, greater involvement in technology development/transfer, collaborative/entrepreneural opportunities, training, travel, and detailing or sabbatical leave to other organizations, universities and industry may be perceived as incentives. Finally, it is essential that the Army has a clearly articulated and fairly applied policy for recognizing outstanding performance and promoting scientists and engineers. Pride in accomplishment and quality of work are driving forces for most scientists and engineers. Therefore, rewarding Army scientists and engineers with special perquisites, promotions, and monetary awards in recognition of their service as individuals or team members has been and will continue to be a primal incentive for retention.

Hitting the Road. . .

Management Executives Visit Army Acquisition Community

At a video conference on Jan. 7, 1992, Hon. Stephen K. Conver, the Army Acquisition Executive, launched a focused effort to spread to the entire acquisition workforce his vision of the need for commitment to improved acquisition effectiveness. Conver addressed the need to make the acquisition process more efficient by examining and tailoring functional requirements based on program needs, rather than merely including them in lockstep fashion. He acknowledged that eliminating some functional "safeguards" may increase program risk, but explained to his audience that managers should manage and optimize risk, rather than incurring significant inefficiencies by attempting to eliminate it.

Conver, recognizing that this requires a major culture change, directed his military deputy, LTG August M. Cianciolo (now retired), and the Army Materiel Command's (AMC) deputy commanding general for research, development, and acquisition, LTG Billy M. Thomas (now retired), to assemble a multi-functional group of senior Department of the Army and AMC executives to visit the field to personally explain this philosophy to the acquisition workforce, and answer the questions and concerns of the "doers" at each major acquiring installation in the Army.

Under the direction of Generals Cianciolo and Thomas, this "Executive Roadshow" travelled, over a three-week period in March and April, to 10 locations throughout the country and carried the banner for doing things smarter.

The executive panel included George E. Dausman, deputy assistant secretary of the Army for procurement; Walter W. Hollis, deputy under secretary for operations research; MG Joe W. Rigby, AMC's deputy chief of staff for research, development and engineering; and other senior Army and AMC officials representing the general counsel, the assistant secretary for financial management, acquisition, logistics, personnel, and international areas. At each location, the message carried by these senior leaders was the same:

> *In these times of reduced resources, Army acquisition must continue to provide world-class, effective, supportable equipment to soldiers, but in a significantly more efficient manner.*

The success of the visits was directly attributable to the format—each executive provided a brief overview of their area of expertise and how it was involved in improving acquisition.

Then, the rest of the six- to seven-hour presentation was used to answer questions. Detailed responses to the audience's questions were supplied directly by the panel members. A few questions that required further research will be answered in writing.

An unusual and very valuable aspect of the visits was that all the key Army and AMC acquisition players were in the room simultaneously, responding directly and forthrightly to audience questions, comments and concerns.

While it is difficult to do justice to a six-hour presentation in a few pages, several common threads ran throughout the presentations. In a few brief sentences, they were:

- Best Value must become a way of life in the acquisition world. In contracting, this means selecting contractors not on the basis of lowest contract cost alone, but also considering such non-cost factors as quality, industrial base, past performance, cost realism, and management structure. For testers, it means that field testing should only be conducted to obtain essential information that cannot be obtained in any other way. In general, best value implies maximizing the benefit-to-cost ratio of each course of action by doing only those things which are best for each specific program.
- Army acquisition must become a world leader in quality for all products and services, in both government and industry. This all-encompassing statement demands doing the right things, the right way all the time. Through cross-functional teamwork, we will achieve an environment of continuous process improvement that yields quality products that exceed the specifications and expectations of the soldiers who use them.
- Ensure all functional considerations are integrated early and considered throughout the life cycle. Generally referred to as concurrent engineering, this approach insists that everyone involved in designing, acquiring, maintaining, or using a piece of equipment be involved in planning from the beginning—"when the paper is blank." Our senior leaders recognized that, in the past, we have developed a stovepiped acquisition system where, for example, designers do not necessarily talk to users, and sustainers are not adequately involved early. If we are to maximize scarce resources and provide world-class equipment, representatives from every functional area must participate, and their concerns be addressed up front.

This brief article merely touches the surface of the presentations. Paper copies of the vugraphs used by the executives during the presentations are available to interested organizations. Send requests to Headquarters, U.S. Army Materiel Command; ATTN: AMCAQ-AP; 5001 Eisenhower Avenue, Alexandria, VA 22333-0001.

This series of executive visits was successful in providing the direction that the acquisition community must go to meet Army needs. Follow-on field visits will provide more training and continue the impetus that the initial executive-level visits established. These follow-on visits will use case studies and a combined acquisition team approach to "train the trainers" to practice better ways of doing the business of acquisition. This training will be another important step along the path of acquisition improvement.

The preceding article was written by MAJ Tom Aeillo, a research and development coordinator in the Acquisition Policy Division at the Headquarters, U.S. Army Materiel Command.

IMPORTANT NOTICE

The *Army RD&A Bulletin* office has relocated to Fort Belvoir, VA. All correspondence should now be addressed to: Army RD&A Bulletin, Building 201, Stop 889, Fort Belvoir, VA 22060-5889. Our new phone numbers, which were unavailable at press time, will be published in the September-October issue.

BRL Evaluates Captured Iraqi Armor

As U.S. forces began the ground phase of the liberation of Kuwait, they did so with an enhanced understanding of an armor technology used by the Iraqis, thanks to efforts of the U.S. Army Ballistic Research Laboratory (BRL). This key information was disseminated to troops on the ground by the U.S. Army Foreign Science and Technology Center based on the results of a rapid materiel exploitation effort by BRL's Terminal Ballistics Division (TBD). This knowledge, in addition to the prior confidence American troops had in their equipment, provided a combination for success.

The genesis of this program was the Battle of Khafji in late January 1991. In the aftermath of that short offensive action, U.S. and allied forces captured a number of Iraqi armored vehicles. One of these was a Soviet T-55 tank with an armor upgrade package put on by the Iraqis. This design consists of a series of external armor appliques mounted on the T-55 to provide enhanced protection along the hull glacis, the turret front, the hull sides and the turret rear.

It is critically important to determine just how much armor protection was provided by this armor array and to assess how it functioned against U.S. munitions. Although this design had been displayed previously at the Bagdad Arms show in 1988, no actual detail had been possible. The capture of this vehicle provided a windfall opportunity to evaluate an unknown armor threat against U.S. weapons by U.S. experts and provide results to our forces before further ground contact with the Iraqi Army occurred.

Mid-war opportunities to exploit new or unknown enemy technologies are extremely valuable sources of information that often lead to battlefield victories. As a case in point, during the early stages of the Aleutian campaign in World War II, a Japanese "Zero" aircraft was captured intact after it crashed on the soft, peat-like tundra of one of those arctic islands. This enemy fighter was one of the most advanced aircraft of its type and could out perform other fighters in use with allied forces. The resulting U.S. exploitation of that captured plane led to improvements in our fighter designs that contributed significantly to later air operations in the Pacific campaigns.

Aware of the benefits for U.S. forces of a timely materiel evaluation effort, intelligence personnel in the Kuwait Theater of Operations (KTO) rushed actual components of the Iraqi armor package to BRL. A team of engineers, scientists and technicians was quickly formed to analyze this foreign equipment.

The program methodology for examining the Iraqi armor had three phases. First, the Terminal Ballistics Division made a detailed inspection of the armor appliques, including disassembly, measurement, material property testing and photographs of internal components. Next, a ballistic testing phase was undertaken to evaluate the armor components against a variety of U.S. munitions. This test program included the use of BRL produced surrogates of the Iraqi applique that used on-hand materials of a closely similar type and size. In addition, portions of the captured items were mounted on an actual T-55 tank and evaluated in the same way as the surrogates were.

During the last phase of this program, the ballistic test results were provided to the Vulnerability/Lethality Division for their use in performing a detailed vulnerability analysis of the Iraqi equipment.

Unlike the WWII example, the results of this foreign material exploitation did not lead to any design changes in U.S. equipment. Although exact findings cannot be disclosed, the BRL assessment gave U.S. forces a better understanding of the new Iraqi threat.

Adding to the significance of this accomplishment, was the fact that the evaluation was completed in less than two weeks. A rapid, effort such as this, which impacts directly on history making events, is yet another successful contribution from government laboratories such as the BRL.

The preceding article was written by Hugh Denny, a mechanical engineer in the Terminal Ballistics Division at the U.S. Army Ballistic Research Laboratory.

Military Revises Transportability Criteria

The U.S. Armed Forces drawdown has begun and pre-positioned forces overseas are being brought back to the United States. As a result, the United States will not have the advantage of large pre-positioned forces in Europe, the Philippines, and other foreign areas. The new DOD emphasis is on "power projection." This means fast and efficient transport of military equipment is now more critical than ever. An item, regardless of its capabilities, is useless if it cannot be transported rapidly to a conflict point when needed. If you are a materiel developer or contractor within DOD, and you are developing, modifying, or rebuying materiel for use by the Armed Forces, where can you turn for information in designing readily transportable military equipment?

A document is now available that is a "must" for equipment design. It is MIL-STD-1366C, Military Standard Transportability Criteria. The Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) recently revised and updated this publication from cover to cover. The MTMCTEA effort combined MIL-STD-1366B and MIL-HDBK-157. The revision updates transportability criteria and covers a broader spectrum of transportability design criteria. Various experts throughout DOD were consulted to obtain critical information on selected areas in this revision effort.

MIL-STD-1366C covers many areas under transportability including, but not limited to, transport by highway (United States and foreign), rail (United States and foreign), water (both tactical and strategic transport), and air (fixed-wing and rotary-wing). The criteria for the water and air modes include information on Army, Navy, and USMC watercraft (to include lighterage used in tactical operations such as Logistics-Over-The-Shore) and Army, Navy, and Air Force aircraft. Also included are criteria on lifting and tiedown provisions, airdrop, containerization, shelters, overloads, and item assembly/disassembly. Because

MIL-STD-1366C is intended to be the "umbrella" document for transportability guidance, other documents that cover specific areas of transportability are also referenced.

The updated criteria in MIL-STD-1366C will help developers avoid common mistakes in transportability design. For example, many communications and electronics systems have overloaded the shelters in which they are housed.

Another typical overload problem is that equipment designers have often had difficulty in accurately determining the weight of the crew that will operate a system. This can cause an overload on a small tactical vehicle such as the HMMWV where the crew weight is part of the payload.

MIL-STD-1366C provides maximum external payloads for U.S. Army and U.S. Navy helicopters under three different scenarios.

DOD materiel developers and contractors can obtain copies of MIL-STD-1366C through standard publication channels.

Depot Maintenance Competition to Save Millions

What began as a U.S. Army Materiel Command pilot experiment in 1991 has become a DOD-wide program designed to get equipment requiring maintenance back in service by utilizing the finest technical expertise available and at the same time saving millions of dollars.

Instead of sending broken vehicles and parts expressly to Army depots for repair, as was the tradition, the Depot Maintenance Competition program allows both depots and private companies alike to make bids for vehicle repair work, thereby ensuring the highest quality work and driving the cost down. According to Ed Bonikowski, an employee of the U.S. Army Tank-Automotive Command's (TACOM) Maintenance Directorate and TACOM's 1991 depot maintenance competition coordinator, bidders are ranked first by the caliber of their technical expertise, followed by their ability to complete repairs at a competitive price.

The moving force behind the institution of the program is the Appropriations Act of 1991, which allowed the government to compete depot-level programs to both public and private organizations. The concept of competing depot work is by no means new...both the U.S. Navy and the Air Force have competed maintenance work for quite some time.

Bonikowski said that the initial cost study for the 1991 project has been completed and TACOM alone saved approximately $8 million to the Defense Business Operating Fund in the pilot phase.

Wsewolod Hnatczuk, chief of the Production Engineering Branch of the Tank-Automotive Research, Development and Engineering Center's (TARDEC) Propulsion Systems Division and chairman of one of the Source Selection Panels (SSPs), added that it is still unclear how much will be saved this year as the program goes DOD-wide.

Bonikowski explained that the competition is not meant to eliminate the depots, but rather to be a supplement to the existing depot system. "We have to maintain an expertise in the depots in case we have to go to war," he said. "The program is going to take some of the work out of the depots. But I look at it as probably a boost to the economy, by giving some other companies a chance to make money on it."

TACOM competed two engines in the pilot phase of the program: the 6V53N, which powers M113-series armored personnel carriers, and the multifuel LDT465-1D, which is used in M44 series 2-1/2-ton trucks. The LDT engine contract was awarded to the Tooele Army Depot, UT, and the 6V53N contract went to the Detroit Diesel Corporation based on the best value to the government evaluations.

Other major subordinate commands participated in the pilot phase as well. They include: the U.S. Army Missile Command, the Aviation Systems Command, the Communications-Electronics Command and the Troop Support Command, which worked in conjunction with the Military Traffic Management Command.

According to Hnatczuk, two independent but concurrent SSPs comprised of representatives from the appropriate TACOM directorates evaluated the proposals for the two engines competed last year. The SSPs interfaced at the chairmanship level to ensure consistency in the evaluation process. Following the evaluation of all the proposals that were submitted, recommendations were made to Dr. Kenneth J. Oscar, director of TARDEC and the source selection authority for the pilot phase, who made the final selections.

Bonikowski stressed that the pilot was a command-wide project. "It definitely took an exorbitant amount of effort from every directorate in the command because we were under a very compressed schedule to get it out. We had five months to award a contract from the time they notified us to go ahead with the program," he said.

Jim Kovanda, of TACOM's Product Assurance Directorate, who chaired the 2-1/2-ton truck SSP, agreed. "This program is an excellent example of the type of successes that can be achieved when all of the organizations within the command focus on an objective," he said.

Hnatczuk also was impressed with the command-wide effort. "The dedication of everyone involved resulted in TACOM successfully awarding the 'first ever' contracts for depot maintenance under full and open competition," he said.

TARDEC was extensively involved in the project. "The success of the program can be directly attributed to the expertise and dedication of TACOM personnel. TARDEC provided the main technical expertise for evaluating the proposals for both of the panels last year," Hnatczuk said. "Furthermore, more than 40 percent of the personnel on my panel were from TARDEC. We're getting even more involved because one of the lessons we learned on the last panel was that the evaluators were not involved early enough in the program. This time, the people who will be evaluating will also be closely involved in defining and writing the evaluation criteria," he added.

This year, TACOM has expanded its program and plans to compete the following items in the Depot Maintenance Competition: the T142 track pads for M60-series tanks, the 6V53N engine, the M113 vehicle transmission, the M88-series medium recovery vehicle transmission and left and right final drives.

According to Bonikowski, every command will be competing items this year. He said other candidates have been nominated through 1996 and preparations are being made now that the 1992 Appropriations Act has been passed. Bonikowski said that

the 1992 Act authorizes the FY92 Depot Maintenance Competition efforts.

The preceding article was written by Rae Higgins, a writer in the U.S. Army Tank-Automotive RDE Center's Marketing Office. She holds a bachelor's degree in communications from Oakland University and is an associate member of the Public Relations Society of America.

Army Accepts First Paladin Delivery

The first production delivery of the Army's M-109A6 self-propelled 155mm howitzer, the Paladin, took place April 24 at the BMY-Combat Systems production plant in York, PA.

The Hon. Stephen K. Conver, assistant secretary of the Army for research, development and acquisition, spoke to the audience of BMY employees and invited guests, stating that "Although BMY will produce 164 of these, it will be over a three-year period. You have learned to produce efficiently at low volume. This is our hedge against the future. The soldier needs the best equipment available now, in case our leap-ahead programs get extended even further.

"As we look to the future, fiscal constraints will continue to make it more attractive to upgrade existing equipment rather than invest in leap-ahead programs which are decades away.

"All of our efforts are dedicated to the American soldier. He must be able to win decisively, quickly and with a minimum of casualties." Conver noted that the Paladin can operate autonomously without support vehicles.

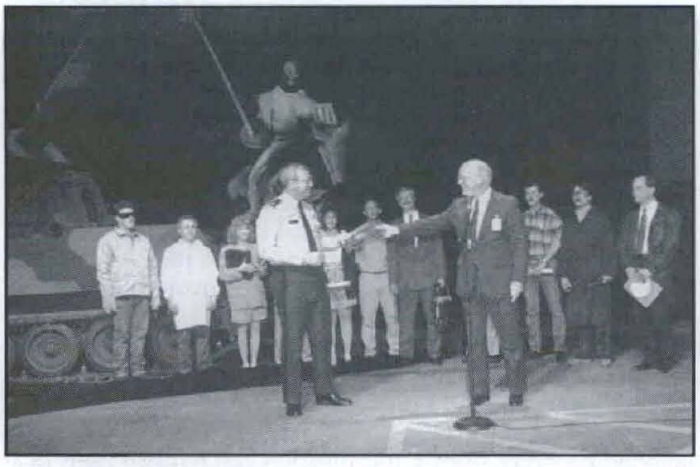
"We'd like to have programs like the Paladin across the Army. We must continue to have the ability to take technology out of the lab and put it in the hands of soldiers in the shortest possible time, and at the least cost," said Conver.

Conver added that with some 7,000 earlier versions of the M-109 howitzer in the hands of U.S. allies, there will hopefully be a steady market for the Paladin A-6 version during the next decade. He said U.S. forces have about 2,500 M-109s in their inventory.

The Paladin will increase the Army's fire support capabilities. It can receive fire missions and compute firing data while on the move. With no external technical assistance, it can select and take up firing positions, automatically unlock and point its cannon, and fire and move out before it's exposed to counter-battery fire. Unlike its predecessors, it has night vision and chemical protection capability and secure voice and digital communications. And its crew never has to leave the vehicle to fire the gun.

From the time the Paladin gets a fire mission, it can compute

Playing a key role in the Paladin program are, from left: MG Fred Marty, the Fort Sill, OK, commander, the Hon. Stephen K. Conver, assistant secretary of the Army (RDA), Sen. Arlen Specter, Dale Adams, PEO Armaments, and LTC William Hertel, PM Paladin.



Dan Delaney of BMY hands LTC William Hertel, PM Paladin, the log book of the Army's first delivered Paladin.

Invitees view the Paladin Howitzer on display outside the ceremonial facility.

targeting data, take up a firing position and fire the first round in less than 60 seconds. Its predecessors take 11 minutes. Its range increases from 18 to 24 kilometers for unassisted rounds and from 23.5 to 30 kilometers for rocket assisted projectiles. Its hull, turret, suspension and automotive system upgrades extend the time between failures by two-thirds and cuts in half the time between repairs. Although it weighs 8,300 pounds more than earlier M-109 versions, its fuel capacity, speed and range remain the same.

Workshop on Wheels... A New Concept in Battlefield Vehicle Maintenance

The U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI, is playing a key role in the development of an armored maintenance vehicle that may someday make it easier for troops to repair disabled combat vehicles in forward battle areas.

A prototype of the vehicle, referred to as the Heavy Repair Vehicle (HRV) is now being designed and fabricated in TARDEC's Design and Manufacturing Technology Directorate and should be ready for testing in June.

The HRV would improve the effectiveness of the Army "Fix Forward" concept by increasing the mobility, survivability and capability of maintenance crews working in front-line locations.

Under Fix Forward, a concept the Army adopted during the 1980s, maintenance personnel move into forward combat areas and repair vehicles at the breakdown site whenever possible rather than tow them to a rear area. The time saved by eliminating towing means disabled vehicles can be returned to service more quickly, and recovery vehicles are free to perform other tasks.

But according to TARDEC's CPT Patricia Overton, HRV weapon system manager, the concept has been only a partial success because the Army has no vehicle designed specifically for front-line maintenance and repair missions.

Full view of the Heavy Repair Vehicle.

"Right now, we use the M113-series armored personnel carrier as a maintenance vehicle," Overton explained. "But the problem with the M113 is that it does not have enough stowage capability. It can get the people where they need to be, but it doesn't have enough room to carry the right tools and equipment needed to make repairs. So what happens is that they end up using a recovery vehicle to tow the vehicle back to a rear area where the maintenance people keep their equipment, and this takes much longer."

To solve this problem, the Training and Doctrine Command's Ordnance Center and School developed a set of operational requirements for an HRV. These requirements specify that such a vehicle must have a minimum cruising range of 275 miles without a towed load and be able to travel cross-country and ford water up to 40 inches deep. It must be able to maintain a convoy speed of 35 mph without a towed load. The vehicle must also have a towing capacity equal to its own weight. Moreover, it must provide sufficient room to carry a four-man crew—a driver and three technicians—tools, test equipment and spare parts as well as an on-board crane for removing and installing engines and transmissions.

The HRV will be transportable by air. It will also be required to carry a machine gun and a universal weapon mount. Additional requirements are that it must provide its crew members with easy access to ammunition without having to leave the cab, and offer protection from a variety of munitions.

In 1988, TRADOC asked TARDEC to formulate a tracked-vehicle concept based on the HRV requirements. Then in 1990, TRADOC decided to conduct a follow-on analysis to examine both wheeled and tracked vehicle concepts. At TRADOC's request, TARDEC gathered information from industry on existing candidate vehicles that could serve as an HRV with little or no modification. The center evaluated the information it received and submitted a report on its findings to TRADOC. TRADOC in turn pursued development of a wheeled concept built on the truck chassis of the Army's Palletized Loading System, the M1074, and asked TARDEC to build the HRV prototype now under development.

The HRV maintenance module will be 13 feet long, 7-1/2 feet wide and 6-1/2 feet high. It will carry two of the three technicians, and the driver and the third technician will occupy the module carrier vehicle. The walls of the module's interior will be lined with cabinets and shelves for storing tools, test equipment, spare parts and maintenance manuals.

That module will also have a 15-kilowatt auxiliary power unit that will supply electricity for operating drills and other power tools and an on-board electric air compressor for use with pneumatic equipment. "It is intended that this vehicle would be able to handle the full range of repair tasks for Bradleys, M1s or any other vehicles combat units need," Overton said.

Overton said plans call for the HRV to undergo eight weeks of performance tests at Aberdeen Proving Ground, MD, and user evaluation at an unspecified location. She said the Army will then decide whether to pursue further development of the concept.

The preceding article was written by George Taylor, a technical writer-editor for the U.S. Army Tank-Automotive Command.

RoboCop Research Will Aid Facilities' Security

By the mid-1990s, the security of government warehouses and office buildings will be vastly improved if the Army's version of RoboCop lives up to the expectations of engineers at Picatinny Arsenal, NJ.

According to the electronics and robotics experts at Picatinnny, this new system will help to reduce the loss of millions of dollars of inventory that is being stolen each year from government facilities.

"It's called MDARS, for Mobile Detection Assessment Response System," says Al Franz, the project's team leader.

At the beginning of Phase II of a three-phase project that will eventually cost $10 million, MDARS is a computer-based system that controls six-foot, three-wheel drive, 500-pound mobile robots. What's unusual is that they patrol using artificial intelligence—or the ability to make independent conclusions and decisions. The system's job is to guard against break-ins and theft.

If an intruder enters an area being patrolled by an MDARS robot, here's what the unsuspecting intruder faces:

• A sound detection, using three microphones, that pinpoints the direction of unusual sound, such as breaking glass or dropped items. Routine sounds unique to the robot's patrol area, such as air pouring through heating ducts, are ignored through system programming.

• Forty-eight passive infrared sensors that detect the motion of warm bodies in a 33-foot radius, from the floor to the ceiling.

• Six microwave sensors that detect motion up to 50 feet.

• Twenty-four ultrasonic "sonar" Polaroid distance sensors that can detect motion and any other changes to the robot's physical environment out to 25 feet.

• Nine additional collision avoidance sensors that help guide the robot along its patrol path.

• A night vision video camera that automatically turns toward the direction of detected sound or movement and begins recording what it sees to a remote tape player. An alarm is sounded in the control station where a security guard can view the scene on a TV monitor. The guard can get a closer look at the area in question by manually turning and zooming in the camera.

• A "barrier tag" system that detects when pre-wired doors or windows have been opened, regardless if they were returned to their original position. An alarm is automatically sounded and an immediate report is sent back to a control station.

• A built-in speaker and microphone, which allows a monitoring security guard to immediately challenge an intruder without risk of life.

At the end of a tour, an MDARS robot automatically moves to a charging station and plugs itself in.

During normal patrol, the mobile unit navigates throughout the secured area without operator supervision. The mobile unit randomly selects its next destination and computes a way to get there. If an obstacle such as a trash can or misplaced box are in its way, the robot automatically finds a way around it.

If the obstacle was never seen before in that particular place, the robot activates its audiovisual system for the operator to look it over before moving on. In an alarm situation, the operator can command the patrol unit to proceed to a specific location under automatic navigation; and if there is a real emergency, the operator can drive the robot there manually.

At the end of the tour, the unit automatically moves to a self-charging "fill-up" station. A four-hour charge will normally keep it running for 12 hours. But if its two 12-volt batteries run low during a patrol, the robot immediately goes to the nearest charging station and plugs itself in.

Although the destination is random, a map of the patrol area, all the paths that the robot can take through the area and designated locations on these paths—called nodes—are built into the data base so the robot knows where the boundaries are and where to stop. The robot is programmed to stop at designated nodes to perform searches.

As a bonus, the prototype has also been equipped with an inventory detection system that will report when specially tagged items have been moved out of their assigned areas. This, Franz says, will enable sensitive and expensive items to be inventoried virtually every day. The same system is used to check barrier tags as the unit moves along its patrol path.

Another bonus is a built-in environmental detection system that constantly monitors temperature, humidity, smoke, flames, hydrocarbon gasses such as propane or hexane and carbon monoxide. Readings from these sensors are displayed on the operator's console in the control station.

This prototype completes the advanced development portion of the Phase I program, Franz says.

The Phase II engineering development portion has just begun and will run through 1998. Phase II will incorporate a manually-controlled response system, such as mace or a noisemaker, in the robot. The Phase II version will enable the robot to detect intruders while it's moving. The Phase I prototype must stop at predetermined spots before it can turn on most of its sensing devices.

The goal of Phase III, scheduled for 1995-2001, is to consolidate the computer system to one user-friendly console that can simultaneously control all the robots and fixed sensor systems located on a military installation. That system may include the design and control of exterior robots, whose development may begin as soon as 1993, according to Franz. Phase III will also incorporate any advances made in robotics and related technologies.

CAREER DEVELOPMENT UPDATE

FY93 Project Manager Selectees

Congratulations to the following colonels selected by the FY93 Army Selection Board as project managers.

PROJECT	DESIGNEE	FA/BR
Advanced Attack Helicopter (AAH)	COL James R. Schnieder	51/15
Army Data Distribution System (ADDS)	COL John D. Hartman	97/25
Avenger (AVG)	COL Daniel M. Prescott	51/91
BAT Office	COL Willie B. Namce Jr	51/91
Clothing and Individual Equipment (CIE)	COL William T. Meadows	51/92
Defense Information System Network (DISN)	COL James R. Lingvai	53/25
Future Armored Resupply Vehicle (FARV)	COL Roy D. Lheureux	97
Global Positioning Systems (GPS)	COL Sammie G. Young	51/25
Heavy Tactical Vehicles (HTV)	COL Michael J. Neuman	51/91
Information Management & Telecommunications Pentagon Renovation (IM&TPR)	COL John W. Barnes, Jr.	51/25
Instrumentation, Targets and Threat Simulators (ITTS)	COL Stephen S. Overstreet	51/12
Kiowa Warrior	COL Edwin P. Goosen	97/15
Medium Tactical Vehicles (MTV)	COL Michael W. Boudreau	51/91
Mines, Countermines and Demolitions (MCD)	COL David C. Smith	51/13
Night Vision Electro Optics (NVEO)	COL Nelson P. Johnson	51/91
Satellite Communications (SATCOM)	COL Dennis K. Raymond	51/25
Sense and Destroy Armor (SADARM)	COL William J. Ervin III	51/91
Signals Warfare (SIGWAR)	COL Melvin L. Heritage	53/35
Special Management Office (SMO)	COL Gerard P. Barrett	51/13
Special Project-Systems Integration (SP/SI)	COL Sammy J. Cowden	51/35
Special Project-Systems Development & Integration (SP/SDI)	COL William F. Jaissle	51/25
Tactical Management Information Systems (TACMIS)	COL Charles L. Mudd	51/25
Tank Main Armament Systems (TMAS)	COL Richard W. Bregard	51/91
Theater High Altitude Area Defense (THAAD)	COL Walter F. Kilgore	51/14
Training Devices (TRADE)	COL James E. Shiflett	51/12

Army Opens Acquisition Corps Training Office

The Army Acquisition Corps (AAC) is delighted to announce the opening of the newly established Acquisition Education, Training and Professional Development Office. The purpose is to establish policy and procedures that guide management of training and professional development programs for AAC members and the acquisition workforce.

The new office will play a key role in the Army's effort to build a "world class" corps of innovative acquisition leaders and managers. Fully-funded unique educational and training opportunities will be identified and announced throughout the year for AAC members.

The following initial developmental opportunities for AAC members were announced in early February 1992:

- Senior Service College Fellowship Program at the Institute for Advanced Technology, University of Texas at Austin.
- Long-Term Training with the Institute for Advanced Technology, University of Texas at Austin. This program encompassed graduate studies in business administration, computer science, electrical engineering, operations systems, mechanical engineering, materials engineering and physics.
- Part-Time Graduate Study with the School of Engineering and Applied Science at the University of Pennsylvania in Philadelphia. This course of study leads to an executive master of science in engineering degree.
- Tuition Reimbursement for undergraduate/graduate studies at various colleges and universities.

A second announcement offered AAC members opportunities to participate in seminars designed to stimulate fresh approaches and new ideas to meet the challenge of staying current, competitive and forward looking. Seminars were offered at Harvard University, The Brookings Institution, The Wharton School, Executive Seminar Centers, and the Institute for Advanced Technology.

Continued improvement and enhancement of the AAC is contingent upon increased education, training and developmental opportunities for AAC members. The Professional Development

Office will continue to offer broadening experiences that will stimulate strategic thinking and provide members with a global perspective of the Army's acquisition system. Local civilian personnel offices and functional advisors will receive copies of all announcements relative to these career enhancing programs.

The new Professional Development Office is staffed with five dedicated and talented individuals committed to service to the workforce. The staff is comprised of LaVerne Jones, chief, Acquisition Education, Training and Professional Development Office; Christel Hignett, program analyst; Jim Welsh, acquisition training specialist; Willie Lanier, acquisition training specialist; and Sue Winkler, acquisition training specialist.

Telephone inquiries to discuss the various programs managed by the office are invited. The telephone numbers are: DSN 289-2445/2292 or commercial (703) 756-2445/2292.

FY93 TRADOC Systems Manager Selectees

Congratulations to the following colonels selected by the FY93 Army Selection Board as Training and Doctrine Command systems managers.

PROJECT	DESIGNEE	FA/BR
Cannon	COL Bristol W. Williams	51/13
Ground Based Common Sensor (GBCS)	COL Gerald K. Johnson	51/91
Joint Surveillance and Target Attack Radar System (JSTARS)	COL Jeffrey W. Wright	35
Kiowa Warrior	COL David L. Ahern Jr.	51/15
Multifunctional Computer (MFC)	COL Thomas M. Hall Jr.	51/25
Tactical Wheeled Vehicle (TWV)	COL William G. Balkus	88

Command and General Staff College Selections

Congratulations to the following YG 81 and 82 officers selected for attendance at the U.S. Army Command and General Staff College.

NAME	FA	BR	YG
ABERCROMBIE, Henry E.	53	AG	82
BERGQUIST, Craig A.	51	OD	81
BUMGARNER, Ronald L.	51	FA	81
CARSON, Peggy R.	97	OD	81
COUTTEAU, Charles G.	51	AV	81
DIVELY, Walter L. JR.	51	IN	81
DRIESSNACK, Charles H.	51	AD	81
GILLEY, Paul D. JR.	51	FA	81
GOGGIN, James D. IV	51	MI	82
INCOVATI, Anthony R. II	97	QM	81
JONES, Winston M.	53	QM	82
KLIMA, Brian L.	51	IN	81
LAMBKIN, Glen D. JR.	51	SC	81
LIBERATORE, Nicholas S.	51	AD	81
MADDUX, Jonathan A.	51	SC	82
MARR, Patrick M.	51	MI	81
MOORE, Steven R.	51	AV	82
NEUMANN, Susan B.	51	OD	81
OBEN, Roger R.	51	AD	81
PINTER, Steven S. JR.	51	IN	81
RECK, Keith F.	53	SC	81
RIDER, Mark D.	51	FA	81
RUNYON, Carl	97	QM	82
SCARBROUGH, Jess A.	51	AD	81
SEEBODE, Gary W.	53	SC	81
STANLEY, Gary R.	51	TC	81
STOLESON, Michelle D.	51	OD	82
TRONTI, Lyn O.	51	AD	81

FY93 Contracting Command Selectees

Congratulations to the following functional area (FA) 97 colonels selected by the FY93 Army Selection Board as contracting commanders.

DESIGNEE	FA/BR
Armour, Arthur A.	97/15
Barnes, Thomas R.	97
Bond, William L.	97/14
Downey, John M.	97/91
Hobbs, Quincy C.J.	97/92
Hornaday, James D.	97
Huke, Henry R. III	97
Moeller, Delane F.	97
Paulson, Peter G.	97/25
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BOOK REVIEWS

Developing Superior Work Teams

Building Quality and the Competitive Edge

By Dennis C. Kinlaw, Lexington Books, Lexington, MA, 1991

Reviewed by MAJ Duane A. Austria, operational evaluator, Operational Evaluation Command. He has served as an R&D coordinator in TACOM and a force development officer in the Ordnance Center and School. He was the Assistant S3, DISCOM 3AD during Operation Desert Shield/Storm.

Developing Superior Work Teams presents two organizational strategies to meet the challenge of producing consistently superior services and products in a highly competitive world. The strategies involve developing superior teamwork and developing superior work teams. The book serves as a special guide for people having responsibilities in Total Quality Management team-development initiatives. An excellent functional model for developing superior work teams is presented with detailed and insightful vignettes from industry supporting each concept.

The first strategy is the development of teamwork and the change in traditional roles of managers and supervisors. Teamwork describes the functioning of a group of people who are closely knit around a common purpose, who work easily together and have positive work relationships. Teamwork is also the way people must work together and cooperate in order to produce some product or service that cannot be produced by a single person. In jobs where superior teamwork is achieving success, the roles of managers and supervisors are changing: from managing by control to managing by commitment; from focusing individual motivation and output to focusing on team motivation and output; and, from the traditional functions of planning, organizing, staffing and evaluating to the functions of coaching and facilitating. The Team Leadership chapter presents, in depth, the changing role of managers and supervisors and is the most critical for review.

The second strategy is the development of superior work teams where teamwork is a way of life. Superior work teams are consistent in their pursuit of excellence. They are characterized by achieving distinctive results (maximum use of a team's human resources, superior outputs against all odds, continuous improvement); employing successfully certain kinds of informal work processes (communicating and contacting; responding and adapting; influencing and improving; appreciating and celebrating); developing in their members certain feelings (inclusion, commitment, loyalty, pride, trust) and developing leadership that focuses both on team development and on team performance. Group synergism is maximized with corresponding increases in quality performance. Senior level management support is critical to the successful building and development of superior work teams. Their commitment to this strategy ensures long term organization success.

Kinlaw provides a functional model describing these two strategies. The model is a tool for study and review by work teams. Team members should discuss the model and develop a common understanding of all its elements. They can then prepare a plan to address the elements needing improvement or attention with the goal of achieving superior work team characteristics. The bottom line achievements are superior, highly competitive products or services.

Fundamentals of Computer-Integrated Manufacturing

By Arthur L. Foston, Carolena L. Smith, and Tony Au

Englewood Cliffs, NJ: Prentice Hall, 1991

Reviewed by CPT Eric S. Parker, HHB 6th ADA Brigade, Fort Bliss, TX

Fundamentals of Computer-Integrated Manufacturing attempts to address the opportunities in modern manufacturing to apply computer technology. The authors have designed the book to be used as an advanced undergraduate text or an introductory graduate level text in manufacturing or industrial management. The book is sub-divided into two independent major sections. The major sections are also sub-divided into stand-alone chapters, with topics ranging from the manufacturing process to the human factors of computer-integrated manufacturing (CIM).

The book has its strengths and weaknesses. The authors do manage to make several good points, but unfortunately, the weaknesses outweigh the strengths. There are strengths in some of the individual presentations, but many of the others are not useful for various reasons. The weaknesses generally fall into two areas; style and content. The book is not well integrated, and the problems of flow and mixture of writing styles detract from the usefulness of the book. There are also questions of fact and currency of data. I do not recommend this book as an addition to your acquisition library.

The strengths of the book lie in three places: the description of the manufacturing process, support and commitment to the CIM system, and the implementation of the CIM system. The authors describe the manufacturing process as a continuous process much like the life cycle process we utilize in DOD acquisition management. The marketing/sales department is responsible for generating user requirements and evaluating customer responses after items are produced. I find this presentation very helpful in understanding how civilian companies conduct business. The authors also describe the required support and commitment to implement a CIM system. The organization and structure described supports a CIM system in all areas and at all levels of an organization. I feel I could apply the supports they recommend to almost any large organization. The section on implementing a CIM system completely describes details involved in actually implementing a system in an organization. Details from procurement to maintenance are discussed in sufficient depth to allow someone not familiar with computer systems to do a good job in obtaining CIM support for an organization.

The weaknesses of style are rampant throughout the book. In some chapters, acronyms are used for most of the terms, yet the next chapter uses no acronyms at all. There are also some cases where acronyms have more than one meaning. I think an acronym list at the end of the book would have been very helpful. The flow of ideas from one section to another is almost non-existent, and most of the chapters seem to be put together without regard to making them read as if they had a single author.

The weaknesses in fact are also spread throughout the book. The computer and communications information is written as if the person who wrote it were completely unfamiliar with common computer terms. For example, the term Video Display Terminal (VDT) is used throughout the book, but is rarely used in most of the literature I have seen in the last few years. Also, the personnel section cites a 1986 report on the effects of VDTs without any update. I am certain that some research has been published between 1986 and the book's publishing date in 1991. These weaknesses of fact are serious detractors from the useful information in the book.

In conclusion, *Fundamentals of Computer-Integrated Manufacturing* presents some good information in the middle of a muddled mass of useless data. It may be useful as a one-time reference, but I would not recommend it for purchase.

PERSONNEL

Dausman Named Director of Acquisition Career Management

George E. Dausman, deputy assistant secretary of the Army for procurement, Office of the Assistant Secretary of the Army for Research, Development and Acquisition (ASA(RDA)), has assumed duties as the director of Army acquisition career management (DACM).

Dausman holds B.S. and M.S. degrees in aeronautical engineering, and an M.S. in management from Massachussets Institute of Technology.

A member of the Senior Executive Service, Dausman previously held positions as acting ASA(RDA); deputy for materiel acquisition management, Office of the ASA(RDA); deputy director, procurement and production, Headquarters, U.S. Army Materiel Command (HQ AMC); major system acquisition coordinator, HQ AMC; deputy project manager, advanced attack helicopter, HQ AMC; and V/STOL and helicopter systems engineering director, Air Force Systems Command, Wright Patterson Air Force Base.

Dausman is a 1988 recipient of a Distinguished Executive Presidential Rank Award and a 1982 Meritorious Executive Presidential Rank Award.

AWARDS

Award Recipients Named

Listed by agency, the following Army Acquisition Corps personnel are recent recipients of key awards. **Strategic Defense Command:** MAJ Wallace T. Downs, Meritorious Service Medal (MSM); CPT Paul A. McGuire Jr., MSM; and LTC John S. Lawrence, Legion of Merit (LOM). **Army Acquisition Executive Support Agency:** MAJ Randolph A. Mathews, Army Commendation Medal (ARCOM); LTC Alan J. Bacon, ARCOM; MAJ James P. Sanders, LOM; COL Lawrence W. Day, LOM; COL James T. Huey, LOM; MSG Michael R. Womer, LOM; LTC Glenn J. Harrold, MSM; LTC Douglas P. Ason, MSM; and SFC George A. Williams, MSM.

Rubery Receives SES Award

Daniel J. Rubery, logistics director, U.S. Army Aviation Systems Command (AVSCOM), recently received the 1991 Senior Executive Association Professional Development League's Executive Excellence Award.

Rubery's award is based on his outstanding management at AVSCOM and as the architect of the Theater Aviation Support Program in Southwest Asia.

His recognition marks the first time since 1985 that the prestigious award has gone to the Army.

IMPORTANT NOTICE

The ***Army RD&A Bulletin*** office has relocated to Fort Belvoir, VA. All correspondence should now be addressed to: **Army RD&A Bulletin, Building 201, Stop 889, Fort Belvoir, VA 22060-5889.** Our new phone numbers, which were unavailable at press time, will be published in the September-October issue.

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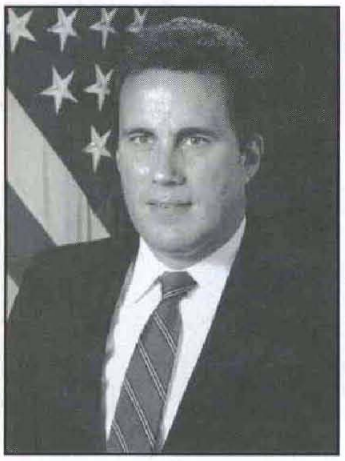


FROM THE ARMY ACQUISITION EXECUTIVE

The Department of Defense (DOD) has revised its approach to acquisition in response to dramatic changes in the national security environment. The revised approach has been the subject of much debate, and I would like to discuss what these reforms in the acquisition process will mean to Army modernization.

In reality the current acquisition environment has been shaped by the virtual elimination of the Soviet threat, the need to maintain an effective military capability against a range of less predictable regional threats, and the fact that the DOD budget is in decline. Refocusing the approach to acquisition is an integral part of DOD's overall effort to resize our armed forces and efficiently use constrained resources in the post-Cold War era. In essence, all of DOD acquisition now faces the fiscal austerity that Army acquisition has lived with for several years. It is not a coincidence that there is similarity between this revised approach and that which we, in Army acquisition, have been advocating for some time.

Defense acquisition in the future will be characterized by (1) fewer new system development and production programs, (2) greater reliance on technology insertion through upgrades of existing systems to avoid tactical, logistical, and technological obsolescence, and (3) greater use of Advanced Technology Demonstrations (ATDs), the "show-me" phase of our science and technology (S&T) program, to validate the maturity and utility of advanced technologies and thereby reduce risk in future acquisition programs.

A commitment to the acquisition of a new weapon system will occur only when the following criteria are met: (a) the technologies have been demonstrated, thoroughly tested, and shown to be producible; (b) there is a clear and verified military need; and (c) the production program is cost-effective. For example, the Comanche is an absolutely essential new weapon system. We have the need and the technology, and our existing light helicopter fleet–the AH-1, OH-58, and OH-6–is tactically and logistically obsolete. There are other essential new development/production programs for major platforms, such as the Advanced Field Artillery System (AFAS) with its Future Armored Resupply Vehicle-Ammunition (FARV-A). However, new starts, at least for major platforms, will be few and far between.

Future acquisitions will consist of more product improvements, system/block upgrades, and technology insertion programs. We are currently evaluating all opportunities to upgrade our equipment by inserting modern technology into existing platforms. We have made a good start in this area with our armor and aviation forces, and are continuing to make progress, although some significant opportunities for upgrading remain unfunded.

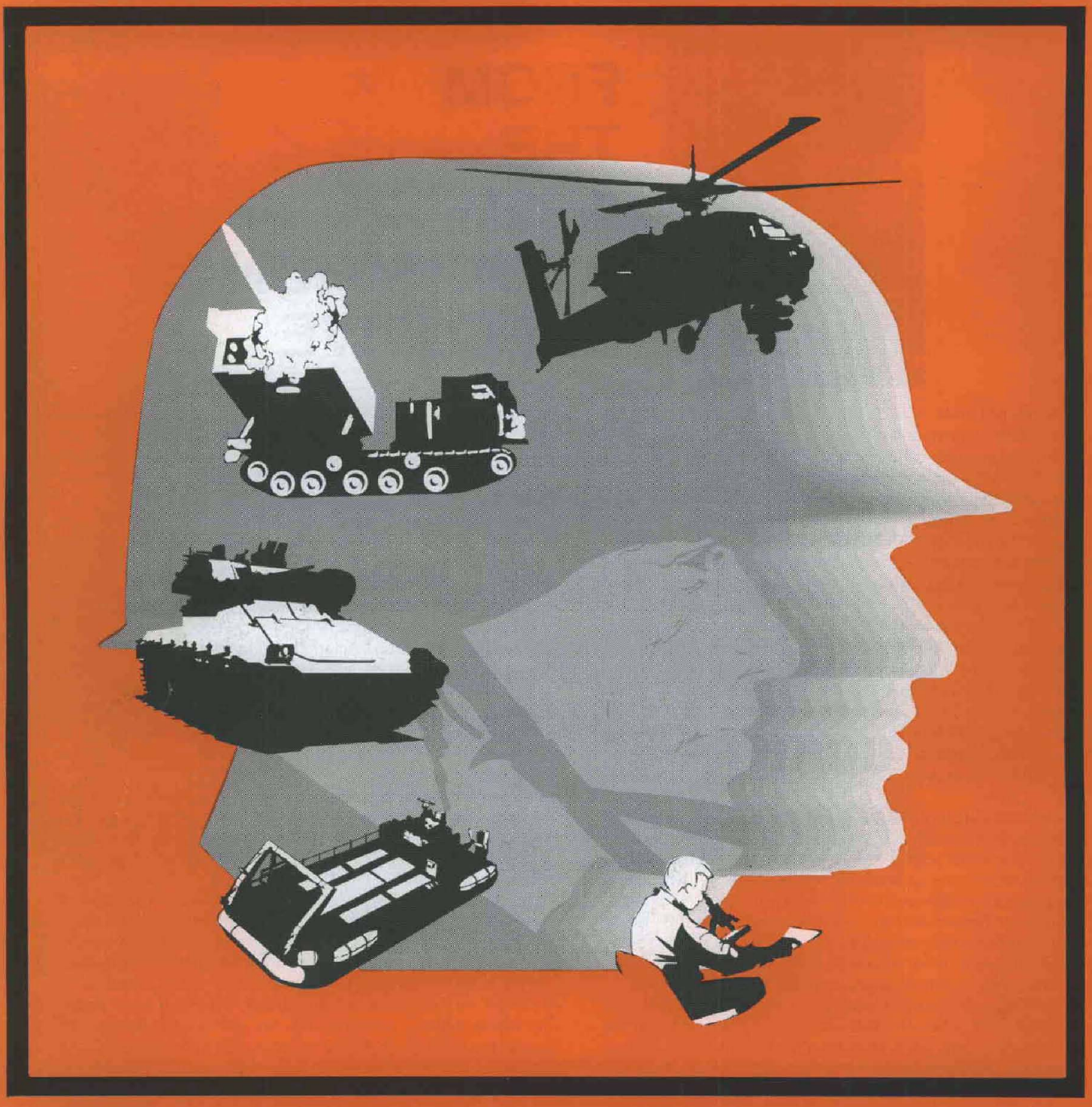
The Army procurement account ($6.8 billion) is now less than one-half of what it was just two years ago. Our RDT&E account is also declining with one exception, the S&T program.

To maintain our technological edge, S&T has been given a central role within the revised acquisition process. We have placed increased reliance on science and technology. We are emphasizing a greater role for ATDs and the exploitation of the revolution in Distributed Interactive Simulation (DIS). User and industry participation is essential. DIS will enable us to virtually prototype new concepts and technology. It will also support training and strengthen the requirements process.

In order to get the highest payoff, the Army has been working closely with the Director of Defense Research and Engineering, Dr. Vic Reis, to formulate strategy that gives S&T a more prominent role and provides more comprehensive oversight of S&T activities in order to identify and demonstrate the most promising technologies. The core of the S&T strategy is to exploit the information technology explosion, achieve early and continued user involvement, and stress extensive and realistic technology demonstrations. Seven areas, or thrusts, have been identified to allow us to focus on promising ideas that will help meet our most pressing future military requirements: (1) global surveillance and communications; (2) precision strike; (3) air superiority and defense; (4) sea control and undersea superiority; (5) advanced land combat; (6) synthetic environments; and (7) technology for affordability. An article by Dr. Reis on the new defense S&T strategy will be published in an upcoming issue of *Army RD&A Bulletin.*

We are in the midst of change, but realities remain. We are reducing the size of our active component by approximately 25 percent, and we are terminating or restructuring key weapon systems programs. Despite recent world events, there are still threats to our security. We must continue to support a trained, ready, and well-equipped Army.

Stephen K. Conver



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