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# ARMY RD&A BULLETIN

**MAY - JUNE 1993**

# DISTRIBUTED INTERACTIVE SIMULATION

## ...A Synthetic Battlefield

**MAY–JUNE 1993**
**PB 70-93-3**



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# Research Development Acquisition

# ARMY RD&A BULLETIN

*Professional Bulletin of the RD&A Community*

## FEATURES



## DEPARTMENTS



## COVER

The primary objective of distributed interactive simulation is to create synthetic, virtual representations of warfare environments by systematically connecting separate subcomponents of simulation which reside at distributed, multiple locations. The cover shows some of the potential subcomponents to be connected.

# VISION FOR THE NEXT DECADE

By MAJ David W. Vaden

## Introduction

The success or failure of any organization depends in large measure on the leadership and vision of the organization. With the uncertainties of future force structures and anticipated cuts in the Defense budget, it will become more difficult to sustain, by field exercises alone, the level of force readiness mandated.

Recent victories in Granada, Panama, Desert Storm and Desert Shield have carved a new standard and expectation that will require a determined and steadfast vision for future success on the battlefield. Distributed Interactive Simulation (DIS) is the newest program that provides the integration of computers and communications that will prove equally beneficial to Army users: the trainer, tester, developer, and acquisitioner. DIS will be built around the concept of fully interoperable standards and protocols, allowing each community to leverage the concepts and products from the others. This article states the Army's vision of DIS for the next 10 years.

## DIS

It is important that all users in the DIS community have a common understanding of what each element of DIS represents. Distributed means geographically separated simulations, each hosted on a computer connected via communication networks to create a shared synthetic environment (i.e. no central computer).

Interactive means different simulations electronically linked (not remoted) to act together and upon one another; this may include humans as part of the simulation. Simulations are categorized into three types: live, virtual, and constructive. Live simulation means real equipment and soldiers operating in the field. Virtual simulation means the use of manned simulators. Constructive simulation refers to wargames and models (with or without human interaction). DIS could consist of any combination of live, virtual, and constructive simulations. DIS, for this article, is defined to include the simulations as well as the networks and the standards, protocols, and data bases that comprise the synthetic environment.

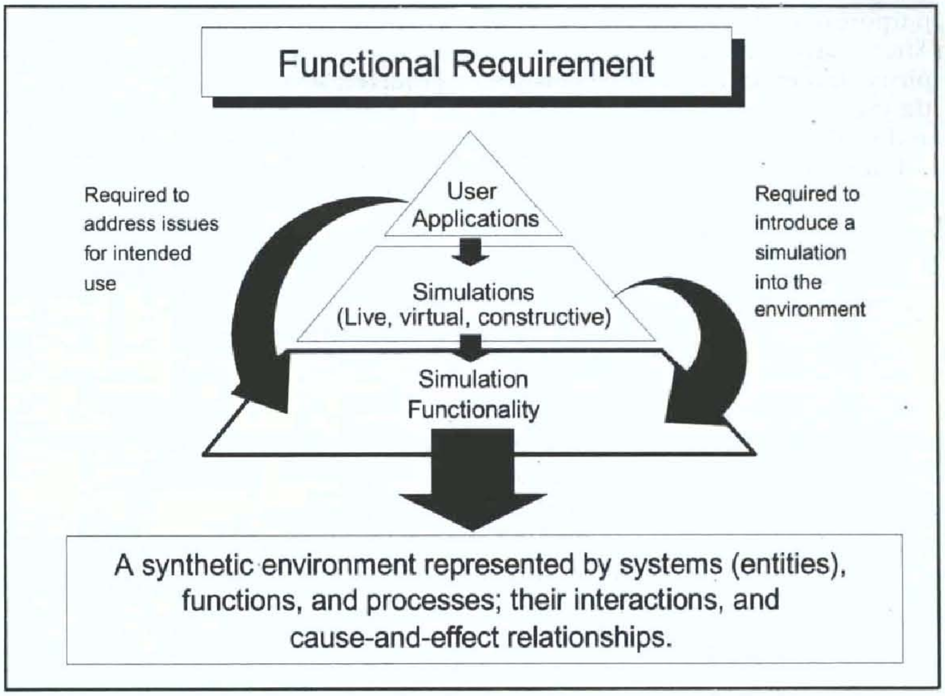



**Figure 1.**

## Functional Requirements

Users within the DIS community will compete against each other for available resources based upon functional requirements. Figure 1 depicts the categorization of functional requirements as a pyramid. The apex of the pyramid is classified as applications. They drive the simulations. The base of the pyramid describes the simulation functionality that cascades into a synthetic environment represented by systems (entities), functions, and processes. Users are most concerned with their interactions and cause-and-effect relationships. It's not enough to say "build a simulator," without describing how you want the simulator to effect the environment.

## DIS Domains

Functional requirements from the DIS community at large will fall into one of three major DIS domains: research, development and acquisition (RDA); training; and military operations (Figure 2). Functional requirements will be exercised in synthetic environments and can use any combination of live, virtual and constructive simulations.

It is anticipated that experiments within any domain could and probably will cross over any combination of the domains. After a piece of equipment is developed, tested, and fielded, the training community has the opportunity to utilize the equipment for its intended purpose during some training exercise. After a particular training event is completed, leaders can go back and analyze the exercise to determine shortcomings and study lessons learned.

If it is decided that a deficiency exists due to training, leaders can go back to the training community to determine if more training is needed or if better tactics are needed. If it is determined that a new piece of equipment is needed or modifications are necessary to existing equipment, then the leaders would return to the RDA domain. The pendulum constantly oscillates between the three domains and keeps all communities actively involved in the program.

## Users' Vision

The Army users' vision is best described by a combination of tenets and elements. These tenets provide the cornerstones for a structurally sound foundation (Figure 3). The DIS elements in-common provide the mortar that strengthens and cements the domain structures together. The DIS community must build upon current functionality and exploit proven capabilities. Conventional wisdom says we can no longer afford to take two steps back for every step forward.

The DIS elements, in-common, provide a basis for the new technologies and are the mortar that solidifies the domains with one another. The following list of elements are of primary importance and are in no particular order of priority. DIS must:

- Represent all phases and the entire spectrum of conflict;
- Have verified, validated and accredited (VV&A) synthetic environments for both individual and confederations of linked simulations;
- Have computer generated forces (Semi-Automated Forces (SAFOR), Automated Forces (AFOR), and Intelligent Forces (IFOR)) that are accurate physically, behaviorally and tactically;
- Accurately represent environmental effects, both natural and man-made (i.e. dynamic terrain affected by weather and man);
- Protect all levels of classified and proprietary data during transmission;
- Have the ability to interface a classified simulation with an unclassified simulation without compromise;
- Provide dual standardized data bases. The RDA and military operations domains require classified data bases, while the training domain requires unclassified data bases.

The DIS environment must provide a library of subject matter expert (SME) approved data, nomenclature, icons, algorithms and subroutines, and provide standardized terrain data bases (TDBs). It must facilitate the automated collection and recording of simulation events, including human-generated, wherever possible. In addition, the DIS environment must provide relocatable Distributed Simulation Internet (DSI) nodes and on-demand circuits for locations not having fixed DSI nodes. Finally, it must provide a suite of simulation interfaces. The elements mentioned above are critical to the success of DIS and should receive the highest priority for funding, research, development and procurement.

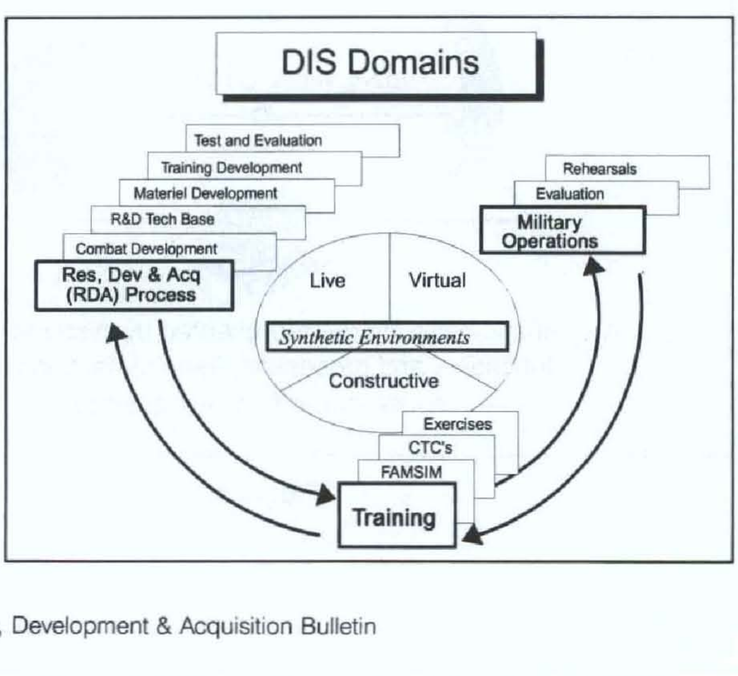
## Training Philosophy

The philosophy of training under the DIS environment is to drastically reduce support requirements for training events while increasing realism. The Battle Simulation Center (BSC) in the DIS world will be a small facility with a few technical support personnel which may broadcast an exercise either over the air similar to a radio station or through a high capacity wide area network.

## Critical Elements

There are some critical elements of training required to achieve success in the DIS environment. DIS must simultaneously train multi-echelon, joint and/or multi-national forces by providing a seamless linkage of dissimilar training events across all echelons, including single, concurrent, or sequential interactive training events. It must stimulate the essential elements of the battle staff, and allow soldiers to train wherever they are located, including their home station, in the field, during exercises, while deployed, and during battle preparations.

Figure 2.



Tactical command and control systems will be used as exercise workstations and interfaces, allowing soldiers to train on the same equipment they will take to war. The DIS environment should minimize the personnel support requirements for workstation controllers, opposing forces (OPFOR) controllers, and observers.

DIS will also provide voice activated interfaces (orders via communication's stimulate simulation), touch screens and hands-free operation. Commanders will have a virtual portal to "see the battlefield" at any time and from any location on the battlefield.

Another key element will be a robust after action review capability that automatically synchronizes multimedia sources (voice, video, and digital), provides instantaneous feedback and replay upon demand, captures all events the user defines as critical, and customizes the take-home package to meet the user defined needs. A robust automated course-of-action analyzer will have the capability to run at real time and faster than real time, be used online before, during and after an exercise, and automatically simulate what-if exercises. Finally, it must ensure that soldiers are never used as a training aid for staffs.

The Army has a continuing requirement to conduct experimental tests and analysis in support of decision making related to force modernization, materiel and training requirements definitions and documentation, organizational design, and experimental tests. Traditional methods of materiel development, combat development, training development, and operational testing are increasingly limited, expensive, and time consuming.

The DIS elements of the RD&A process provide the building blocks for the new technologies and are the foundation for the RD&A domain. New simulations will be introduced into the synthetic environment with minimum software changes (i.e. individual live soldier as a virtual simulation entity). The DIS environment will provide reusable simulators that can be reconfigured at a low cost and effort. An option of using humans or code (i.e. SAFOR, AFOR, or IFOR) to simulate soldier actions should also be available.

The DIS environment should also be capable of collecting or recording actions, reactions or events generated by humans with minimum interference by observers or controllers. It must provide early access to new system concepts by the user at home station to assess system and training concepts. Finally, it must readily transfer system concept and design among simulations as it matures during the acquisition process.

User DIS Tenets

- Doctrinal - represent joint and combined arms operations relevant to practitioners
- Credible - acceptably credible for intended applications
- Practicable - efficient use of soldiers, resources and time
- Accessible - readily accessible to users
- Friendly - easy to learn and use
- Evolutional - facilitate growth of functionality

Build upon current functionality; exploit proven capabilities

**Figure 3.**

For the synergistic vision of the RD&A domain to be successful, it must include proposed weapon system simulations for concept definition and requirements validation, analysis to establish design parameters, and evaluations coupled with live demonstrations to validate theoretical models.

Perhaps the most exciting and potentially the most valuable aspect of DIS is in the area of military operations. The same synthetic battlefield used for acquisition and training applications will be an invaluable tool in mission planning, rehearsals, and evaluations.

Systems in the next 10 years should have embedded connections into the DIS environment. This connectivity will allow forces deployed during a military operation to remain connected to the internetted infrastructure.

The DIS elements of military operations provide the building blocks for new technologies and are the foundation of the military operations domain. The DIS environment will rapidly introduce a real situation into the synthetic environment to support the planning process (i.e. must be inside the crisis timeline). Other essential elements are: the capability to examine operational plans wherever the staff is located, and the ability to integrate an electronically recorded real operation into the synthetic environment. This would include some type of "black box" recorder on each piece of equipment that facilitates an after action review. It should include the capability to change parameters and repeat the battle as a simulated operation. It should also allow you to rehearse for follow-on real operations.

## Summary

The vision described in this article is robust, challenging, and difficult, but necessary and doable. The DIS environment offers a new and dynamic opportunity for the Army to sustain and maintain the level of force readiness mandated and expected by the public. It provides the unconstrained environment needed to conduct tests and evaluations, quickly and safely. Finally, it can greatly reduce the acquisition life cycle, produce better analytical products, and the technology for building "right" training devices.

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# DISTRIBUTED INTERACTIVE SIMULATION

By John S. Yuhas

## Introduction

As the 21st Century rapidly approaches, the Army's challenge will be to maintain the "Warrior's Edge" with creative and innovative methods and techniques within constrained budgets. Distributed Interactive Simulation (DIS) is a developing, revolutionary technology that the Army is aggressively exploiting to augment and support this challenge.

The synthetic environment created through the augmentation of DIS will provide the synergistic network for modeling and simulation to be used by DOD, industry and academia. This synthetic environment will fundamentally alter how U.S. military forces acquire weapon systems and train under real time wargame scenarios. It will do this by empowering thousands of talented individuals and teams, traditionally separated through invisible functional barriers, to work as one.

But what is DIS? DIS is defined by some as "a time and space coherent representation of a virtual battlefield environment, measured in terms of human perception and behaviors of warfighters interacting in free play with other warfighters and/or computer generated forces." DIS is further defined as capable of including the many DOD live, constructive and virtual models and simulations that are employed and selectively linked as a synthetic environment to conduct training and acquire weapon systems.

**The synthetic environment created through the augmentation of DIS will provide the synergistic network for modeling and simulation to be used by DOD, industry and academia.**

The Defense Science Board's (DSB) 1992 Summer Study titled: *Impact of Advanced Distributed Simulation on Readiness, Training and Prototyping* states that "Everything is Simulation Except Combat." This premise, coupled with the effective inclusion of this empowered force, will significantly augment the U.S. capability to meet the future training and acquisition needs of improved performance with reduced cost and risk.

Trainers, developers, users and policy makers will have access (i.e., entry portals) to all levels of information pertaining to this process, both classified and unclassified, without regard to global location. Perspectives and results will be able to feed-back and feed-forward for continual development of comprehensive decision metrics at every stage of the training and acquisition process. A virtual warfighting environment will be created, capable of incorporating the human factor of war into systems development.

## Distributed Interactive Simulation provides the ultimate means to train units to function as teams and function with each other as groups of teams.

Stand-alone models and simulations are not new to the DOD. Nonetheless, this new visionary perspective is considered by many to be a significant paradigm shift, cultural change and challenging corporate strategy on the part of the DOD. Only recently, the U.S. Army sponsored Advanced Research Projects Agency (ARPA) research project known as Simulation Network (SIMNET) was declared successfully completed on July 2, 1990. Its deliverables continue to serve as the bedrock architecture and methodology that enables geographically dispersed simulators and simulations to function in DIS as we know it today.

### Education, Training and Military Operations

As applied to DIS, the descriptive of Education, Training and Military Operations (ET&MO) encompasses doctrine and tactics development, command and unit training, operational planning and rehearsal and recreation of historical battles. Traditional methods will no longer solely meet the demands of these exercises due to a constantly changing world situation, the complexity of weapon systems, the shortage of available ranges, safety concerns, and environmental limitations.

Desert Storm warfighters were extensively trained in a synthetic environment (DIS) prior to and during deployment. An essential element of readiness is teamwork. DIS provides the ultimate means to train units to function as teams and to function with each other as groups of teams. DIS networks possess extensive replay and after action review capabilities, including clear documentation of the exercise. These reviews help warfighters learn from their mistakes and provide the means to monitor progress.

### DIS and Acquisition

DOD Directive 5000.1 will continue to be the standing acquisition policy. This materiel acquisition process is one in which systems are conceived, developed, produced and sustained throughout their life cycle. Functionally, it can be described through the use of five acquisition domains titled: Requirements Definition/Analysis; Science and Technology; Engineering Development; Test and Evaluation; and Production and Logistics.

A DIS term that is developing as a part of the acquisition process is "Virtual Prototyping." Virtual prototyping can be expressed by the DOD community as: *an acquisition process capability to almost entirely investigate and evaluate, through a mode of modeling and simulation augmentation, the conception, design, development, validation, production and sustainment of a weapon system's life cycle in a synthetic environment.*

**The Army has been and continues to be the lead service in developing and applying modeling and simulation and DIS.**

Various uses of virtual prototyping provide needed acquisition flexibility by enabling constant interaction between warfighters, and combat and materiel developers. Almost 90 percent of a weapon system's cost is decided by the beginning of the engineering development phase. The Army can no longer wait for errors in the decision making process to be discovered in the development, production and/or deployment phase. These errors can potentially make the weapon system unaffordable and/or potentially overcome by competitive and rapidly changing technological events. Virtual prototyping will continue to be exploited and expanded as an innovative and revolutionary information process. It will increasingly dominate a great deal of the Army's future acquisition activities well into the 21st Century.

### Future Plans

The Army has been and continues to be the lead service in developing and applying modeling and simulation and DIS. Following the completion of the SIMNET project in 1990, the Combined Arms Tactical Trainer (CATT) and Battlefield Distributed Simulation-Developmental (BDS-D) programs were the two-pronged DIS strategies established to support Army training and acquisition needs. Both efforts will provide real-time, man-in-the-loop, combined arms synthetic battlefield environment capability. This includes linkage of actual weapon systems, battlefield simulations, and manned simulators to achieve an integrated extended battlefield environment; open architecture standards and protocols; effective behavioral representation on the battlefield to represent the battlefield environment at successively higher echelons of command; and long-haul networking.

CATT will be comprised of multiple training simulators and simulations geographically dispersed at the various mission area schools and tactical units and will be based on current weapon systems, configurations, tactics and doctrine. Included in the CATT programmatic strategy envisioned for this decade is the Close Combat Tactical Trainer (CCTT) (armor/mechanized), Aviation CATT (AVCATT), Air Defense CATT (ADCATT), Field Artillery CATT (FACATT) and Engineering CATT (ENCATT). Presently, only the CCTT effort is fully funded and on contract as of first quarter fiscal year 1993.

BDS-D will be utilized for development of: operational tests/assessments, training tools/models, system upgrades and next generation/future system investigations, science and technology program evaluations, and tactics/doctrine. It will include the development and networking of low and high fidelity, real time, man-in-the-loop simulators at combat and materiel developer facilities including Training and Doctrine Command (TRADOC) Battle Labs, the Operational Test and Evaluation Command (OPTEC), Army Materiel Command (AMC) research, development and engineering centers and laboratories and Corps Of Engineers laboratories.

BDS-D Advanced Technology Demonstration (ATD) fiscal years 1992-94 are specifically focused on the networking of dissimilar simulators and simulations and employment of the "fly before you buy, build, fight" concept in a manned combined arms environment. The ATD will include demonstrations in support of several key acquisition programs (including: Line Of Sight Antitank, Command Ground Station, Combined Arms Command and Control, Combat Identification, STINGRAY, Rotorcraft Pilot's Associate, RAH-66 Comanche, and the Rapid Force Projection Initiatives). Extensive simulation is a part of their identified exit criteria and deliverables.

The Army has begun restructuring and downsizing in response to the end of the Cold War. In support of these efforts, the Army instituted a number of key actions in fiscal year 1992 that extensively involve the use and/or development of DIS as a part of the synthetic environment. These actions include Louisiana Maneuvers (LAM); TRADOC Battle Labs; the Simulation, Training and Instrumentation Command (STRICOM); and the Distributed Interactive Simulation General Officer Steering Committee (DIS GOSC).

## Louisiana Maneuvers (LAM) and Battle Labs

LAM is a process for the Army to study how warfighting, modernization, and policy will best shape the Army of the future. It will provide Army leaders the capability to address key issues such as the development of new weapon systems, force structure development and doctrine of the future. Currently, LAM is in the concept formulation and planning stages. In fiscal year 1994, LAM will begin to collect information from joint and combined exercises which depend heavily on the use of aggregate level interactive simulations distributed on a global basis.

The TRADOC has established and is equipping six Battle Labs focused on the changing dynamics of the future battlefield, including tactics, doctrine and supporting technologies. They are: Mounted Battlespace (Fort Knox), Early Entry Lethality and Survivability (Fort Monroe), Battle Command (Fort Leavenworth), Combat Service Support (Fort Lee), Depth and Simultaneous Attack (Fort Sill), and Dismounted Battlespace (Fort Benning). All of these Battle Labs and schools will make extensive use of DIS in developing combat and materiel requirements, conducting training and wargamming, and directly supporting LAM with analysis of assigned issues. The Battle Labs, Advanced Technology Demonstrations and supporting DIS experiments will provide important building blocks for the LAM process.

## Simulation, Training and Instrumentation Command (STRICOM)

STRICOM was formed in the first quarter 1993. In addition to procuring simulators and training devices, it is the Army's technical agent for DIS technology development and network management. It is also responsible for developing and maintaining DOD and Industry modeling and simulation DIS standards and protocols. The CATT and BDS-D programs are managed by STRICOM.

## DIS General Officer Steering Committee (GOSC)

To oversee DIS networking activities from a corporate perspective, the Army has established a DIS GOSC co-chaired by the deputy chief of staff for operations and plans and the deputy under secretary of the Army (operations research). On Oct. 9, 1992, the first meeting of the GOSC was held. Members of the GOSC represent the assistant secretary of the Army (ASA) for research, development and acquisition; the ASA for manpower and reserve affairs; the ASA for financial management, the director of information systems for command, control, communications, and computers; the deputy chief of staff for intelligence; the director of program analysis and evaluation; the Army Materiel Command; the Training and Doctrine Command; the Operational Test and Evaluation Command; and the Corps of Engineers. Two key actions were initiated, including the development of a DIS Modernization Plan with STRICOM as the lead, and a DIS Master Plan with TRADOC TRAC as the lead. The first drafts of the documents are currently being prepared.

## Summary

Distributed Interactive Simulation will continue to augment the development of synthetic environments. The future envisions soldiers, sailors, airmen, scientists, engineers, and technicians able to work at a higher level of interaction than has yet been experienced. Military echelons from individual warfighter to theater level commanders will participate at all levels of combat and materiel development, thus revolutionizing the training and acquisition process. The key element to make this vision a useful reality is a cooperative effort. This includes DOD, industry and academic corporate strategic planning through cooperative and participative initiatives.

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# INDUSTRY APPLICATIONS OF DISTRIBUTED INTERACTIVE SIMULATION

By Charles Burdick, Jorge Cadiz and Gordon Sayre

## Introduction

Sweat was pouring off SSGT Johnson and CPL Lafoy in their brand new M1A2 Abrams main battle tank. The rolling, bleak, sand blown murky blackness of night didn't help much in the filthy desert environment the crew had been operating in for the last three days. The "pucker factor" was high, significantly more than in the long training days that preceded this combat mission. Everybody was tense. Had they trained enough?

Accompanying the Abrams, was a strange looking armored vehicle. It was tank like, but more lightly armored, with a strange articulated square pod where a normal turret should be. Inside, LT Stadler and SGT Collins in the Line of Sight Anti-Tank (LOSAT), were tasting the same pre-combat tension.

The greenish haze of the thermal sights both vehicles were using was starting to strain the eyes of the crews. These were the systems their lives depended on to penetrate the real darkness and find the enemy T-72s main battle tanks waiting in ambush. That, teamwork, crew drills and skills built up over the previous six months, would mean the difference between victory and death.

Orbiting high above "Mutt and Jeff," the Abrams and LOSAT, COL Stan Fegalman, call sign "Warlord," was intently watching the instruments and displays of his F15E fighter configured for a ground attack mission. He was monitoring the AWACS and strike frequencies, the FM frequency being used by Johnson and Stadler, and a UHF frequency where a lone "Comanche" and OH-58D scout/light attack helicopter team was performing a "visual reconnaissance" mission in front of the ground forces. This scout team was the "eyes and ears" of the force.

The latest Frago was passed to all of them from "Battle 6"—LTC Wulf, the task force commander, via the Combat Vehicle Command and Control (CVCC) system. The mission was simple—"Find, Fix, and Destroy" the enemy before he did it to us. The aero scout team was to "find" them, "Mutt and Jeff" were to "Fix" them and strip out the accompanying enemy air defense vehicles, then "Warlord" and everyone on the team would contribute to the "destroy" part of the mission.

"Lead, I got 'em," yelled CW2 McGowan in the scout aircraft. "Walleye 16, spot report! Alpha: Walleye 16; Bravo: 16 Tango 72s, 2 Zulu Sierra Uniform 23-4s, 10 Bravo Mike Papa-2s; Charlie: Grid 634834; Delta: Dug in defensive positions along the Red Ball from east to west; Echo: Continuing to observe and lasing the two Alpha Delta systems in 30 secs." This same verbal message appeared in writing on the screen of Johnson's Commander's Integrated Display inside the M1A2 Tank.

The Comanche prepared to fire the Hellfire missiles, unmasked 30 seconds later, launched two missiles, and remasked. The two glowing missiles headed for the unsuspecting ZSU 23-4s, guided by the laser illumination spots from the scout's mast mounted laser designator. Suddenly, the night's quiet was ripped by the explosions from the two air defense systems. Flames licked the sky as ammunition and fuel burned fiercely. "Warlord" could see the bright circles of fire on the ground from his airborne orbit.

Five minutes later, "Mutt and Jeff" topped a small wadi and led by McGowan in the scout, started to "service" the enemy targets. McGowan called in "Warlord" and the sleek F15E started to contribute to the organized

**Table 1.**
Operational Testing Cost Comparisons.

| NLOS Operational Testing | |
|---|---|
| Live Simulation | Distributed Virtual Simulation |
| $15.5M | $2M |
| 13 Months | 3 Months |
| **Abrams Tank Operational Testing** | |
| Live Simulation | Distributed Virtual Simulation |
| $40M | $0.64M |
| 24 Months | 3 Months |

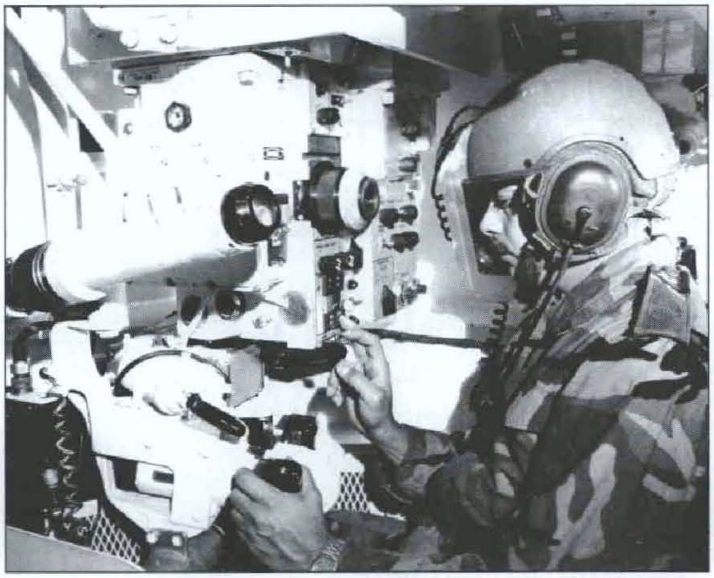

**Figure 1.**

**General Dynamics Distributed Interactive M1A2 Tank Simulator.**

Photo courtesy of Loral Corporation.

mayhem of the ensuing battle. At the end of 30 minutes, it was over. Smoke, fire, explosions, and molten rivulets of burning enemy machines, men, ammunition, rubber, and fuel dotted the battlefield and were spread as far as Johnson and Lafoy could see. Good Lord, this must be what hell is like after the fire and brimstone falls, thought Johnson. We're safe, alive, and damn, we got six T72s in what seemed like a minute!

"Okay, that's it for this exercise. Everybody meet me in the classroom for the After Action Review in five minutes" came over the radio system of the tank. Johnson and Lafoy climbed out of the square box-like SIMNET tank simulator and breathed the crisp, cool, air-conditioned air of the Close Combat Test Bed at Fort Knox, KY. "Going to the club tonight,?" asked Johnson.

The Close Combat Test Bed is one of the Army's Battlefield Distributed Simulation-Developmental (BDS-D) facilities where soldiers like SSGT Johnson and CPL Lafoy participate in life-like, interactive simulation exercises that are a part of the critical research that is expanding the realm of simulators.

The events described in the above narrative may seem like high drama from a modern war flick; but to the soldiers and the research scientists that work in facilities such as the one in Fort Knox, it is serious business. It provides soldiers with the opportunity to train as they would fight in an actual battle; however it also allows them to have an impact on the development of future warfare systems. Prototype vehicles like LT Stadler's Line of Sight Anti-Tank vehicle and battlefield communication systems like the CVCC are readily available in the virtual world created by Distributed Interactive Simulation. In addition, the ability to fight against advanced futuristic enemies is available in this synthetic battlefield. This allows us to determine the combat effectiveness of present and prototype vehicles against world class threats.

Distributed Interactive Simulation provides researchers with the ability to preview the impact of new and future battlefield systems. Increased industry involvement, the maturation of core technologies, and the evolving simulation standards have made Distributed Interactive Simulation a pivotal technology for military developments.

## Applying DIS in Industry

BDS-D is being developed by an industry team led by Loral Corporation under a contract issued by the Army Simulation, Training, and Instrumentation Command (STRICOM) called Advanced Distributed Simulation Technology or ADST. The ultimate objective of BDS-D is to create and maintain a distributed state-of-the-art network linking government, university and industry sites into a seamless simulation of the combined and joint arms battle. BDS-D provides development tools for combat development, material development, operational testing system acquisition, test and evaluation, and training development. BDS-D allows real soldiers to test new ideas in an integrated combined arms battlefield environment.

One of the most interesting aspects of distributed simulation is the potential for building highly realistic prototypes of future systems long before the design is frozen and well before large sums of money have been spent on full-up hardware prototypes. By observing these simulated prototypes in viewable operational environments, the design team can analyze the environment in which the system will be used, refine how the system might be employed doctrinally, and measure its contribution to the battlefield.

While many technologies work well in the laboratory, they often fail when the prototype system is put on a test range with actual troops using specific tactics. In the past, there has been little opportunity to obtain such feedback from operational tests until the design stage was essentially complete. While distributed simulation will not replace field testing, it offers tremendous opportunities for early and continuing coordination during system development that can potentially realize a substantial cost savings.

As an example of the way Loral Corporation is using distributed simulation, the LOSAT weapon system development program has already obtained a lot of highly useful information from a very realistic soldier in the loop simulator. Traditional analytical simulations without direct human involvement often show significant improvements in loss exchange ratios due to the introduction of a new weapon. However, many times the simplifications of such aggregated simulations make their answers suspect.

By using distributed simulation with soldiers in the loop, we are creating an environment much more like the anticipated battlefield of the future. Incorrect assumptions, which might be buried in an analytical model, often become obvious when a seasoned crew member in a manned simulator experiences them in the synthetic battlefield.

A particular benefit of the distributed simulation standards for industry is that access to this common simulated environment will become much easier and broader in the future. As distributed simulations expand beyond their current focus on weapons systems, all types of communications devices, sensors, countermeasures, command and control and intelligence systems will be able to join the network and be evaluated in a common environment. This expansion is critical, not only to provide a test bed for industry, but to better portray the realities of the combined arms battlefield without requiring each manufacturer to become expert in all of its aspects.

In the distributed simulations envisioned in the future, internal IR&D projects can be evaluated on a small workstation version of the distributed battlefield with the knowledge that if it works there, it can be transported into the larger simulated battlefield without extensive and time consuming conversions to new models and test beds. This vertical movement is not possible with current families of models.

Early availability, ease of use, low cost and interoperability are the qualities of distributed simulation that appeal to industry because they have an almost immediate impact on the bottom line. Industry has found standards useful in applications ranging from communications to power generation, and simulation should be no different. However, as with all new initiatives, the hardest part is getting started.

The initial DIS Protocol Data Unit (PDU) standards took almost three years to reach the approval process. However, the second version is taking only a little more than a year and the third version (already in the design stage) should go even faster. Similarly, the number of contractors capable of generating DIS protocols over a Distributed Simulation Network has skyrocketed from just two years ago when there were only a handful of vendors with the necessary skills. This means that industrial teams can now literally build a prototype system using distributed simulation technology and demonstrate it to the government without gathering large teams at a central site.

For example, Loral manufactures weapons, communications equipment, sensors, countermeasures, training equipment, and test instrumentation. It is envisioned that all of these areas will benefit from distributed simulation. In particular, the availability of a common evaluation environment allows the various divisions of Loral to pool their resources to reduce design and development costs while improving overall capabilities, especially for the smaller divisions.

Most hardware and software development already involves test beds, simulators, and simulation. However, distributed simulation offers the opportunity to link those many different test beds directly to a common operational environment. This provides many of the advantages of a field test early in the development process. Furthermore, if the client is also "on line," early demonstrations offer tremendous opportunities for feedback before the design is frozen.

There is also the opportunity to interact with the test community early in the acquisition cycle to better define what field tests will eventually look like and which requirements will drive the evaluation process. All of these benefits come at relatively low cost in comparison to the current acquisition system where prototypes are not evaluated until just before production decisions and the entire program often "marks time" while that occurs.

Loral will shortly initiate Project BODYGUARD involving seven Loral divisions in a common effort to demonstrate a systems approach to task force command and control and an area approach (rather than only point defense) to electronic combat. This competitively awarded DARPA project

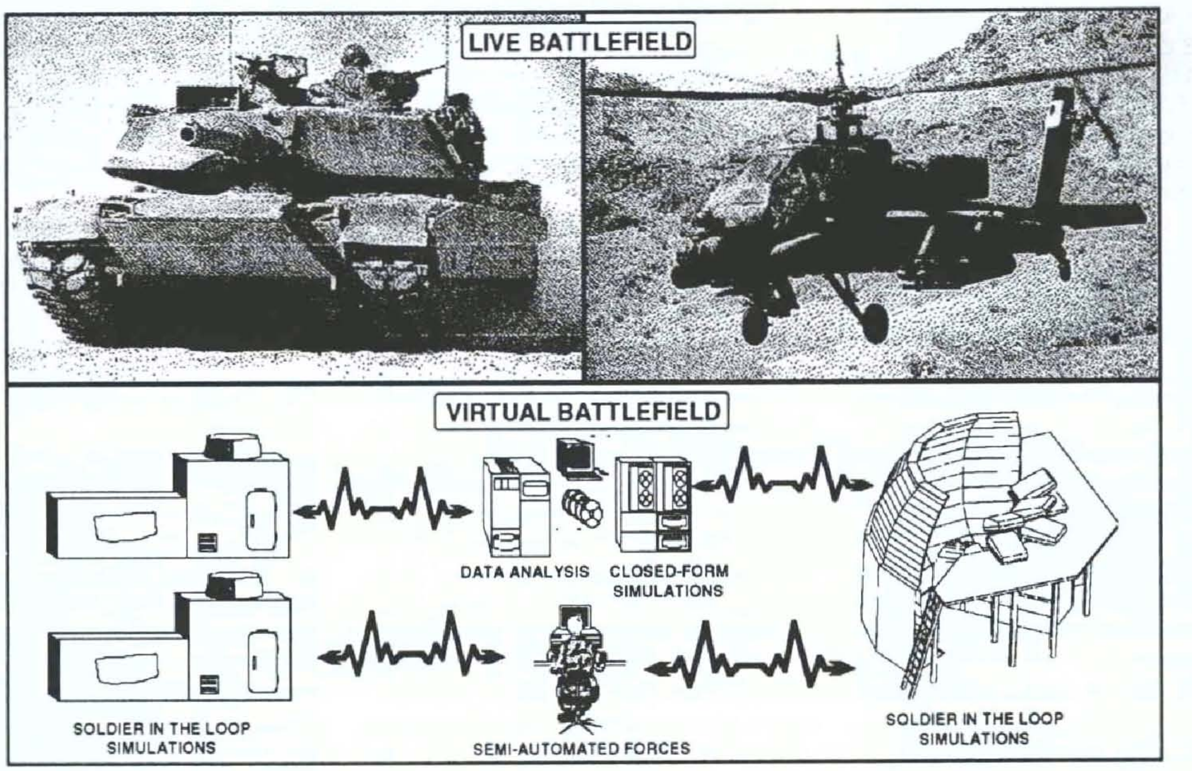


**Figure 2.**
Synthetic environment representations of live battlefield elements.

is cosponsored by the Army Tank-Automotive Command, Communications-Electronics Command, and STRICOM in a cooperative effort to use a common distributed simulation environment to simultaneously meet the needs of several programs.

BODYGUARD will be one of the first users of the new DIS Protocol Data Units being developed to represent communications, sensor detections, and countermeasures. Several technological challenges remain to be solved before BODYGUARD can be successful, but potential users of this extended DIS technology are already volunteering to test it.

A final example of how industry can utilize DIS is Loral's development of an in-house distributed simulation capability to support its many divisions. Because of our major roles in training and simulation, instrumentation, and combat system development, Loral has all the parts needed to provide a highly effective integration of lab and field tests in a distributed simulation environment. When this system is fully on-line, analysis, development, and testing will all have access to a common simulation environment which replicates specific battlefield situations and environments in a highly realistic manner.

Photo courtesy of Loral Corporation.

**Figure 3.**
NLOS Simulator at Fort Rucker, AL.

## Design and Operational Testing

The LOSAT weapon system operated by LT Stadler and SGT Collins is a simulator of a prototype vehicle being considered for acquisition by the U.S. Army. The LOSAT weapon system is a dedicated hypervelocity antitank missile system designed to replace the current Improved Tow Vehicle (ITV). A distributed interactive simulator of the LOSAT system was developed by the LOSAT Project Office in support of both systems design and early user testing.

Simulator development began in 1990. Tests were conducted in 1991 to collect MANPRINT data, make modifications to the Fire Control System (FCS), and measure design improvements. Changes made to the simulator controls and functions showed significant improvements and led to critical changes in the baseline LOSAT system design.

In 1992, a second test effort was conducted to refine the FCS and included additional capabilities such as autocueing and autosearch. Results from these tests fed the final LOSAT System Design Phase. The resulting system design improved MANPRINT by reducing operator error types by a factor of four and cutting operator timelines in half. Additional testing and virtual prototyping tools will be used to evaluate tactics, techniques, and procedures, examine $C^3$ capabilities, and conduct additional development work to incorporate new control/display technology.

As previously mentioned, this type of operational testing can result in large savings in time and dollars during the prototyping process. Two experiments, one involving the Non-Line of Sight (NLOS) vehicle and the second concerning the Abrams Main Battle Tank, have demonstrated savings potential in operational testing.

The Non-Line of Sight vehicle (See Figure 3) underwent operational testing using an NLOS prototype and Helos on an instrumented range. This testing costs \$15.5M and was completed over a 13-month period. A similar test, using distributed simulation, involved an NLOS simulator connected via a long haul telephone link to helo simulators at Fort Rucker. The simulation cost \$2M and was completed in three months. The virtual simulation was found to be highly effective.

In another example, an operational test of Abrams Tank upgrades was conducted using real hardware. This simulation took 24 months (1984–1986) and incurred a cost of \$40M. Last year, a comparative analysis was conducted using distributed simulation. This simulation compared the operational effectiveness of the M1A1 and the M1A2 Tanks and was completed in three months at a cost of only \$0.64M.

Concept development and testing in the DIS environment are not restricted to ground combat vehicles. Considerable efforts are ongoing to develop greater DIS interfaces for aircraft and helicopters, command and control nodes and support vehicles.

## Advanced Distributed Simulation Technology

Most of the elements encountered by "Mutt and Jeff" in the battle scenario are available to researchers that work under the Advanced Distributed Simulation Technology (ADST) contract. The ADST contract is the mechanism used by the Army to increase the envelope of their simulation applications. Currently, there are 19 projects or experiments under the ADST contract. These projects are called

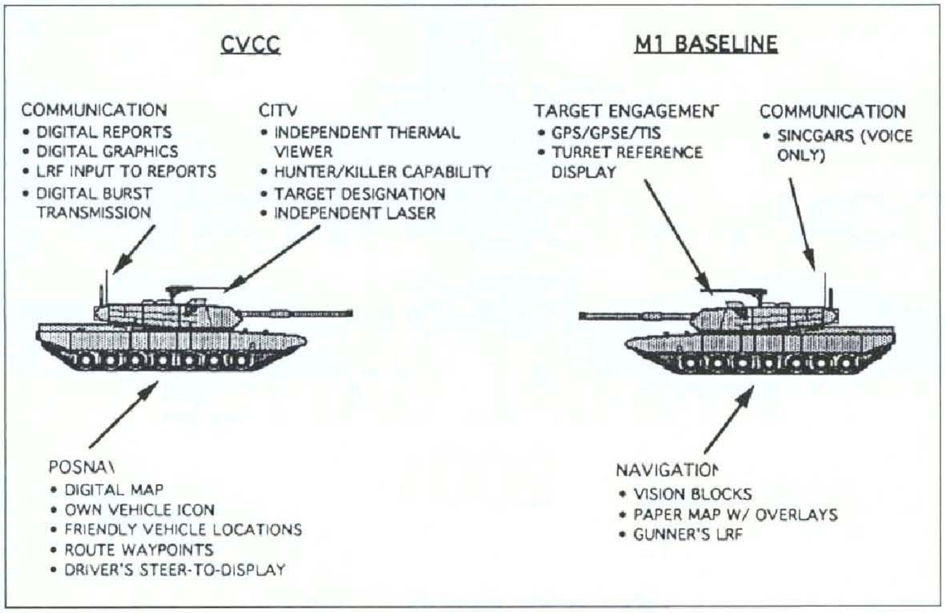


**Figure 4.**
CVCC and baseline M1 System Highlights.

Delivery Orders, and cover a large spectrum of development activity, including combat development, materiel development, operational test and evaluation, and training development.

For example, the system used by "Battle 6" to transmit the Frago of "Find, Fix, and Destroy" is the CVCC system. Figure 4 highlights several CVCC enhancements, as well as baseline M1 Tank capabilities. This system is used under the CVCC Delivery Order that is a follow-on to earlier efforts sponsored by the Army Research Institute. These efforts studied the performance deltas of units equipped with combat vehicles utilizing enhanced command and control devices. Those units involved in earlier experiments were below battalion level.

The current effort, which focuses on the battalion, involves the use of the Inter-Vehicular Information System, the Command and Control Display, the Commander's Independent Thermal Viewer, as well as a steer-to display for the vehicle driver.

Hardware was procured and software developed to support the evaluations. These systems were integrated and installed into baseline M1 Simulators to create an M1A2-plus armored vehicle simulator. Based on experimental and scenario design, data will be collected to analyze the resulting performance deltas.

A series of data collection exercise excursions are being completed to analyze vertical communications within the battalion. An additional task involves the development of innovative training strategies for future development. Recently, the effort to be performed under this Delivery Order has been extended to incorporate additional data collection to complete the evaluation of solder-in-the-loop performance using interactive simulation of selected future tank and Tactical Operations Center technologies.

## Conclusion

LOSAT, NLOS, CVCC, and the M1A2 are only a few of the battlefield systems that utilize Distributed Interactive Simulation. Low cost, interoperability, and ease of use makes Distributed Interactive Simulation attractive to both industry and government. Advantages of Distributed Interactive Simulation provide for early and continuing coordination during system development, along with early interaction with the test community. The ability to conduct highly realistic soldier in the loop simulations provides for excellent supplemental experimentation to computerized, aggregate testing.


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*GORDON SAYRE is a program management engineer in the ADST Program Management Office. He has extensive operational, combat development, training, and simulation experience with the U.S. Army.*

# THE COMMANDER-IN-CHIEF'S FIRST VIRTUAL BATTLE 2001

## By Lloyd Neale Cosby

***Author's Note: This is a fictional look at the use of simulations in the 21st Century. The appropriate disclaimers apply to the Institute for Defense Analyses and the Department of Defense. Only Cosby's career is at risk.***

(The time is 0439 hours, 21 January 2001)

**NATIONAL SECURITY ADVISOR:** *Mr. president, I'm sorry to wake you after only a short sleep following last night's inaugural partying, but we have a massive movement of forces supported by SCUD IX missiles on the border of the volatile nation of Alpha. This is a threat to Bravo, a nation of vital interest to the United States. The Joint Combat Command is already rehearsing a likely contingency plan.*

**PRESIDENT:** *OK, I'll be right down.*

The president turns on a large thin-film screen situation map and watches the deployment of forces as he dresses. His thoughts immediately turn to his first responsibilities as the commander-in-chief.

The president arrives downstairs and is briefed on the world situation by the secretary of state. The secretary reviews the position of the United Nations and outlines the geopolitical considerations of national interest to the United States.

**SECRETARY OF STATE:** *Mr. president, before I offer a recommended option and before you make a decision, I would like for the Pentagon to cover our military plans for this part of the world.*

The secretary of Defense, speaking from the Pentagon and appearing on a large digital display in the Command Center, lays out all of the contingency plans. Finally, he arrives at the plan that is being rehearsed today.

**SECRETARY OF DEFENSE:** *Mr. president, you are in the Command Center, a bubble room with a 360 degree high definition surround display. I will immediately teleport you into the synthetic environment of Alpha, a former third-world communist country. First, I would like to take you on a reconnaissance of Alpha by flying you through the synthetic environment of this small country on the other side of the world. During this tour you may go any place, see anything, stop any place in this three-dimensional terrain. Your pilot is CPT Eprobt. Please give him your directions as we lift off. The chairman, joint chiefs of staff will now read you into the situation.*

**CHAIRMAN:** *Mr. president, let us first look at the enemy situation. The Alpha forces are building up along their southern border for an imminent attack into Bravo. Note the dug-in tanks and armor vehicles along this ridge line. The follow-on forces are located...*

**PRESIDENT:** *Wait! CPT Eprobt, can you give me a ground view from the enemy perspective? I want to see what they will be facing as they cross the border.*

**PRESIDENT:** *Thanks, now take me back to our side and put me inside one of Bravo's front-line tanks.*

The pilot flies back across the border; tethers on the lead tank; zooms into the cupola; and jumps into the gunner's seat. The president watches through the gun-sights as the gunner scans the horizon across the impending combat zone. The president is obviously struck by his visit to this virtual battlefield. The chairman tells the pilot to pull back for a God's-eye view of the opposing forces.

**The frequent and intensive access to synthetic battlefields was needed for joint forces to rehearse battle plans along the full range of weapon systems, doctrine, tactics, techniques, and organizations against sentient opponents anyplace in the world at any time, many times.**

> **CHAIRMAN:** *Sir, our friends are at a 1 to 4 disadvantage here. Plus, the enemy is supported by massive artillery, missile and air forces.*

The chairman instructs the pilot to teleport to the artillery sites and air bases deep inside Alpha for a close-up look at the total enemy threat.

> **CHAIRMAN:** *Mr. president, as you and I and the SECDEF speak, I'm flying high above the Atlantic and the commander, Joint Combat Command is on the ground in the capitol of Bravo. We are all networked together in a synthetic world. Let us all now join the Joint Combat Command as it rehearses the most likely course of action. I will ask you to make the critical decisions while watching the forces carry out your orders.*

The commander-in-chief is immediately immersed into the ongoing warfight. He is teleported from place to place in the battlezone. He is beamed to the aircraft carrier; flies with the strike aircraft as they roll-in on the mobile missiles. He is placed on the ground as attack helicopters take-out early warning radars. He sees the potential results (read consequences) of his decisions. He observes American combatants fighting on foreign soil. He watches people "die" before they die. In essence, he "fights" his first battle—before breakfast—on his first full day on the job.

> **PRESIDENT:** *Thanks general, I appreciate the orientation. That's a good preview of what we can expect. Let's have some breakfast while you tell me how all of that happened.*

He is told that it is a long story. It all started almost 25 years ago with a few visionaries. It has been growing ever since, to the point that the Department of Defense now has a world-wide simulation network for practicing warfighting missions. Furthermore, there is an international standard by which simulations around the world talk to each other. The commander-in-chief wants to know more.

This unique capability of doing things in simulation before you do them for real is the outcome of a happy marriage of military need and advanced technology. The frequent and intensive access to synthetic battle-fields was needed for joint forces to rehearse battle plans along the full range of weapon systems, doctrine, tactics, techniques, and organizations against sentient opponents anyplace in the world at any time, many times. Why, you ask, is it needed. Because military commanders believe that practice makes perfect, wins wars and saves lives.

> **PRESIDENT:** *So, this is the result of the 1990s technology strategy. Or should I say the use of affordable high technology as the key to national defense. Or whatever it's called, it appears as though our warriors have joined technology sponsors of information systems, communications, computer, and intelligence experts and delivered a high pay-off return for our nation.*

This revolution in military readiness began with an idea. In 1977, a young Air Force officer with a new Ph.D. believed the cardinal principle of psychology—the difference between amateurs and experts is practice, practice, practice. He wanted to apply it to the ancient art of warfighting. And he foresaw that the necessary technologies of computer, communications and displays were maturing to the point of doing just that.

The Defense Advanced Research Projects Agency (DARPA) planted the seed of virtual simulations in the 1980s. With the Army, they developed the technology for networked simulations (SIMNET). Other nations were given the technology and they built their own systems to standards, which were worked by the National Institute of Standards and Technology (NIST), Department of Commerce.

In the 1990s, the services made it grow into a joint and allied capability for mastering the art of warfighting. In fact, the system has matured to the point that today, at the turn of the century, synthetic environments are quickly created for any place in the world. They are in existence 24 hours a day and forces from all nations are "fighting" year round!

Let's liken it to the world-wide digital television/telephone system.

It is easy to set up a conference call of say 50 parties each located at a different point on the globe. Now, envision a simulator (tank, helicopter, airplane, etc.) at every place there is a telephone. You now have a simulation "conference call" for training.

**PRESIDENT:** *OK. I guess I'm also seeing the results of the military-industry policy of the late '90s. The dual-use or transfer of technology from research agencies in industry and government has paid off and thus was a worthy experiment. Is it only used for training?*

**SECDEF:** *No. It is used for developing joint doctrine which is further institutionalized in the operational force by doing. We use it to define requirements for new systems. We use it to design, prototype and manufacture the new weapons and command systems. And like you have just seen, we use it for contingency dress rehearsals, after action reviews and historical analyses.*

**CHAIRMAN:** *Furthermore, it permits us to network with Reserve forces and it lets us practice with our allies. The National Guard in each state, and among states, is networked with local governmental agencies for emergency response training. Through the Community Learning Information Network, we are able to provide at-home courses taught by on-line colleges. Yes sir, regardless of the gateway from which the information is accessed, the information is displayed in a standard manner and pulled from standard sources with standard protocols and processing capabilities.*

**SECDEF:** *Mr. president, the forces that you have just "commanded in war" were made up of a mixture of actual soldiers in real combat vehicles, commanders and their staff in wargames and virtual combatants in synthetic environments. All of them were fighting on the same battlefield in Alpha and none of them left their home station. And most importantly none of them really died!*

The exercise is terminated. The troops are now out of their fighting vehicles. They are taking a break and the commanders, at all levels, are conducting an After Action Review (AAR). This is the real value of shared experiential learning. All of the participants are learning from each other. They are able to revisit the battlezone; look at the battle from any angle, any place, many times.

**CHAIRMAN:** *In fact, Mr. president, you should know that at each level, the forces that just participated in this exercise, have the same capability that you have here. Watch as we fly freely and revisit your decisions in this contingency exercise.*

All of the combatants were able to fight together because we have simulation standards. It is an international standard called Distributed Interactive Simulation (DIS) and sanctioned by the International community (IEEE Standard-P 1278). Just as we do with telephone and television systems, each nation adheres to common communications protocols by which simulators "talk" to each other. Likewise, standard computer image generator interfaces (Visual Standard-2851) permit participants to operate on the same terrain database, i.e., the same synthetic environment.

**SECRETARY OF STATE:** *The military, like the world itself, has changed for the better. We are all safer today, thanks to high technology that has brought us closer together. Mr. president, let's hope you never have to commit forces to battle but if you must in the defense of our nation, you can be sure that the forces that you commit will be prepared for the fight. They will have mastered their warfighting skills in scores of hard fought exercises in the face of tough enemies. And they will arrive on that battlefield having been there many times before via synthetic environments.*

**CHAIRMAN:** *Likewise, thanks to international simulation standards, the world is now networked with simulations and simulators. We exercise on a routine basis with our friends regardless of where they are located on the globe and none of us ever leave home. In reality, it is a global network of electronic highways for peacekeeping or warfighting if necessary.*

**SECDEF:** *Mr. president, would you like to select another spot on this globe to exercise a contingency plan?*

**PRESIDENT:** *Not today. But to assure you that I got your message, let me say that in the future we will do it again, and again, and again. I am deeply grateful for the opportunity to rehearse these kinds of dangerous operations before we commit American lives to war. I'll bet that wise old man who said, "the pen is more powerful than the sword" never envisioned that information would emerge as such a powerful weapon. Indeed, this global grid of interoperable systems provides a significant force multiplier and thus a decisive advantage for freedom loving peoples. Please thank all of those who participated this morning.*

**CHAIRMAN:** *You did it yourself Mr. president. They were all listening as you spoke! Thank you sir.*

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*LLOYD NEALE COSBY, (USA Ret.), is manager of the Simulation Center at the Institute for Defense Analyses. Since retiring from the Army in 1985, he has been involved in networked simulation sponsored by the Defense Advanced Research Projects Agency. He holds master's degrees in international affairs and public administration.*

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# THE SENIOR SERVICE COLLEGE FELLOWSHIP PROGRAM AT THE UNIVERSITY OF TEXAS AT AUSTIN

By CPT(P) Steven E. Lopez

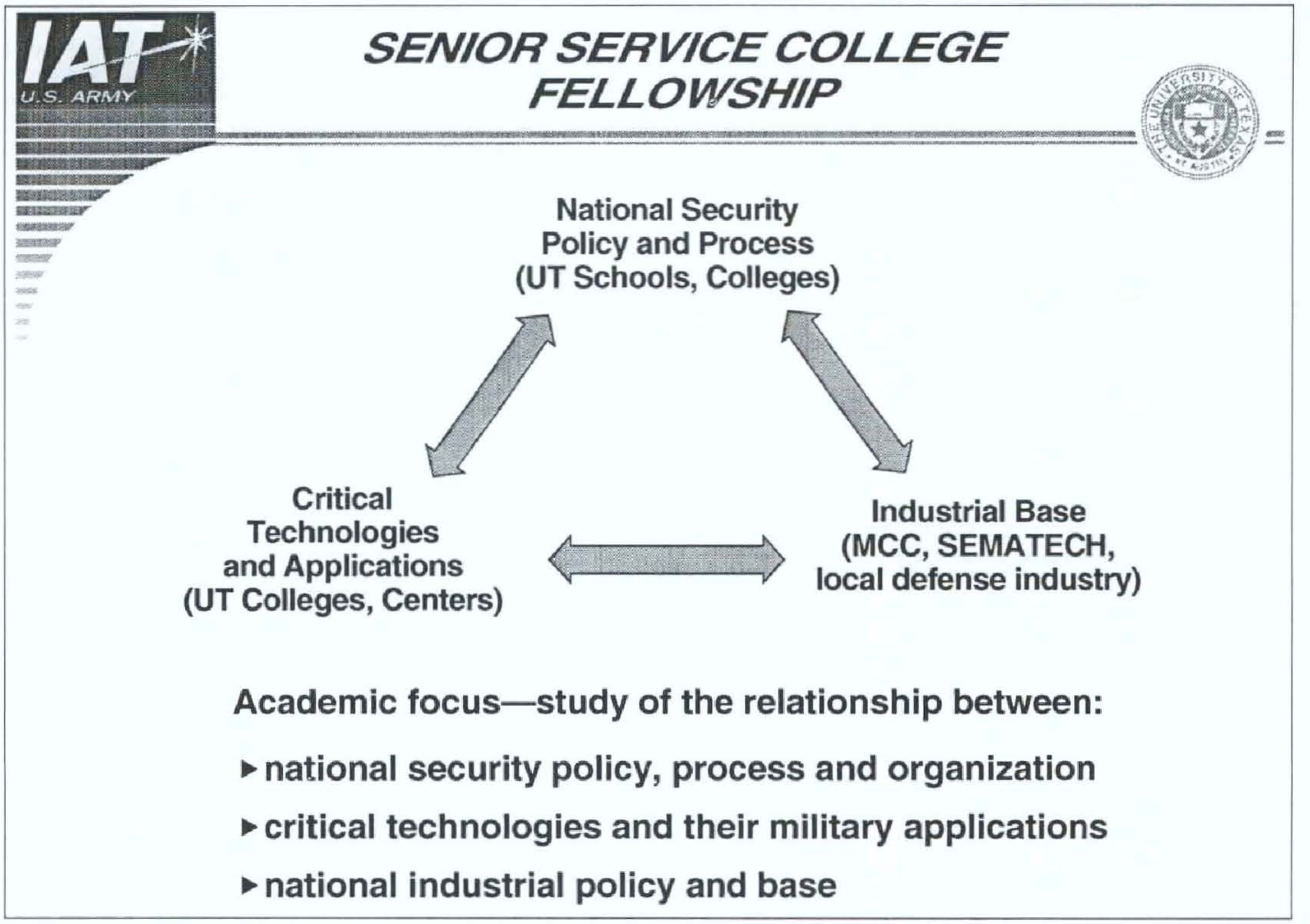
The U.S. Army has designated the University of Texas at Austin (UT) as a host university for the Army's Senior Service College (SSC) Fellowship Program. The Institute for Advanced Technology developed the fellowship specifically for Army Acquisition Corps (AAC) officers and their civilian counterparts selected for the resident SSC. Five fellows, three Army officers and two DA civilians, make up the inaugural class that began in August 1992. Fellows reside at the University of Texas for one academic year and receive the award of Military Education Level One upon completion.

The fellowship features a unique trilateral focus, with the fellows studying the relationships between national security, the Army's critical technologies, and the defense industrial base (see accompanying figure). "The program is comprehensive, but also flexible in that it allows each fellow to tailor his program for maximum emphasis in a given area," says SSC fellow LTC(P) Paul Wolfgramm.

## National Security

The national security module places national objectives in their geopolitical content, explores all facets of national power, addresses the organizational structure for national security, examines military strategy, and reviews the force development and acquisition process. The core of the module is built around a series of lectures by guest speakers of national prominence. Past speakers have included: George Singley, deputy assistant secretary of the Army for research and technology; Dr. Stuart Johnson, director of sponsored research, National Defense University; LTG Dale A. Vesser, USA (ret.) assistant deputy undersecretary of defense for resources and plans; MG Paul E. Funk, commanding general U.S. Army Armor Center and School, and MG Fred F. Marty, commanding general U.S. Army Field Artillery Center and School.

Fellows audit graduate courses at the LBJ School of Public Affairs and the University of Texas School of Government. "Participation in the UT courses allowed face to face conversation with such national figures as John Connally and Walt Rostow," says Bobby Bowles, one of two DA civilian fellows. "These people have been there and made the tough decision and were willing to share their knowledge and experience."




## Critical Technologies

The Critical Technologies and Military Applications module focuses on key emerging technologies such as micro-electronics, robotics, directed energy, advanced propulsion, advanced power generation and space technology. A combination of professors, experts and leaders in the specific technology areas present survey courses that provide an overview of the technology and its military applications.

"The critical technologies survey courses provide an excellent introduction to the technologies which are fundamental to developing some of the Army's newest weapons systems, says SSC fellow LTC(P) Chet Rees. Fellows also participate in a number of ongoing conferences and symposia sponsored or hosted by the Institute for Advanced Technology, such as the recent *IC²* Technical Issues Forum entitled "Technology and the New World Order."

## Industrial Base

The Industrial Base module explores the relationship between the government and the defense industry. Fellows receive an orientation to industry through internships with local high technology corporations, such as Texas Instruments, Motorola and Lockheed.

"Working with private industry provides a unique opportunity to understand how businesses operate and how executive level decisions are made," explains SSC fellow LTC(P) Ed Harrington.

"I've gained a better understanding of the corporation's problems in relation to defense contracting," adds Dr. Ashok Patil, a DA civilian fellow.

## Political-Military-Industrial Simulation

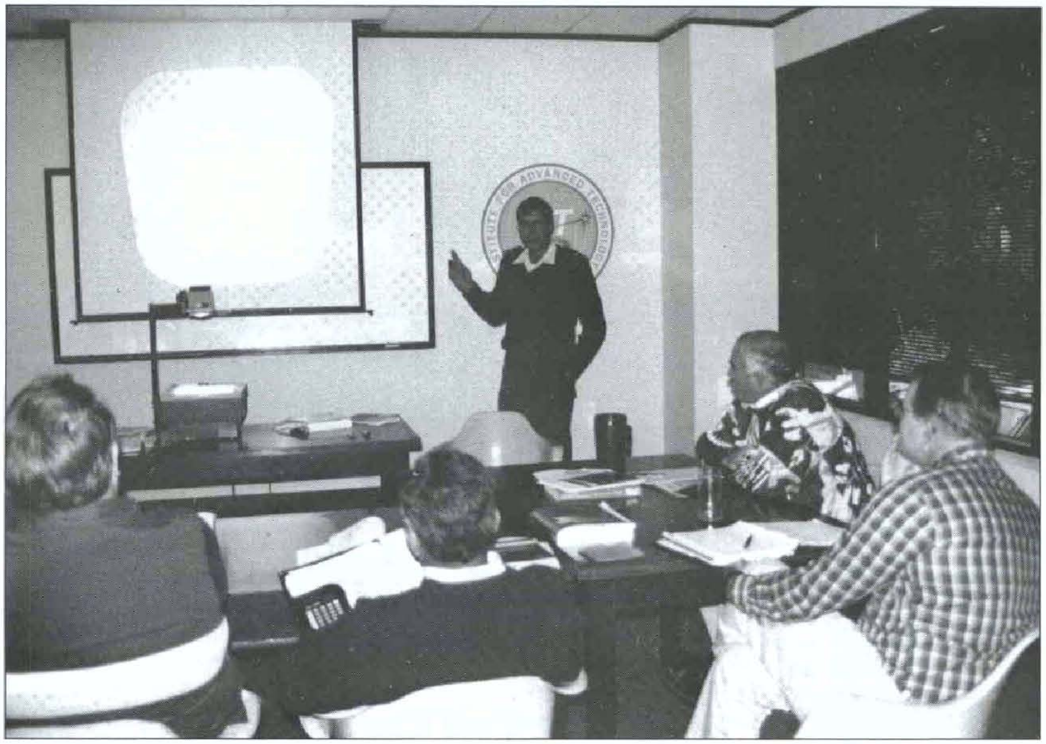
The capstone to the program is a computer-assisted simulation exercise in which fellows serve as political, military, and industrial role players. The University of Texas faculty, industrial executives, senior military personnel, and policy analysts participate as guest players and controllers. During the simulation, fellows are called upon to make political-military-industrial policy decisions as they respond to a series of regional crises.

## Research Activities

The SSC Fellowship Program is product-oriented and fellows are required to submit a research paper, report, or analysis to the Army War College (AWC) in order to receive Military Education Level 1 designation for officers and the equivalent for Army civilians. Fellows select their own topic in consultation with the Institute for Advanced Technology and the Army War College. Fellows can use the outstanding reference sources of the university, make research related trips and conduct their own research.

## Role of the Institute for Advanced Technology (IAT)

The IAT, an autonomous element of UT, is the Army's only federally funded research and development center (FFRDC). Along with its research efforts in electric armaments, IAT also provides the Army with world class education and training in advanced technologies. A key element of this mission is the establishment of the specialized SSC Fellowship Program at UT. IAT provides full service administrative



**COL Charles S. Rousek, director for Force Development Studies, U.S. Army War College, gives a presentation on "National Military Strategy and the Joint Strategy Planning System" to the SSC fellows as part of the guest speaker series.**

support to the SSC fellows throughout their course of study. SSC fellows also have the opportunity to interact with a variety of distinguished scholars, scientists, and military leaders associated with IAT.

## Summary

Comments on the program from the inaugural class have been extremely positive. "AAC officers and civilians now have an SSC program specifically designed for senior acquisition managers," says LTC(P) Edward Harrington. "I have gained much deeper understanding of the Army's role in national defense as a critical member of the national security establishment in an ever changing world," he adds.

"The diversity and the depth of the program has broadened my exposure and this surely helped me to understand the global and strategic perspectives of the Army," says Dr. Ashok Patil. "I recommend the program highly to all civilian acquisition leaders."

"The program is superb in preparing senior AAC officers to meet the future challenges of materiel acquisition management," says LTC(P) Wolfgram. "On a personal level, the effects of this program will pervade all aspects of my future work."

"I feel fortunate to have been part of the first class of this remarkable fellowship. I am confident that in the future, all AAC officers selected for SSC will vie for this program. It is absolutely the best SSC program to hone acquisition skills and broaden horizons in the critical technologies," says LTC(P) Chet Rees.

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*CPT(P) STEVEN E. LOPEZ is assigned to the Education Division at the Institute for Advanced Technology. He is a member of the Army Acquisition Corps and a distinguished graduate of the Materiel Acquisition Management (MAM) Course. He holds a B.S. degree in business administration from the University of Colorado, and is enrolled in the Executive MBA Program at the University of Texas at Austin.*

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*Modernizing the Army...*

# CHALLENGES AND OPPORTUNITIES

By GEN Gordon R. Sullivan
Chief of Staff
U.S. Army

**GEN Gordon R. Sullivan**

## The Need for Modernization

Today's Army is already significantly different from the Army of the Cold War period, and there are more changes to come. As we continue to reshape the Army into a smaller, contingency-oriented, power projection force, our modernization program is more critical than ever to our future at the same time that it is more complex in the planning and execution.

Modernizing the Army requires balance and teamwork. The past 20 years of hard work, dedication, and incredible vision have led to resounding victories around the globe—battlefield victories in the jungles of Panama and the deserts of Iraq as well as victories within our native shores from riot control in Los Angeles to hurricane relief in Florida and Hawaii. These victories were made possible by the military-industry team that had the foresight to build an Army that focused on balance and synergy.

Effective modernization requires a marriage of technology with force structure, doctrine, and people. The greatest advantage the United States Army holds over all other armies is the synergy we have achieved by marrying the best people with the most modern equipment; putting them through rigorous, realistic training and continuous leader development; organizing them into the right mix of Active, Guard, and Reserve; and giving them a battle-winning doctrine that provides a base for operations and gives soldiers a shared understanding of their capabilities.

Modernization requires optimum use of modern equipment by organizations employing their doctrines. Without the proper equipoise of these elements, investments in technology can be wasted. As Michael Howard, the noted British military historian, said in his 1973 acceptance speech for the Chesney Memorial Gold Medal, it is the task of military science in an age of peace to prevent the doctrine [and the technology] from being too badly wrong. Think about that. Just a few years ago, the Fulda Gap was the paradigm with which we evaluated our ability to optimize each piece of this complex organization we call the Army. We can no longer measure our capabilities using the Fulda Gap scenario. While our recent performance in Desert Storm gave clear evidence of current capabilities, the yardstick for measuring future prowess is not yet clear.

Other domestic priorities now demand attention, and resultant military budget cuts mean fewer soldiers and fewer dollars for needed equipment. This is a time for us to adjust and accommodate other national needs. At the same time, the shift from focus on potential global warfare to pressing domestic concerns does not free us from our responsibilities to provide for America's defense. The American people still look to us to remain trained and ready, to provide decisive victory in the missions we are called upon to perform. In order to do this, our modernization efforts must take into account the variety of challenges we face.

We know we cannot predict the future or model the next fight with any precision, so the challenge is to avoid getting it so wrong that we take ourselves out of the fight before it begins. Look at our most recent military experiences to see the dichotomy we face—from the precision strike, high-technology warfare of Desert Storm to the labor intensive humanitarian relief efforts of Somalia. In recent years, we have focused most of our modernization efforts on the high tech warfare we demonstrated with great success in Panama and Desert Storm. But the kinds of national service missions that are gaining more attention require very different resources. Missions such as peacekeeping and peace making are soldier intensive, placing greater demands on people and less on weaponry. Our tasks include trying to accommodate the demands of conditions in developing countries like Somalia while, at the same time, preparing the Army for the 21st century. We need to strike a balance among the requirements. We are trained and ready today. Can we be trained and ready tomorrow, for whatever the crisis?

### Historical Lessons

As we look forward to the future, we should not ignore the lessons of the past. History is a great source of strength for us, but it can also be a source of unease. As we look back and try to understand the lessons of the past, I have to wonder—are we doing things the right way, the best way for our Army and this great country? Let me share some of my concerns generated by missteps of our past.

During World War I, the great military powers of the world began investigating the possibilities of sound-ranging equipment. Originally developed to assist Field Artillery units in detecting enemy batteries, and the Coastal Artillery to locate and track distant ships, the benefits of sound location devices were later explored for use in anti-aircraft batteries. (See Figures 1 and 2.)

These systems were high tech for their times. They were developed and fielded by intelligent, well-intentioned men who believed this was the advanced technology needed to keep the enemy airplane from the sky. And, as cumbersome as they were, these systems worked as designed. Unfortunately, to be used at night, the sound locators had to be paired with an 800 million-candle power searchlight. It did not help to be able to hear incoming aircraft if you could not also see it to shoot it down. But, lighting up the sky to search for planes also meant exposing the sound rangers to enemy fire.

The history of the sound ranging equipment is worrisome. It demonstrates that technological solutions must be well thought out before use. Ultimately, the leap-ahead technology of radar put the sound rangers out of business. Some would say that pushing sub-optimal technology was better than doing nothing at all. Maybe it was back then, but, with today's austere resources, we cannot afford this approach to adopting new technologies. The lesson seems to be that we must carefully pick the right horse, not settle for a Hobson's choice by simply taking the horse nearest the door.

Allowing gaps in technology to develop is also dangerous to systems modernization. In the days when we used black powder, terminal ballistics effects were poor because the powder in the shell itself was not a powerful explosive. Dynamite was a very powerful explosive, but it couldn't withstand the shock of exploding propellant in a standard gun. As a stop-gap measure, the Army and Navy adopted the Zalinski Dynamite Gun for use until a more conventional technological solution could be found. Dynamite guns, which used compressed air and a 40-foot gun tube to achieve a range of about three miles, were installed at coastal defense fortifications and aboard the Navy's "dynamite cruiser" *Vesuvius* in the 1890s. The dynamite gun faded into oblivion with the development of the modern shrapnel round. The dynamite gun is proof that all "good" ideas are not good ideas. (See Figure 3.)

But what happens when you turn your back on technology, either due to lack of interest or lack of funds? The Army learned that lesson with the Trap-door '73 (Model 1873) Springfield. After the Civil War, the Army faced severe resource constraints. Sherman didn't have the money to purchase modern repeating rifles, so he settled for the Trap-door '73 Springfield. This was basically a product improvement program that turned the old muzzle-loading rifles into breech-loaders. But, they still used black powder and had to be reamed after firing 6-8 rounds. The soldiers thought so little of this weapon that they spent their own money to purchase Sharps, Spencers, Henrys and Winchester repeating rifles. Our soldiers are used to sacrifice, but we cannot expect them to buy their own tanks, helicopters, and fighting vehicles.

The question that plagues me is this: Where do we focus our efforts? I do not expect that we will get everything completely right, BUT, we cannot afford to get it completely wrong.

It is not that our predecessors were not good men—they were. We have advantages they did not have. We can look at warfighting holistically and test equipment and concepts before we

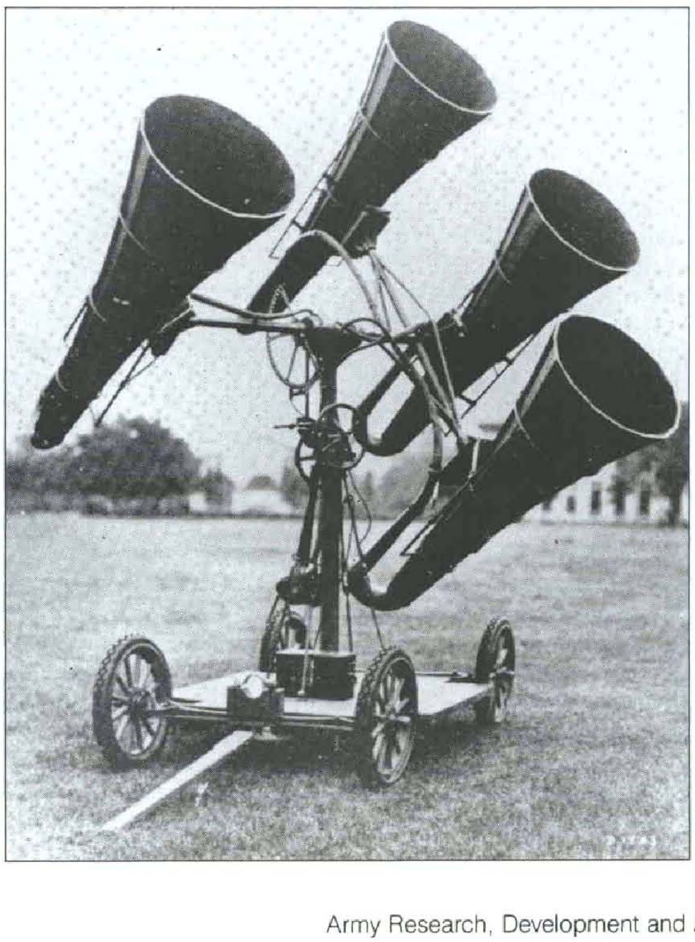

**Figure 1. The exponential sound locator.**

risks—not gambles. Vast improvements can be made to our already considerable strengths through integration of superior technology across the force. This is how, ultimately, we will break the mold and end the precipitous decline in effectiveness that our Army has historically ridden after every major conflict.

## Battlefield of the Future

I have looked at history as a means of preparing for the future. Our actions in Desert Storm have been carefully studied by many of our potential adversaries; state-of-the-art weapons systems are available to anyone with the funds; and the technology to produce weapons of mass-destruction is becoming more readily available.

The battlefield of the future calls for America's Army to continue to win decisively and with minimum casualties. Vast improvements can be made to our already considerable strengths through integration of technology across the force. We will meet future challenges through the simultaneous application of complementary capabilities—complementary capabilities that will offset quantitative and even qualitative force differences by our selective application of technology. Just Cause was only the first example of the power generated from the simultaneous

**Figure 2. "Modern" World War II sound locator.**

commit extensive resources to them. We diminish our risks by using our battle-winning doctrine as a foundation for our modernization objectives, and then testing new ideas and equipment using simulators and simulations to explore capabilities. With the advantages these tools give us, we should be able to avoid much of the risk that our predecessors faced.

In order to ensure the land force dominance our Army now enjoys, we must meet five modernization objectives: Win the Information War; Project and Sustain Combat Power; Protect the Force; Execute Precision Strikes; and Dominate Maneuver. (See Figure 4.)

The key to success is our commitment to a continuous modernization program, no stop-gap measures, no committing limited resources to suboptimal solutions. We must continue to develop technologies, integrate the most beneficial of these technologies across the force, and maintain the ability to overmatch our enemies. To have any hope of doing that with today's dollars, we have to take calculated

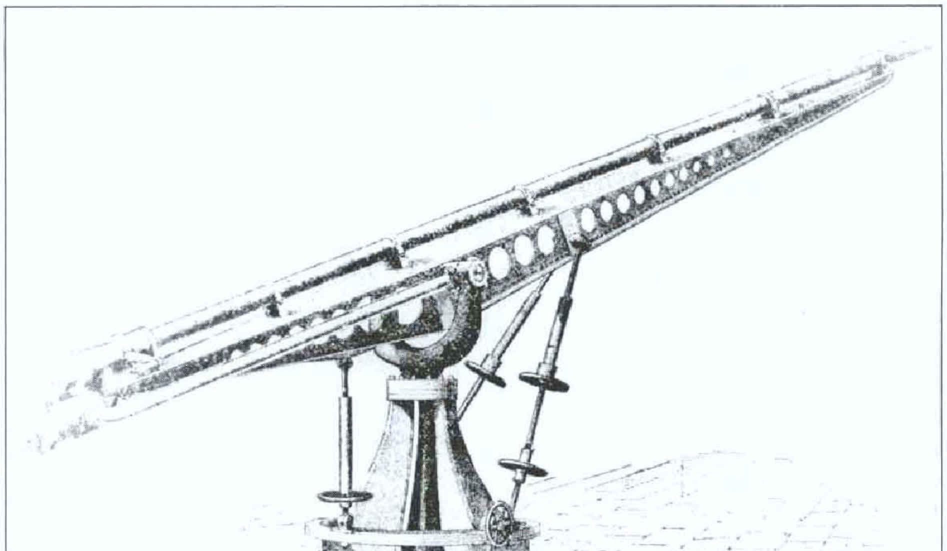

**Figure 3.**
The Zalinski Dynamite Gun.

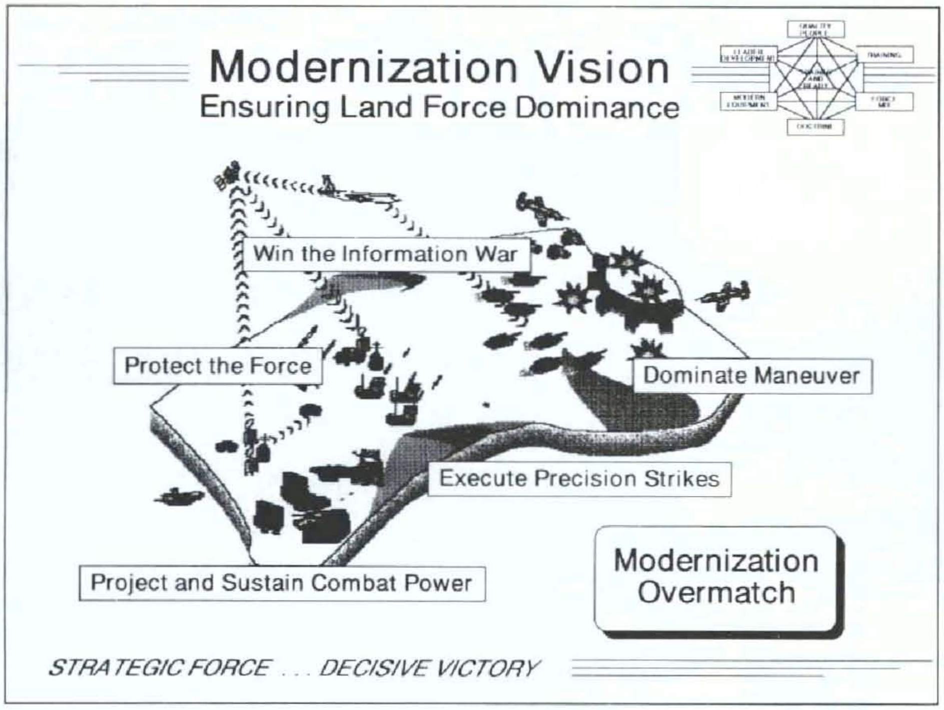


**Figure 4.**
Modernization objectives.

application of force at the tactical, operational, and strategic levels. We must build upon this groundwork for our future.

We have some very effective tools to focus our efforts and lessen some of the risks we face in modernization. The first tool is the TRADOC Battle Lab program. This is where a lot of our experimentation will take place. The Battle Labs—Early Entry, Mounted and Dismounted Battle Space, Command and Control, Depth and Simultaneous Attack, and Combat Service Support—are part of a networked effort to control change; to direct it and guide it for our benefit. Battle Labs link the science and technology community with combat developers to define, test, and analyze ideas. They allow us to experiment with concepts and equipment across a range of threats by using simulators and simulations to explore hardware and software payoffs.

We are also exploring programs for horizontal technology insertions and the integration of technology across families of systems. The challenge is to integrate and balance total force capabilities—we cannot pursue improvements to one battlefield system that cause our other systems to lag behind. We are currently using horizontal technology insertions in several programs including Future Generation Forward-Looking Infrared Radar (FLIR), Command and Control-on-the-Move, and Combat Identification. We will develop new prototype technologies, examine their benefits through our Battle Lab programs, and select the right technologies to place on existing platforms.

One of the major benefits of the Battle Labs is they allow us to do field work—let our soldiers test new methods and equipment in the field and on ranges before we mass produce. We are experimenting—exploring possibilities—in some very sophisticated and exciting ways. The incorporation of horizontal technology insertions in Battle Labs will ensure we develop capabilities across our power projection Army for maximum benefit at reduced costs. This is one of the tools we will use to prevent the modernization mistakes of the past.

Our other major modernization tool is the Louisiana Maneuvers (LAM). This program is extremely powerful and critical to our efforts, and we are still exploring all of its possibilities. LAM is the vehicle we will use to control change at the service level. Through LAM, we can continue to streamline the development and acquisition processes that currently occupy too much of our resources and talent. The Army senior leadership, in concert with the special LAM Task Force, work together to identify specific policy and warfighting issues to be tested. Every level of warfighting and every Departmental function is open to review.

As we review Departmental functions, we will look to make improvements to the ways we do business. Members of the Army Acquisition Corps will be key players as we work to improve the acquisition portion of the modernization process. Success depends on team building, technical and tactical competence, creative zeal and calculated risk-taking.

We do not have all the answers, yet. There are several dilemmas we must confront—the quandary of supporting people-intensive missions like Somalia versus technology-dependent 21st-century requirements and the need to define the balance, pace, and affordability of our modernization efforts. It's not easy to operate in an environment where every dollar we spend on any weapon comes at the direct expense of one of our other warfighting capabilities. Where do we strike the balance? How will we know when the proper balance is attained? These are very tough issues requiring our best efforts and a unified team approach. We are very enthusiastic about what we can accomplish through a focused, simulation-supported, team effort. We are excited about the programs we are developing, and with the participation of American industry, we can refine our modernization efforts even further.

Think about the responsibility we share for providing what America expects of us—a trained and ready Army, serving the nation at home and abroad; a strategic force capable of decisive victory. We cannot predict the future with certainty, but of one thing I am sure. When America calls upon us next, there will be no time for hand-wringing; we must respond as America's Army has always responded. We must learn how to apply scarce resources effectively. This is both a challenge and an opportunity—an opportunity to take America's Army—her sons and daughters—the finest Army ever fielded—into the 21st century.

American industrial and technological capabilities linked with the soldiers of her Army is a team second to none.

# THE SOLDIER INTEGRATED PROTECTIVE ENSEMBLE

By Cynthia L. Mooney

## Introduction

It is clear that the future U.S. Army will be significantly smaller in size, yet will be required to maintain its current level of operational effectiveness. Future strategic demands dictate that the force must be smarter, lighter and more highly mobile. In addition, the 21st century Army will be required to adapt to a full range of conflicts ranging from low to high intensity, as well as require protection from a spectrum of battlefield hazards and environmental conditions.

This organizational requirement necessitates a soldier system oriented approach which yields a suite of modular, interoperable and integrated components (electronics, weapon enhancements, equipment, clothing, etc.) that heighten individual and collective performance while providing balanced multiple threat protection. The Soldier Integrated Protective Ensemble (SIPE) is the U.S. Army's successful initial attempt in applying a systems approach to meet the needs of the 21st century soldier by providing maximum offensive capability and modular, integrated protection.

## SIPE Advanced Technology Demonstration

The SIPE program was a three-year 6.3A Advanced Technology Demonstration (ATD) initiated by the assistant secretary of the Army for research, development and acquisition in 1989. An ATD is a "proof of principle" demonstration in an operational environment that assesses the potential of a new capability and/or enhanced operational effectiveness. The SIPE ATD is specifically intended to demonstrate the capabilities that integration and aggregation of state-of-the-art technologies applied via a soldier system approach can afford the individual soldier.

It is important to note that an ATD is NOT a test of prototype hardware intended for immediate fielding. Rather, it is a means of driving and more clearly defining future soldier system efforts through the evaluation of advanced capabilities. The SIPE ATD is one of 20 funded ongoing ATDs, yet the only ATD focused on the individual soldier. It is the second ATD to be successfully completed and transitioned into a development program.

## The Soldier System

SIPE is the first programmatic step toward the development of a total soldier system. The soldier system approach focuses on the soldier as an integral component of the system. All of the soldier's clothing and equipment are developed and fabricated to

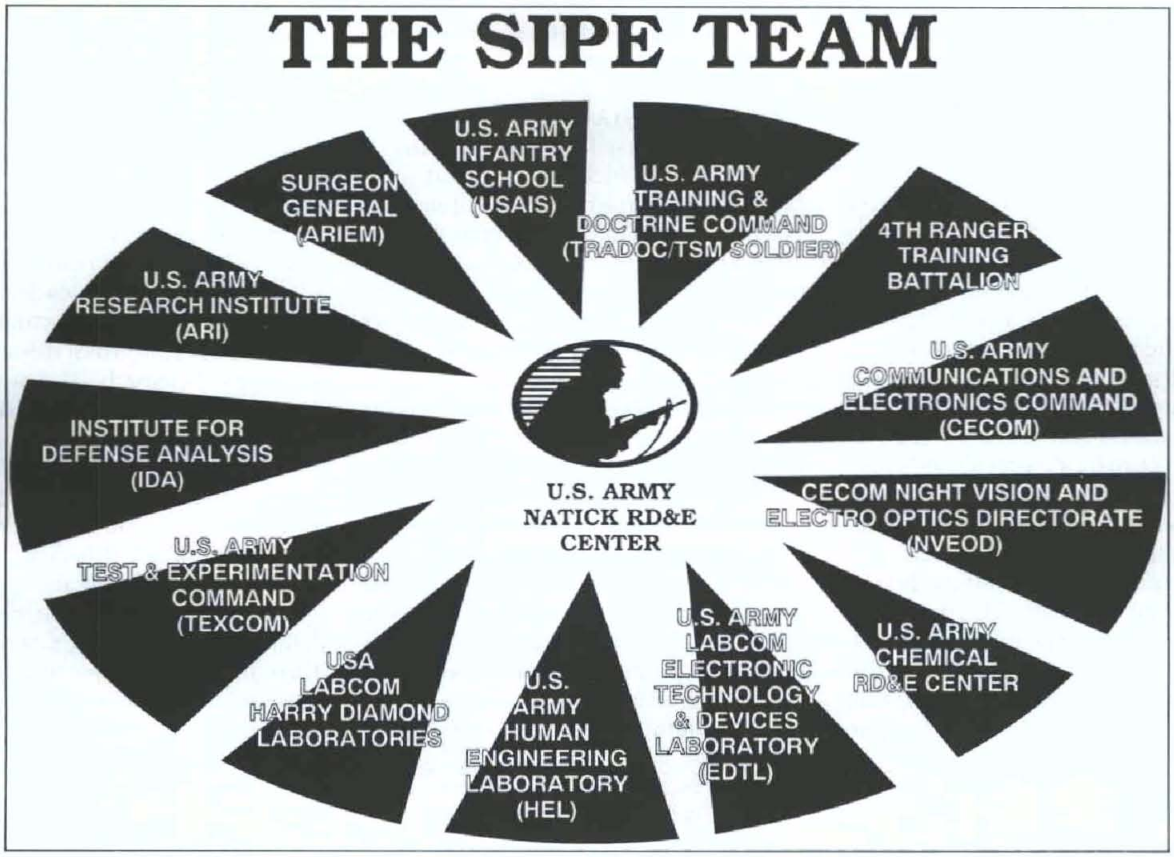


**Figure 1.**

enhance a total capability through the modular and integrated function of each of its components. Most importantly, this approach focuses on balancing offensive capability (lethality) and protection (survivability).

The SIPE ATD program is led by the U.S. Army Natick RD&E Center. To effectively support the SIPE ATD and the systems approach, an unprecedented team from government and industry was formed. This extensive government team is highlighted in Figure 1. The SIPE ATD would not have been possible without this successful teaming effort.

## Operational Payoffs

Some of the operational payoffs that SIPE and the Soldier System approach afford are: improved survivability, improved engagement performance, faster reporting of battlefield information, faster response to changes in mission/situation, improved mission duration or effective mission truncation, improved METT-T (Mission, Enemy, Troops, Terrain-Time) flexibility, interoperability of system components, and potential reduction in weight and bulk.

## What is SIPE?

SIPE is a modular, integrated, head-to-toe individual fighting system designed to enhance combat effectiveness while providing balanced protection against multiple battlefield hazards. SIPE is comprised of five compatible subsystems developed for the dismounted infantry soldier in a temperate environment. The five subsystems' modularity and interoperability function synergistically on an individual and unit level. The subsystems afford protection against ballistic (fragmentation, flechette), flame/thermal, chemical/biological (liquid, vapor, aerosol), surveillance (visual, near infra-red), environmental (rain, wind), and directed energy threats. In addition, aural protection is provided along with measures to reduce heat stress.

The five subsystems are the Integrated Headgear Subsystem (IHS), the Weapon Subsystem, the Individual Soldier's Computer (ISC), the Advanced Clothing Subsystem (ACS) and the Microclimate Conditioning/Power Subsystem (MCC/PS). The five subsystems are shown in Figure 2.

## Field Demonstration

The SIPE three-year research and development effort culminated in a two-month field demonstration at Fort Benning, GA, involving test subjects from the 4th Ranger Training Battalion, Fort Benning, GA. The independently evaluated demo events, which are discussed below, were comprised of a Target Detection Phase, a Target Engagement Phase, Land Navigation, Situational Training Exercises (STX), and a Portability/Mobility Study.

*Target Detection*. The target detection phase was intended to measure a soldier's ability to detect various targets, both visual and auditory, while outfitted in both SIPE and standard configurations in day, night, non-NBC (nuclear/biological/chemical), NBC and smoke conditions at various ranges (600–2000m).

*Target Engagement*. The target engagement phase was designed to measure a soldier's ability to engage thermal targets while wearing both SIPE and standard configurations in day, night, non-NBC, NBC and smoke conditions. Standard record fire (50–300m) and long range firing (400–600m) were evaluated.

*Land Navigation*. Land navigation exercises were designed to measure the soldier's ability to negotiate a land navigation course while wearing both SIPE and standard configurations in day, night, non-NBC and NBC conditions. The standard land navigation course at Fort Benning (Yankee Road) was utilized.

*Situational Training*. The Situational Training Exercise (STX) assessed the ability of the SIPE squad in performing standard dismounted infantry missions utilizing capabilities never before available to the individual soldier. The STXs included recon/hasty attack, raid (support by fire), ambush and NBC recon. STXs were typically planned and rehearsed in the morning and afternoon with the squad moving out at dusk.

*Portability/Mobility*. The portability/mobility study was intended to assess the soldier's mobility in three SIPE and three standard configurations (one non-NBC and two NBC each). The Sand Hill Obstacle Course was utilized for this evaluation.

## Tactical Enhancements

The STX phase highlighted many of the tactical enhancements SIPE affords. Figure 3 diagrams the actual squad level ambush executed. A discussion of the tactical enhancements demonstrated during this mission follows. The mission may be divided into three distinct phases: mission planning; movement; and mission execution.

*Mission Planning*. Digital message management allowed the SIPE soldier to receive mission orders in a remote location, thus freeing him from having to move to his higher commander's location. Receiving a detailed intelligence photo of the objective area allowed the soldier to be better acquainted with the area's terrain and surroundings. This helped in planning approaches using cover and concealment. Before departing the planning area, mission rehearsal was executed more effectively utilizing soldier-to-soldier communications (comms). Individual communications also allowed for planning on the move for quick reaction to mission changes.

*Movement*. Command and control were significantly enhanced through soldier-to-soldier communications by allowing the squad leader to quickly adjust the movement formation, rate of movement and disseminate mission changes. Normally, the squad would communicate via hand-and-arm signals. However, depending on the terrain, cover, and concealment, each soldier may not always see the signal given by the leader; soldier-to-soldier comms reduced this risk.

The SIPE comms also reduced the risk of becoming compromised in friendly and hostile-held terrain. Additionally, soldier-to-soldier comms increased the individual's situational awareness, especially at night, during

## SIPE SUBSYSTEMS

| SUBSYSTEM | COMPONENTS | CAPABILITIES |
|---|---|---|
| Integrated Headgear Subsystem (IHS) | · Helmet Shell/Suspension System<br>· Ambient Hearing Device<br>· Soldier's Radio<br>· Video Enhanced Image Intensifier ($I^2$) and Helmet Mounted Display<br>· Helmet Control Unit<br>· Protective Mask<br>· Power Supply | · Soldier-To-Soldier Communications<br>· Hearing Augmentation<br>· Weapon Interface<br>· Integrated Video Enhanced $I^2$ (night vision)<br>· Video Output for $I^2$, Computer and Thermal Imager<br>· Ballistic, Laser Eye, Respiratory and Aural Protection |
| Weapon Subsystem | · M16A2 (Standard Infantryman's Rifle)<br>· Low Cost Uncooled Sensor Prototype (LOCUSP) Thermal Sight<br>· AIM-1D Laser Aiming Light<br>· Long Range Hearing Device | · Unexposed, Indirect Viewing (thermal sight)<br>· Enhanced Target Detection and Engagement (laser aim light thermal sight)<br>· Hearing Augmentation |
| Individual Soldier's Computer (ISC) | · 386SX/80MB Processor<br>· Integrated Global Positioning System (GPS), Digital Maps/Overlays<br>· Camera/Compass Module<br>· Data Radio<br>· Custom Software | · Real Time POS/NAV<br>· Message Management/Reporting<br>· Video Capture<br>· Digital Compass |
| Advanced Clothing Subsystem (ACS) | · Passive Cooling T-Shirt<br>· Uniform Components (Chemical Vapor Undergarment, Advanced Combat Uniform, Advanced Shell Garment)<br>· Integrated Body Armor<br>· Load Bearing Component<br>· Handwear (Combat and Chemical)<br>· Footwear (Integrated Combat Boot and Chemical Protective Gaiter) | · Flexibility to Tailor to Mission Requirements<br>· Modular Chemical/Biological Protection<br>· Integrated Body Armor and Ammunition Carriage<br>· Enhanced Protection (ballistic, flame, chemical)<br>· Load Transfer to Shoulders or Hips<br>· Houses IHS, ISC and MCC/PS Components |
| Microclimate Conditioning/Power Subsystem (MCC/PS) | · Active Cooling Vest<br>· Filter<br>· Blower<br>· Advanced Batteries | · Positive Pressure Breathing<br>· Heat Stress Reduction |

**Figure 2.**

limited visibility and during the heat of the mission. The SIPE soldier received continuous updates on the status of his fellow squad members, enemy location and mission status. This information alone greatly reduces the possibility of fratricide. Real time Global Positioning System and digital mapping coupled with use of a digital compass kept the squad pointed toward the objective and verified their exact position upon arrival.

*Mission Execution*. Flank security personnel located approximately 400 meters away maintained communications with the assault line and constantly updated the leaders as to the situation at their location. When combined with the capability of long range hearing, this early warning notice alerted the assault line as to the arrival time of the enemy, number of enemy personnel, their direction of travel and the rate of movement.

Soldier-to-soldier comms allowed the squad to communicate effectively in the prone position and maintain stealth. Sectors of fire were divided by the team leaders utilizing the laser aiming light. Viewing the laser through $I^2$ (night vision), the team members identified the sectors and received mission information (via comms) while in the prone position on the ambush line. The ability of each soldier to utilize an integrated night vision and thermal sighting capability significantly enhanced all aspects of lethality, survivability, command and control and mobility. The SIPE equipped soldier truly "owns the night."

If presented, SIPE would allow the squad to maintain fire superiority on obscured (environmental, smoke, etc) targets. Utilizing the thermal sight, the team leaders could view through the obscured objective. The team leaders would then identify and designate targets for the team utilizing the laser aiming light. The team, viewing the laser aiming light through $I^2$, could then bring effective fire onto the laser designation point, thus engaging the target without actually seeing it.

## Potential Mission Outcome

Upon receiving information that the enemy was approaching, the squad leader alerted the team to prepare to initiate the ambush (all via soldier-to-soldier comms). When the enemy (4-man patrol) was in the center of the kill zone, the squad leader initiated fire with the M18A1 claymore. Utilizing the SIPE components synergistically, the squad then delivered a high volume of accurate and well placed fire into the kill zone. The command to cease fire and withdraw was given. The squad was out of the area reorganizing and consolidating before the enemy could respond.

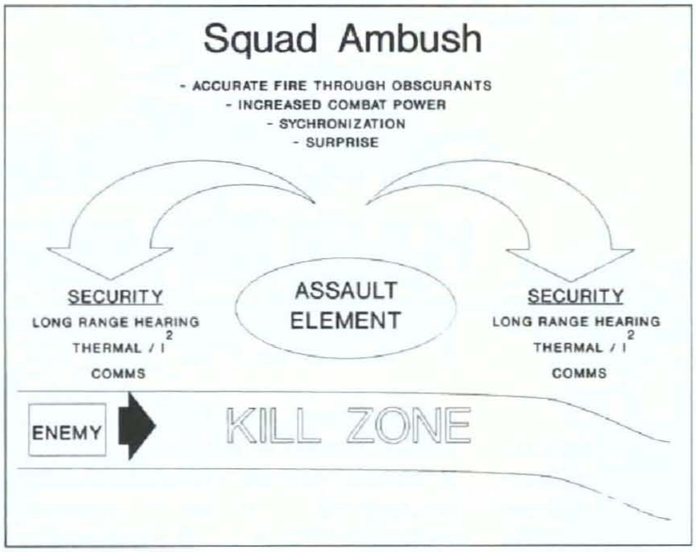


**Figure 3.**

## Summary

The SIPE ATD has successfully demonstrated the tactical enhancements and balanced protection that the Soldier System approach affords. SIPE enhances the squad's ability to react to contact and adapt to changing mission requirements. It also enhances target detection and engagement in day, night and under limited visibility, and provides enhanced protective capability at greater ranges and reduces the chance of fratricide. These capabilities synergistically increase the soldier's confidence in himself and the unit. SSG Paul Mewborn, SIPE squad leader, 4th Ranger Training Battalion, states it best, "The Army's quest for an integrated and modular combat uniform and enhanced components, represented by the Soldier Integrated Protective Ensemble (SIPE), is an outstanding idea. The SIPE Advanced Technology Demonstration displayed the potential to enhance the combat soldier's capabilities. These enhanced capabilities will provide the soldier better command and control, maneuverability, with improved acquisition and target engagement through limited visibility, better intelligence gathering capabilities and greater survivability on the battlefield. SIPE will 'lead the way' for the individual soldier into the 21st century."

Current plans call for SIPE to transition to The Enhanced Integrated Soldier System (TEISS), a full scale development (6.3B–6.4) program slated to begin in FY94, which will concentrate on fielding the most mature and viable SIPE technologies. The 21st Century Land Warrior is the follow-on 6.3A Top Level Demo (TLD, FY94-98) which will focus on miniaturization of the electronics, weight and bulk reduction and small arms protection for the dismounted infantry soldier. SIPE... Paving the Way to the Future.

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# STRUCTURAL HARDENING RESEARCH

## Introduction

The U.S. Army Engineer Waterways Experiment Station (WES) in Vicksburg, MS, has always been known as an international leader in research hydraulics. WES has been testing flood control plans for the Corps of Engineers since 1929.

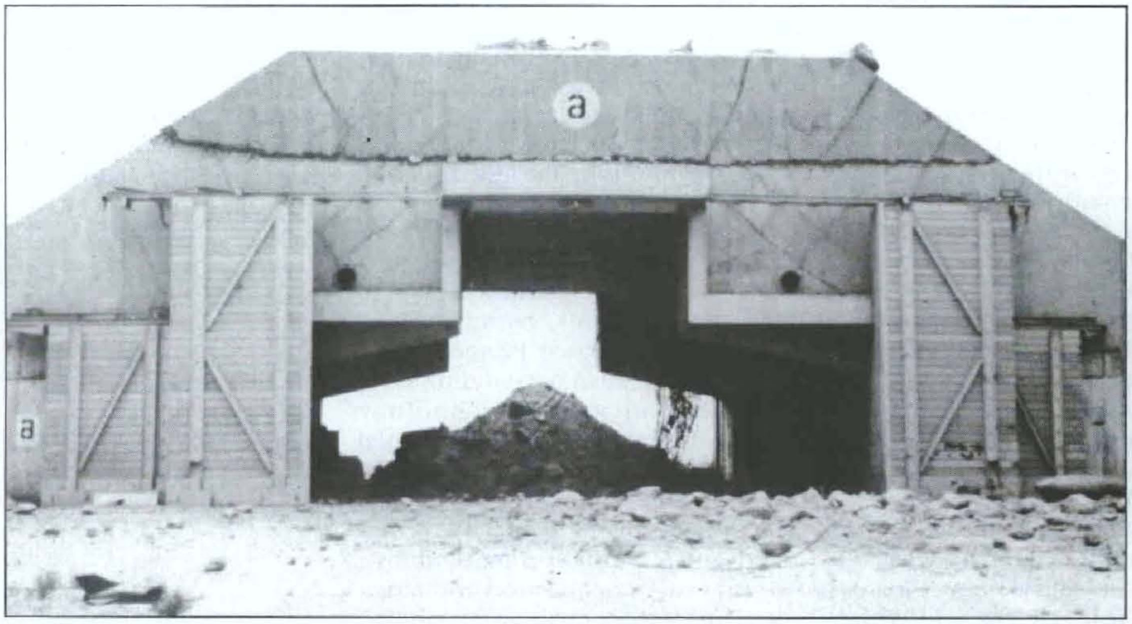
But the WES Structures Laboratory is also a world leader in explosive effects and structural behavior. WES has been working with structural response to weapons effects since the 1940s. Over the years, WES has conducted hundreds of large-scale explosive tests at remote field sites to test full-size and scale-model bunkers, shelters, and field fortifications.

In the last few years WES has relied more and more on computer generated models to simulate blast effects on various structures. While some of these computer models require the massive computing power of the CRAY supercomputer located at WES, many of the new blast effects computer codes are purposely developed for personal computers (PC) so the designer in the field can easily access and use them.

Under Project Reliance, WES was designated the tri-Service lead laboratory for structural hardening, a broad research area that consolidates technologies for design and construction of permanent and temporary hardened structures. This research includes anti-penetration and shock-mitigation systems, explosive storage safety, terrorist threat protection, field fortifications, and obstacle creation and reduction. These technologies all address the same basic problem—survivability of a structure from blast and shock.

WES structural hardening research efforts are basically providing two different types of products. One thrust is developing, updating and refining "user friendly" PC codes and manuals. These design tools are used by engineers at the Corps' Protective Design Center at the Omaha District, by other Army and Air Force structural designers, and by NATO and other allied government agencies to design new structures or upgrade existing facilities. The other thrust is providing newly developed equipment and construction techniques for use by troops in the field.

WES research efforts in the hardened structures area recently produced several very useful PC-based prediction codes for design and analysis of above ground and buried structures subjected to "Desert Storm era" conventional weapons effects. These codes address projectile penetration, ground shock, in-structure shock, and in-structure airblast propagation.



**The PC-based PENCURV computer code accurately predicts the position of a penetrating projectile in a hardened shelter such as this bombed aircraft shelter from Operation Desert Storm.**

**WES research in terrorist threat protection has run the gamut from small arms fire on masonry shown here to large-scale field tests.**

## Projectile Penetration

WES has developed a series of computer programs to predict the trajectory of rigid axisymmetric projectiles impacting geologic/structural targets. Projectiles with various nose shapes as well as targets consisting of complex layers of concrete, soil, and rock can be simulated.

The three-dimensional computer code called PENCO3D provides generalized three-dimensional impact conditions for projectiles into a horizontally layered target. PENCO3D outputs the entire dynamic response of the projectile as it interacts with and penetrates into the target. Plots of displacement, velocity, and acceleration, as well as angular components such as yaw, pitch, and obliguity, can be obtained versus either time or projectile path length. The three-dimensional trajectory can be plotted by showing two planes of motion.

A similar, two-dimensional computer code, PENCURV, can be used to analyze projectile impact into structures with curved or irregular shapes. PENCURV can also provide time and path length history plots for the projectile along with trajectory plots as it penetrates the target.

Both PENCO3D and PENCURV are extremely useful tools for investigating the effectiveness of different types of projectiles against a variety of targets. The user's guide was recently published for PENCO3D; the guide for PENCURV will be published this year.

## Ground Shock

The SABER-PC/CWE software package predicts ground shock environments produced by fully buried conventional weapons. First-principle ground shock calculations are performed by a spherically symmetric finite element code. The complete software package includes explosive and soil material property libraries and user friendly, menu driven, pre- and post-processing software.

The user specifies an explosive weight, selects the explosive and soil type from SABER-PC/CWE's libraries, and specifies output locations. The output quantities can be plotted in various on-screen and hard copy formats, including stress, velocity, and displacement time-histories, peak stress and velocity attenuation curves, and stress and velocity profiles. Output from several different calculations can be compared in similar formats.

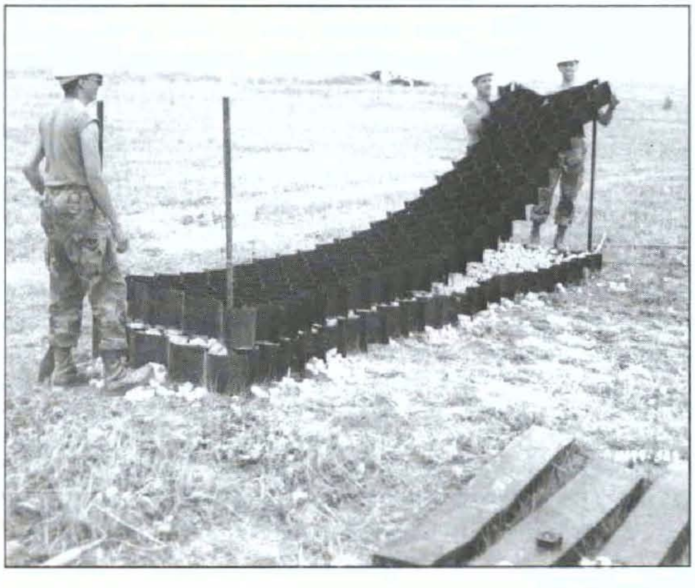
SABER-PC/CWE has been validated against ground shock data obtained from buried bomb tests conducted in the field. The SABER-PC/CWE user's guide was recently published.

## In-Structure Shock

The in-structure shock (ISS) computer code runs on a PC and calculates the structural motions inside of a hardened facility subjected to airblast and ground shock from nearby detonations of conventional air-delivered weapons. The two-dimensional, explicit finite element analysis program can be used for above or below ground structures and includes nonlinear structure behavior and structure media interaction.

The user inputs the position of the weapon (relative to the structure) and the soil properties. The program calculates the ground shock and airblast loads and structural response. Program output includes nodal displacements, velocities, and accelerations and element stresses and strains. The structural motions can be used to generate shock spectra for determining the vulnerability of personnel and equipment.

A user's manual for Version 4 of the



**Soldiers from the 52nd Engineer Battalion at Fort Carson, CO, expand and fill sand-grid sections with gravel for a live-fire test with light anti-tank weapons. Layers of sand-grid are stacked and filled to form a protective revetment. Collapsed sections of sand-grid are shown in the lower right.**

Combat engineers prepare two sizes of explosively formed penetrators for test firing.

ISS program is available. An updated version with improved structural material and ground shock models will be available this year.

## In-Structure Airblast Propagation

A family of PC-based computer codes (BLASTIN, CHAMBER, and BLASTX) are available to calculate the blast environment inside a structure from either an interior or exterior explosion. The codes use a semi-empirical ray tracing technique to compute the shock wave environment and a mass and energy flow model for the internal gas pressures and external fill pressures. The three-dimensional codes can model single and multiple room structures; multiple target locations; and multiple, non-simultaneous blasts.

User's guides are available for all current versions of the codes. A special version of the BLASTX code was written specifically to aid in design of passive blast attenuation devices and will be available early this year.

## Explosive Storage Safety

The principal reference for designing munition storage facilities, the Tri-Service Manual *Structures to Resist the Effects of Accidental Explosions* (DA TM5-1300) was recently revised. WES has adapted the manual for microcomputer use as a computer program technical manual (TM).

With a TM, a user can display the manual's text on the PC monitor and search for key words or phrases. The TM user can also display figures from the manual on the monitor, produce hard copies, and retrieve data points from curves.

## Terrorist Threat Protection

WES is providing input from recent research on protecting military facilities from terrorist weapons effects to Army TM 5-853, *Security Engineering*. The draft of the new manual is scheduled for 1993.

Design information based on WES research will include protection of masonry structures from small arms and assault weapons, reduction of blast loads on buildings by using perimeter walls, and blast resistance of windows and doors. Continuing research results, such as retrofitting windows to reduce blast loads, will be incorporated in updates of the manual and through engineering technical letters and guide specifications.

## Field Fortifications

Lightweight, expandable, plastic sand-grids, developed by the WES Geotechnical Laboratory as a pavement system, have been tested as an expedient field fortification. Sand-grid revetments filled with soil or gravel provide very effective protection for personnel and equipment.

The pavement version of sand-grid expands from 8 inches by 4 inches by 11 feet to 8 inches by 20 feet by 8 feet. It is a Class IV (construction material) item of supply in the Army Facilities Component System (NSN 5680-01-198-7955). This version can be easily cut in the field to a width of 55 inches for use in revetment applications.

A smaller notched version of sand grid was more stackable during testing for revetment applications. This version expands from 8 inches by 4 inches by 55 inches to 8 inches by 20 feet by 3 feet. It currently must be ordered through the General Services Administration. Requests should specify that the material is a 5680 class item similar to Presto Products Number NGW 3280. It is available in black, green and tan.

## Obstacle Creation and Reduction

Research in this category is in its early stages. However, one item that may be fielded in one form or another in the near future is the Navy-developed Explosively Formed Penetrator (EFP).

WES is refining the design of the EFP in an attempt to maximize its capabilities for standoff attack of bridges, walls and bunkers. It is being tested with regular Army and National Guard combat engineer units.

## Summary

The research discussed in this article is only a snapshot of the total WES structural hardening program. The WES program emphasizes vigorous technology transfer of test-validated, PC-based analysis tools and state-of-the-art manuals to hardened facility designers and improved equipment and construction techniques to troops in the field.

*Contributing authors of this article from the U.S. Army Engineer Waterways Experiment Station's Structures Laboratory are: Dr. Guy Jackson, Don Cargile, Steve Akers, Dr. Jon Windham, Richard Dove, Will McMahon, David Hyde, Dave Coltharp, Bill Huff, and Hank McDevitt Jr. Wayne Stroupe from the WES Public Affairs Office is also a contributing author.*

# ENGINEERS AND SCIENTISTS GET 'GREEN' AT FORT KNOX

By Rae A. Higgins

Associates at the Tank-Automotive Research, Development and Engineering Center (TARDEC) seldom get a chance to see or hear from our ultimate customers—the soldiers in the field—although they are the reason why we come to work every day. TARDEC officials are out to change that through the new Military Orientation (or "greening") Program.

Offered through TARDEC University, this forward-thinking, mission-oriented course is for TARDEC engineers and scientists grades GS-5 through GS-12. It is designed to enhance interaction with our customers, who are the users of the vehicles and equipment we produce.

"This is a great opportunity for our engineers and scientists to interface with their customers. By meeting with them, they will learn to appreciate the soldiers' needs. They get to see what it's like to be a soldier in the field. We believe this to be a beneficial program for our engineers and scientists. This is a unique learning experience and it gives our E&S personnel a chance to walk in the soldiers' shoes. Our technical staff will use this feedback to make changes and improvements to the products we provide to the soldiers," said Gail A. Marciniok, TARDEC's Engineer and Scientist Career Program administrator.

The first group of TARDEC engineers and scientists completed their "greening" program earlier this year. The course is divided into two phases: a one-day class orientation and the two-day "greening" trip to Fort Knox, KY, the home of the U.S. Army Armor Center and School.

The entire program is facilitated by retired Army COL Jack Dice and retired Command SGM Joseph Hill. Class orientation is held at TARDEC and includes instruction on the Army's mission and organization, TARDEC's role in the Army, a description of our soldiers and their environment, the history of combined arms warfare and armor's role, a current AirLand Battle operational perspective, and training methods. There was also plenty of time for questions and answers.

Then it was off to Fort Knox in late January where TARDEC engineers and scientists saw first-hand the day in the life of the armor soldier. They attended informational briefings and more importantly, got to talk one on one with soldiers.

Their first full day at Fort Knox

"This is taxpayer's money well spent. This is the best training we can give them before they go out to the range."

*Hans Sterzenbach, COFT instructor*

featured a tour of the post and tank driver simulator training, where the engineers and scientists were able to "drive" a motion base tank simulator. "I really enjoyed the driver training simulator," said Dan Newport of TARDEC's Concepts Design Branch. "I can appreciate what they do. It was very impressive and realistic. It made you want to stay on the simulated course and not go off-road; otherwise, you'd get your melon knocked around!"

They observed brand-new recruits in basic drill and ceremony training, where Sharon Grinaway of TARDEC's Computer-Aided Engineering Branch, said, "This is great, but I don't think I could handle it!"

Lunch was served at the 2nd Battalion, 13th Armor mess hall, where the "greening" students ate with hundreds of soldiers. The afternoon was spent observing tank and wheeled vehicle maintenance training at the 1/81 Armor, where apprentice mechanics are trained. Next stop was simulation networking (SIMNET) orientation where Armor School students use M1 simulators to increase the opportunity for collective training. PFC Stanley West explained that SIMNET is very realistic and it provides a "reality break" for soldiers who have been out in the field for four or five days. "It provides cross training for those just off basic training," he added.

At weaponeer training, the engineers and scientists fired M16 machine guns in a live-fire simulator. At the end of that very long, yet informative first day, they visited the post's main exchange, where they went shopping.

Day two proved to be just as interesting and hectic as the first. After meeting with their escorts, the group observes master gunner's training. This course is designed to take the best noncommissioned officers from each unit and train them to be the principal advisers to tank commanders. Next was a visit to the Patton Museum, where the pupils got to see many of GEN George S. Patton Jr.'s personal effects, historic military vehicles, and even a section of the Berlin Wall.

The trip's highlight was observing the Army Officer Basic Course (AOBC) class number 2 in gunnery training at the Baum Firing Range. They observed tank crews comprised of second lieutenants actually drive, engage and fire tanks. These officers-in-training will soon assume command of a tank platoon at their first duty station.

When asked how he would compare the simulation phase of training to being on the live-fire range, LT William Benson from the February 1993 session of the Officer Basic Course said, "SIMNET is very good, and if we could do even more with that, it would be great. We did 16 hours in the Conduct of Fire Training (COFT) and it was very beneficial. SIMNET and COFT are the best training tools we have. They are as realistic as they can be."

Although they enjoyed the visit to the range, many in the group were disappointed that they were not able to ride in the tanks with the AOBC students. "I would have really liked to ride in one of the tanks, expecially when it fired," commented Patrick Mulcahy of TARDEC's Bradley Engineering Support Office.

The engineers and scientists got a special treat for lunch that day when they ate Meals Ready-to-Eat (MREs) on the range. Meals ranged from chicken stew to escalloped potatoes and ham, to omelets. The group's general consensus was that the MREs were not as bad as many of the engineers and scientists judged they would be. AOBC student LT Christopher Lovato said that the most difficult thing to get used to is that MREs are served cold. "It really wasn't that bad," said Kathy Tidwell, who is currently assigned to the TARDEC Robotics Office. "But it would have been much better heated," she conceded.

The last stop on day two was to the Unit Conduct of Fire Training facility where officials train nearly 100,000 students per year in tank gunnery. This is where future tank commanders and gunners train first on simulators before they conduct exercises on the firing range. Hans Sterzenbach, one of the COFT instructors, explained that COFT is a very cost effective way of training. "This is taxpayer's money well spent. This is the best training we can give them before they go out to the range," Sterzenbach said.

Marty Laurain, a TARDEC engineer from the Advanced Systems, Concepts and Planning Directorate, said he enjoyed the trip and was glad to have had the opportunity to make the "greening" trip to Fort Knox. "Overall, I'd have to say that I was very impressed," he commented.

With this new program, TARDEC officials hope to increase customer awareness and satisfaction through interaction and communication. Additional "greening" classes are being held this year.

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# FLUIDIZED BED IMPROVES RUBBER REMOVAL OPERATIONS

By Cecil Green

Removing old rubber from Army tracked vehicles has never been easy, but a $3.3 million addition at Red River Army Depot in Texarkana, TX, is revolutionizing the way the job is done, while also making it more environmentally sound.

Officially labled as a "Fluidized Bed Rubber Denuding System," two side-by-side vats mix natural gas, sand, high temperatures and a refined filtering system to decompose rubber items bonded to metal and burn off the resulting gases.

Each vat, or bed, is about 16 feet long, more than five feet wide, and more than three feet deep. Each bed holds about 280 cubic feet (approximately 15 tons) of sand.

The fluidized bed at Red River is definitely the only one of its size in the Army inventory, and possibly the first of its kind in the United States, making it a unique process with a specialized mission.

The removal of old rubber is part of a Red River mission that began in the 1950s, involving the rebuilding of road wheels and track shoes on Army tracked vehicles. The addition of the fluidized bed is now the latest answer to make a difficult job easier and cause less impact on the environment.

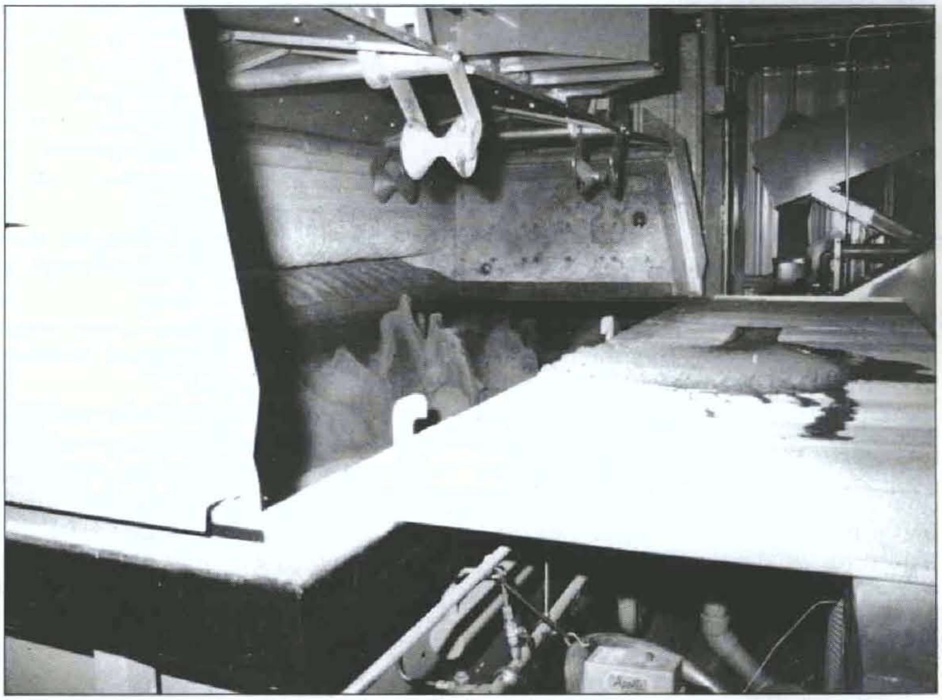
Currently, Red River is the Army's center for depot-level maintenance on medium and light tracked vehicles, such as the Bradley Fighting Vehicles, the M-113 family of armored vehicles, and other weapons systems that use tracks instead of air-filled tires.

Red River is also the only place in the United States where road wheels and track shoes from U.S. Army vehicles are stripped to the bare metal and completely rebuilt on a large scale. Annually, about 60,000 road wheels and 200,000 track shoes are being rebuilt at Red River, all of them meeting or exceeding the specifications for new items.

With the fluidized bed, workers at Red River's Rubber Products Division will be able to remove the old rubber from a track on a Bradley in about 30 minutes, leaving the metal parts much cleaner than earlier rubber removal processes.

The fluidized bed gets its name because the bed of fine-grain sand in each vat is heated to intense temperatures, about 925 degrees Fahrenheit, by natural gas burners. Then, the high temperatures, coupled with forced air that is fed into the bottom of the bed, actually give the sand the same qualities as a liquid, explained Keith Nichols, the chief of the Special Projects Section within Red River's Production Engineering Division.

The sand is actually used as a heat transfer medium, because liquids would evaporate at the high temperatures



**Super-heated sand boils and churns as it completes a cleaning cycle in one of the fluidized beds recently installed at Red River Army Depot, near Texarkana, TX.**

reached in the beds. "The heated sand also has the same movements as a pot of boiling water," Nichols said, "and heavy objects will sink to the bottom and light objects will float on top, just as they would in water." However, unlike a pot of water, the boiling sand in the fluidized bed has a light blue flame hovering on the surface, indicating the high temperatures being generated by the burning gas.

While submerged in the boiling sand, rubber products begin to decompose into other organic gases. "The rubber doesn't melt, and it really doesn't burn while submerged in the sand," Nichols explained, "but it does give off volatile gases through a process called pyrolysis as it decomposes. These gases are then burned along with the natural gas at the top of the bed."

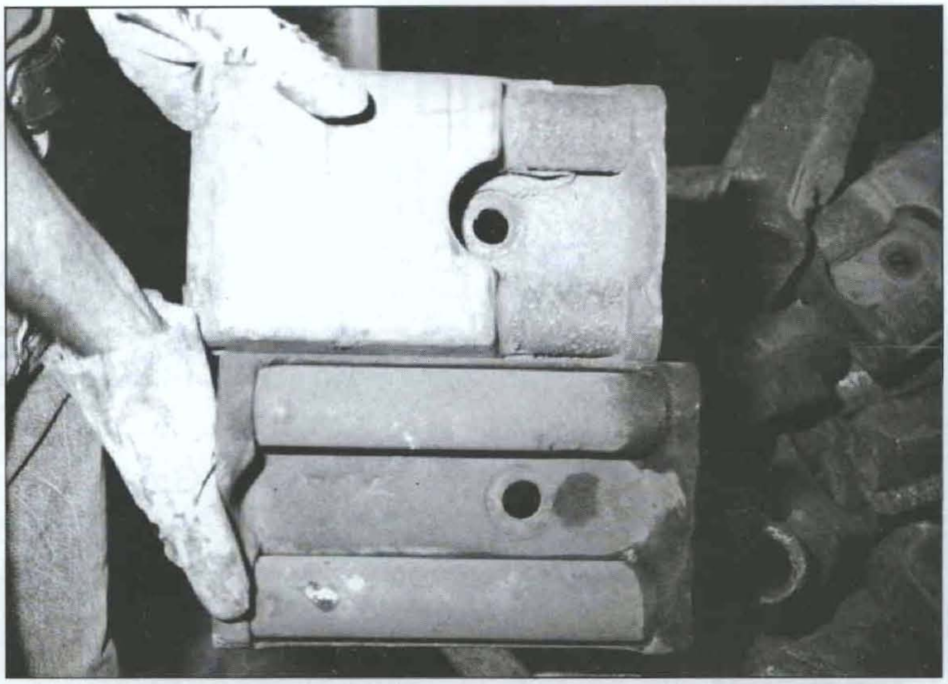
As the heat increases from the pyrolysis effect, the flow of natural gas is closely monitored and reduced proportionally, maintaining the temperature at 925 degrees and saving natural gas.

Also, while submerged in the boiling mixtures, objects are subjected to the mild abrasive effect of the moving sand. "It's not as much force as a sand blaster," Nichols said, "but the process cleans off organic matter and makes other cleaning steps easier."

Gases released by the decomposing rubber are also eliminated in the fluidized bed process. What isn't burned off by the blue flame above the boiling sand is routed into a post-combustion unit where gases are then heated to more than 1500 degrees Fahrenheit.

"Also, to reduce the sulphur content in the gases from the rubber, a mixture of very fine, dry lime is injected into the gas stream above the fluid bed. This action causes the lime to combine with the emission gases and allows them to be trapped later in the filtering process," Nichols explained. Any dust particles or other minute solids generated during the process are also removed by a fabric filter assembly as the gases are prepared for final emission.

"We constantly monitor emissions going out the stack to make sure we meet environmental standards," Nichols emphasized. "Because the fluidized bed is so unique and this machine is so large, the Texas Air Control Board requires the constant monitoring, not just periodic samples. We expect the environmental agencies to keep a very close watch on this system, but we already know that we're reducing our amounts of hazardous waste and releasing cleaner air than we were with our previous rubber removal systems."



A recently-cleaned track shoe (bottom) stands in stark contrast to its uncleaned counterpart that still has blocks of worn rubber bonded to the metal.

The fluidized bed is also efficient in the amount of work it can handle. With both vats operating at the same time, a total of 4,200 pounds of material can be processed at once, although the load cannot contain more than 400 pounds of rubber in an hour. It takes about 30 minutes for each vat of boiling sand to complete a cleaning cycle.

"What that equates to — weight-wise — is about one complete Bradley track at a time in each vat," Nichols said. "And that's quite a savings in manpower compared to existing methods to remove rubber."

Local experiments are still underway to determine the configuration of each load that goes into the fluidized bed. For example, sections of track were initially broken down into individual track shoes, requiring a lot of manual labor to hammer out linking pins and load each basket.

Then, workers at the Rubber Products Division found they could put larger sections of track—with six or more track shoes linked together—into a basket-load at one time with no reduction in quality. After the cleaning process, the linking pins then came out easily, saving a lot of physical effort.

As the metal items are brought out of the boiling sand at the end of a cycle, they are quickly immersed in a quenching tank where water is maintained at a relatively cool 140 degrees Fahrenheit.

The quick dunk in the water serves like a heat-treatment process for aluminum products, and actually strengthens the properties of the metal, according to Nichols.

At the same time as the cool bath, any particles are washed off and recycled back into the fluidized bed where it can be used again to remove the next batch of rubber.

"Most people wouldn't realize it, but a tracked vehicle uses a lot of rubber to make it go, especially on the road wheels and track shoes," said Tommy Patterson, chief of Red River's Rubber Products Division.

The road wheels are large metal hubs that are ringed with about two inches of thick rubber. The road wheels roll inside the treads, and eventually wear down, just like the rubber on an automobile tire.

The track shoes are the individual segments that are linked together to form the continuous tread on a tracked vehicle. On a Bradley, more than 80 track shoes are required to form a single track. The rubber pads on the track shoes are in constant contact with the ground and eventually wear down to the metal.

When the rubber becomes worn, the old road wheel or track shoe has to be replaced, as the rubber is bonded to the metal and there is no way to replace just the rubber part.

"At that point, you can either buy a new road wheel or track shoes," Patterson explained, "or we can rebuild one for a third less than the cost of a new one." A new road wheel costs about $275.00, and a track shoe runs about $125.00. "That difference means we can save the taxpayer a lot of money with our rebuilt products," Patterson said. However, the problem has always been how to get rid of the remaining bits of old rubber so the rebuild process could be done.

About 40 years ago, the removal process was simple and direct, but environmentally unsound by today's standards.

The early technique did have its drawbacks. Besides creating clouds of smelly, black smoke, the burning rubber often created enough heat to destroy the properties of the metal, making the track shoes unusable.

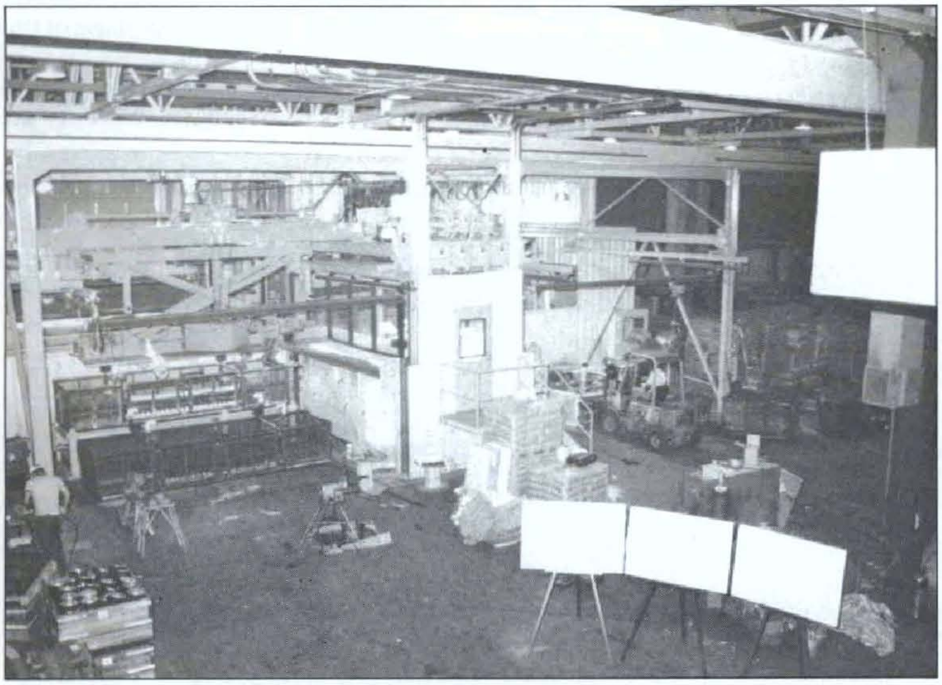
The next evolution in the rubber removal process was the application of an induction heating system that used electrical power to heat tracks to about 800 degrees Fahrenheit. "That temperature was not enough to melt the rubber or cause decomposition," Nichols said, "but it did make it possible for a worker to pry the rubber off the metal and physically break the adhesive bond."

The induction heating system was labor intensive "and very hard work," according to Patterson, requiring about three hours for a team of workers to complete the equivalent of a Bradley track.

The next technological advance—and the one still being used at Red River until the fluidized bed is fully operational—was the salt bath. "In this process, a mixture of sodium nitrate and potassium nitrate are heated to about 600 degrees Fahrenheit and items are soaked in the molten liquid for 15 minutes. However, after the soaking, workers still have to pry off the rubber and break the bond," according to Nichols.

Using the salt bath, a team of four workers takes about an hour to complete a Bradley track.

"The fluidized bed will be much more efficent and effective," Patterson said. When fully operational, the fluidized bed will use a team of 14, including operators, supervisors, mechanics, electricians and electronics technicians, to run 24-hour operations on three shifts.



**The two new side-by-side fluidized beds at Red River Army Depot are preparing loads of road wheels and track shoes for cleaning. The fluidized beds use sands, heated to 925 degrees Fahrenheit, to remove old rubber from the metal parts.**

The arrival of the fluidized bed is closely linked to Red River's on-going program to overhaul and rebuild Bradley vehicles, converting the 1,100-plus older A1 models now in the Army's fleet to improved A2 models. Part of that program includes the rebuilding of the worn road wheels and track shoes in a timely manner. "Over the years, our rebuild program for all types of Army tracked vehicles has generated a lot of scrap rubber," Patterson said, "as much as two million pounds a year."

Most of that rubber has been salvaged for recycling, but the Army has only been able to sell the scrap for minute amounts, sometimes only getting a hundredth of a cent per pound. For example, the two million pounds only netted $200.00. However, the main benefit of the recycling is that the scrap rubber didn't have to be buried in a landfill.

Now, as the fluidized bed is becoming a working reality, new applications for the denuding process are rapidly expanding. One application is to take the old electronic wiring that is removed elsewhere at Red River during the Bradley conversion project and run it through the fluidized bed. What remains is a lot of copper wiring that has a high resale value after all the coating is removed.

"Also, a lot of engine and vehicle parts have rubber bonded to them," Patterson said. "With that rubber still in place, the scrap metal can only be sold for about $9 a ton as an untreated product. However, using the fluidized bed to clean off the old rubber, the scrap metal can be sold as treated for about $90 a ton.

Any organic matter, including not only rubber, but also plastic, oil, paint and other items can be quickly and safely removed by the fluidized bed process. "Overall, we expect impressive reductions in our hazardous waste generation, particulate emmissions, volatile organic compounds, and utilities consumption," Patterson said. The fluidized bed has been in the planning, procurement and installation phase for most of the past two years.

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*CECIL GREEN is the public affairs officer at Red River Army Depot in Texarkana, TX. He holds a bachelor's degree in journalism and a master's degree in mass communications from Texas Tech in Lubbock, TX.*

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# ETC POWER DEVELOPMENT EFFORT AT ARDEC

By A.J. Graf

## Introduction

Electrothermal-chemical (ETC) propulsion is capable of providing both direct and indirect fire armament systems with increased muzzle energy and launch speed, useful in the anti-armor, fire support and terminal missile defense roles. This is accomplished through a judicious selection of the propellant to be used and timely control of the electrical energy input to optimize the combustion efficiency.

Subcaliber (30/60mm) ETC gun firings to date have demonstrated the ability to control the propellant burning rate electrically and achieve higher launch performance from the resulting sustained pressure (Figure 1). A 15 percent improvement over conventional gun performance of similar caliber has been achieved. Another improvement (30 percent) is judged feasible in the near future.

As a part of the overall Army/Balanced Technology Initiatives (BTI) electric armament program, the U.S. Army Armament Research, Development and Engineering Center (ARDEC) has taken the lead in providing the ETC propulsion community with the electrical power sources and technologies required to support ETC cartridge development tests since 1987.

A critical technology of ETC propulsion is the required electrical power supply system. ETC guns require a pulse power supply system capable of delivering gigawatts of electrical power for periods up to 10 milliseconds. The ability to downsize the power supply to a fieldable level is essential to the success of ETC gun weaponization.

## Modules Development

In an effort to carry out the power technology transition from the laboratory stage to field operations, a transportable ETC power supply system has been built under a pulse power modules (PPM) development and integration contract. FMC Naval Systems Division is the prime contractor. This is a battery/pulse-forming-network (PFN) based power supply system (Figure 2), well suited for experimental baseline work due to its modular arrangement. Each of the modules can be quickly replaced to permit new component technology insertion during the test and evaluation phase of this R&D program.

For tactical applications and under a "silent watch" scenario, batteries are

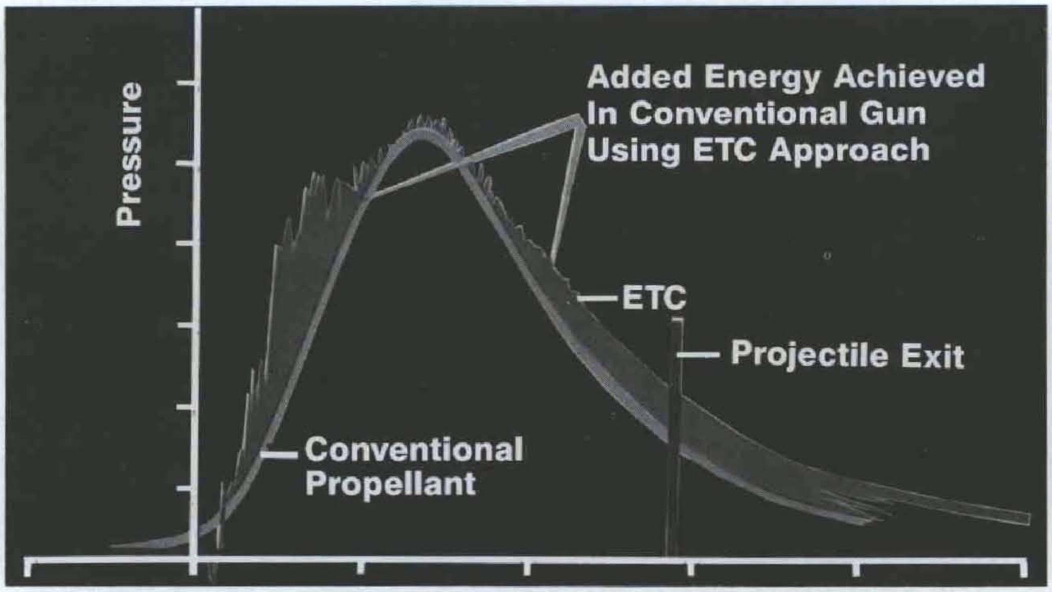


**Figure 1.**
A comparison of ETC vs. conventional gun performance.

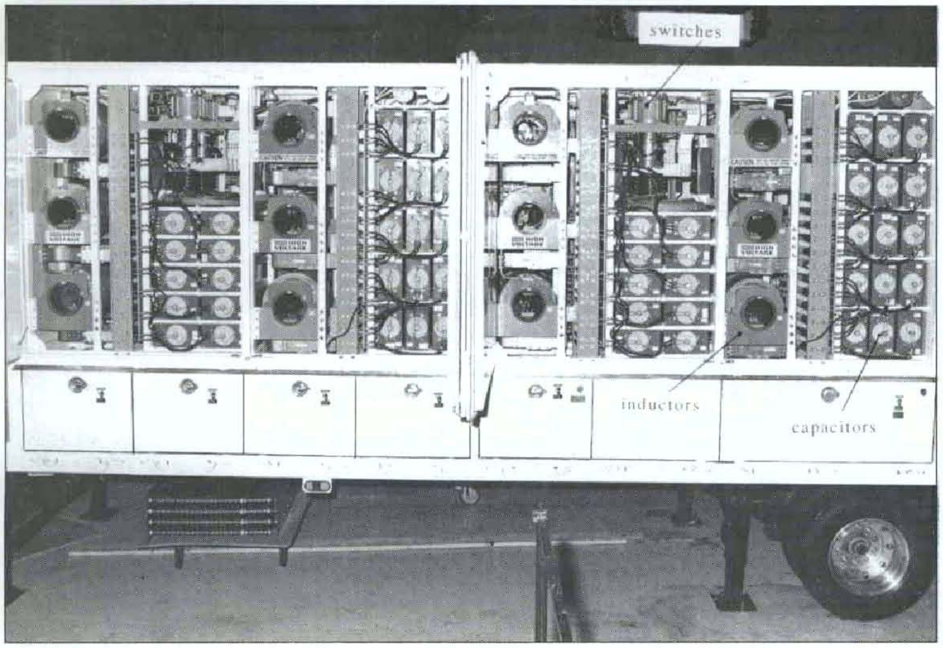


**Figure 2.**
The Army/BTI 8.5-MJ Pulse Power Supply System.

an attractive energy source. The functional block diagram of the PPM operation is shown in Figure 3. The function of the PFN module(s) is to provide the electrical energy input to the ETC gun in a prescribed fashion in terms of current vs. time trace.

The PPM is capable of delivering up to 8.5 megajoules of electrical energy (equivalent to the chemical energy contained in two kilograms of TNT) to the ETC gun from its four identical PFN modules (two modules are shown in Figure 2). Each of the PFN modules consists of two banks of capacitors for temporary energy storage (for a total of 2.125 megajoules), gun firing switches, current pulse shaping inductors, and other fault protection components, such as diodes and fuses.

The DC to DC converter is a voltage step-up device. It is used to charge the PFN capacitors up to 16 kilovolts from a 400-volt battery bank. The PFN and DC to DC converter were designed to be combined with developmental high energy capacitors, "state-of-the-art" high power semiconductor devices and magnetic materials. Hierarchic control strategy and fiber optics technology were also deployed in the controller design to facilitate PPM operations.

Through operator interface and command input, the controller automatically sequences a fire mission. The system controller also permits individual modules or subsystems to be tested during a maintenance mode.

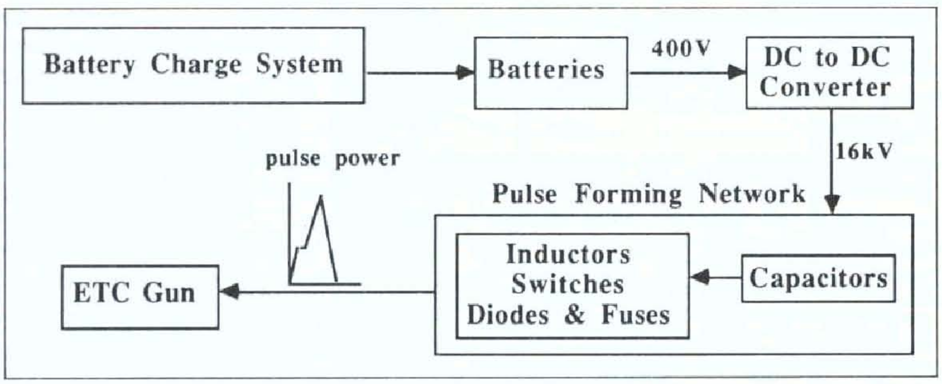


**Figure 3.**
Functional block diagram of PPM operation.

## Testing

Government acceptance tests of the PPM have been completed. Testing included the use of dummy loads and firing live ETC rounds provided by the Navy. Live round testing consisted of five ETC firings from a 60mm gun system. The ETC cartridges tested were designed and developed by FMC Corporation under a Navy contract. Proper cartridge design and precise electrical pulse shape delivery from the PPM demonstrated the ability to achieve the desired breech pressure trace required for "soft launch."

A 60mm projectile which is ballistically similar to a small caliber smart munition (SCSM) has also been successfully launched from the ETC cartridge as a part of the PPM test series. The results of the test have shown stable operation with excellent pulse fidelity and the level of flexibility that is required to support advanced ETC cartridge development tests in the near future.

## Conclusion

This PPM development effort is the first step toward satisfying Army requirements for tactical power supply compactness. Technological issues that are critical to significant size reduction have been identified. Component technologies that improve reliability while reducing weight and volume must be developed.

Although this Army/BTI power supply system will be utilized for ETC gun development testing, it has served an important role in establishing the technological basis required for tactical power supply developments. It will serve as a technology testbed. The Army has a "Focused Technology Program" directed to develop and "feed" the pertinent component technologies into the integration efforts leading to electric gun weaponization.

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*A.J. GRAF is chief, Electric Armaments Division, U.S. Army Armament Research, Development and Engineering Center.*

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# TACOM CREATES THE NATIONAL AUTOMOTIVE CENTER

## By CPT Matthew J. Barr

As legislative barriers disappear, the potential for collaborative research, development, and engineering (RDE) has grown immensely. Both the automotive industry and the government have the opportunity to share the large automotive technology base. A strong need exists for a directed effort toward dual-use RDE and two-way technology transfer. Within the government there is no single agency acting as a conduit or gateway to facilitate the exchange of automotive technologies.

The U.S. Army Tank-Automotive Command Research Development and Engineering Center (TARDEC) has established the National Automotive Center (NAC) which fills this void. TARDEC's unique technical capabilities and location within the automotive capital of the world enables the NAC to leverage governmental and commercial automotive RDE efforts. The mission of the NAC is to serve as a facilitator that links government agencies and industry in all aspects of automotive technology. This dedicated initiative has as its focus research, development, manufacturing, and education. The four main functions are to: foster basic research, facilitate technology development, facilitate manufacturing development, and foster professional development.

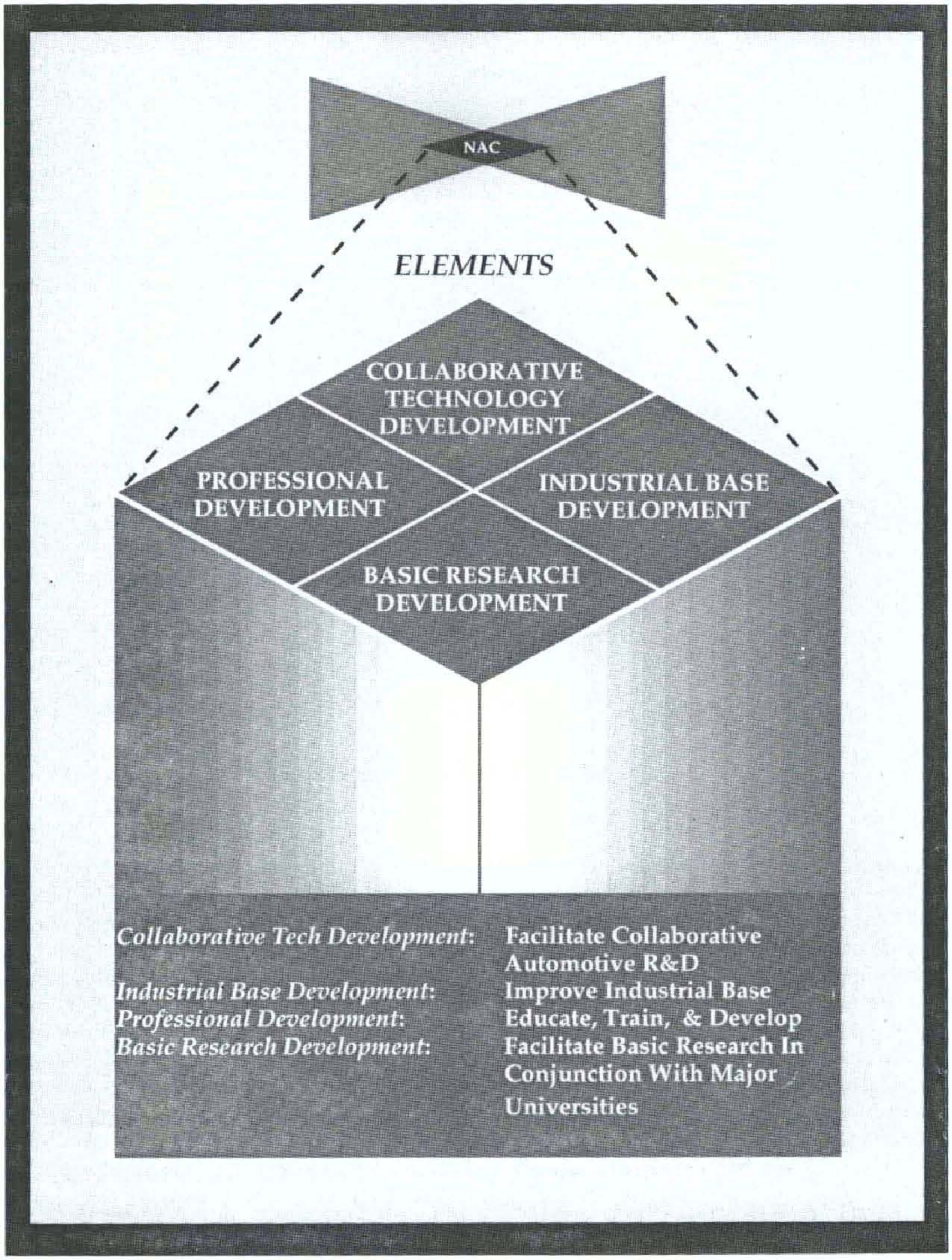
Fostering of basic automotive research entails the NAC providing the critical mechanism to identify current and future basic automotive research from within academia and government. Working closely with leading academic institutions, the NAC will deal itself with such issues as sensors, electronics, and improved mobility and propulsion performance. This basic research will provide key building blocks for future dual-use commercial and defense applications.

In facilitating technology development, the NAC is initiating collaborative RDE with the automotive industry. To be knowledgeable on the current needs and capabilities of the government and automotive industry, an Information Analysis Center (IAC) is being established. The IAC will facilitate the intelligence gathering in which technical information will be consolidated and furnished to government and industry users. With this worldwide information network, the NAC can offer technical and business analyses to find the most viable collaborative opportunities.

The facilitating of manufacturing development includes the development of agile manufacturing capabilities that integrate future manufacturing methods. These new methods will ensure a viable defense industrial base. This advancement will also support the development of a defense conversion plan which uses these manufacturing technologies upon reconstitution during war. Through these efforts, agile manufacturing capabilities will be established through industry, which will enable companies to more efficiently use their resources.

In fostering professional development, the NAC will provide a means of educating, training, and developing individuals within the military, federal service, and the community. Emphasis will be on state-of-the-art operational and technical approaches in ground mobility RDE and manufacturing. The program will also include the evolutionary process of government and industry in collaborative efforts. The purpose is to provide organized learning experiences that will increase job performance and enhance individual, organizational, and community growth. These learning experiences will prepare a work force ready for the 21st century.

Both government and industry will benefit through the innovative efforts of the NAC. By design, the NAC will strengthen commercial and government research and development initiatives. The government will gain from the application of commercial technology into its military products and by support to its defense conversion plan. The commercial sector will




profit from a strengthened vendor base and the application of federal technology into its products. This cooperation will result in the leveraging of individual capabilities by sharing simulators, test ranges, computer databases, unique equipment, and technical expertise.

The advantages of the NAC are extensive. With network linking, common computer protocols, common specifications and standards, improved procurement processes, and agile manufacturing technology, the entire automotive industry can become more efficient in all technical efforts.

By sharing resources, each organization can save money and focus on new ideas. A spawn of innovative thinking will result in the creation of new products. The result is the increased focus of technology and R&D resources.

Through the nationwide application of this initiative, the NAC will ultimately become the focus for advanced automotive technology and will stimulate efficient use of R&D efforts across the nation. This will ultimately lead to improved commercial and military products which will enhance our nation's defense posture and global competitiveness.

*CPT MATTHEW J. BARR is an NAC project officer at the U.S. Army Tank-Automotive Research, Development and Engineering Center. A member of the Army Acquisition Corps, he holds a B.S. degree in business administration from Florida Institute of Technology and M.S. degrees in systems management, human resources management, and psychology from the University of Central Texas. He is also a doctoral candidate with Nova University.*

# THE BATTLE FOR MONS OLYMPUS, MARS

By MAJ Mark E. Salesky

The rusty colored soil glows crimson as the setting sun slips behind Mons Olympus, Mars highest mountain, towering 12 miles above the volcanic plane. At the mountain's base, the enemy waits in bands of defense. The terrain fronting the 1/666 Combined Arms Army is studded with ultra-hard ceramic bunkers, particle beam anti-tank guns, and countless robotic mines that wander over the broken Marscape like nearsighted scorpions searching for prey.

Red sky fades to twilight as A/323 Armored Regiment moves out of its attack position. A concussion charge shatters the evening calm as it cleaves a one-kilometer wide by five-kilometer deep path through the robotic minefield. Orbiting Surveillance and Target Acquisition Relay (OSTARS) has already downloaded target data to each of the 70 M-3 Main Battle Tanks in assault formation.

The tanks launch forward at 100-plus kilometers an hour, hurtling over 3-meter wide crevices under the lighter martian gravity. Three hundred and sixty degree infrared night sights enable the two-man crews to quickly negotiate around boulders and craters.

Their hypervelocity guns, firing without pause, engage the enemy up to seven kilometers away. As A/323 races up the slope, 1/7 Light Infantry (Air Assault) drops out of their hide position in orbit 500 kilometers above the surface. It takes 14 minutes on a juggernaut ride through the thin Martian atmosphere to bring them into position. The orbit assault craft touch down on the far side of the mountain. With the enemy fully occupied with the armor attack to the front, the infantry mount their light attack vehicles to blast the enemy from above and behind. The battle for Mons Olympus will be over in one hour and 45 minutes after it begins. Then we replay.

**The fidelity of synthetic environments makes it not just a training experience, but perhaps more importantly, a tool for analysis and potentially for defining the requirements for future systems.**

This is not a storyline for Star Trek. It is a scenario that could be experienced now by tank drivers, infantry platoon leaders, and pilots within a synthetic environment of computers and vehicle simulators. Today's computer technology allows us to construct "virtual" systems that perform within constraints that mimic reality, but can be experienced not unlike a super video arcade. Telecommunications can then make a "seamless" graft of these virtual systems over any distance, connected and fully interactive by means of telephone line and satellite relay. In fact, it has already been done.

The Defense Advanced Research Projects Agency (DARPA) achieved a milestone of computer technology when they reproduced a battle fought during Operation Desert Storm inside Iraq at a location called 73 Eastings. The details of the battle, recorded from extensive interviews with the soldiers who fought there, were encoded into the synthetic environment of computer and video wizardry with fidelity that rivals the best Hollywood sci-fi films. But the veteran soldiers were not merely able to refight the battle, they were able to refight it *differently*, and do it better. DARPA has documented the synthesized Battle of 73 Eastings on a short videotape, which is worth even paying admission to see.

The fidelity of synthetic environments makes it not just a training experience, but perhaps more importantly, a tool for analysis and potentially for defining the requirements for future systems. Today, weapons and support systems requirements are done with a variety of tools, including computer modeling and simulation. All require the strength of logic, supported by an articulate and polished marketing strategy. But what if, instead of merely explaining why we need a new system, say a new tank, we could show how a new system works. And not only by itself, but also in an aggregate—a full battalion of new tanks. Plus, allow soldiers to "test drive" this tank before it is ever built, not on a test track, but on the battlefield. Like a gameboard military historian, we could even refight past battles with the new system. Imagine Kasserline Pass fought with M-1s.

All this is feasible within a synthetic environment. The potential is to provide a magic window through which the entire cast of players in the acquisition process can look at the same time and see a virtual system in operation. Having agreed on the use of the synthetic environment, the branch proponent for the new system, the materiel developer, the testers, logisticians, even potential contractors, could see persuasive evidence of the merits and shortcomings of any given virtual system. This synthetic environment is infinitely tailorable and infinitely reproducible. How much more convincing could be a simulated "test drive" for key congressmen or staffers.

**Army acquisition policy will have to be concerned with system life cycle from genesis to obsolescence to make full use of the synthetic environment.**

The synthetic environment has its limitations. It is, after all, not reality. It cannot replace final prototyping and testing. But the potential for using the synthetic environment to define and demonstrate requirements before commitment of money to "bend metal" is enormous. Many false starts and major program changes could be avoided, because we could fully define the virtual system so that cost, performance and reliability could be predicted with great certainty. Then, after approval, the data that created the virtual system could be downloaded to the contractor, who, with computer-aided design/manufacturing (CAD/M), moves directly to fabrication—concept to design to fabrication, with data moved electronically, in a fraction of the time of our current process.

This vision requires two major efforts. First, acquisition policy needs to be broad enough to encompass requirements development. Today, the acquisition system begins with a Mission Needs Statement (MNS) and Operational Requirements Document (ORD), which turn needs into clear requirements. The opportunity that the synthetic environment presents is to provide a fast track for system development that starts *before need*, with *possibilities*. It then offers a showcase for the examination of the potential-need-idea-requirements-concept- design-proposal-prototype. This demands a continuity of effort that is currently limited by the Army's convention of the Combat Developer/Materiel Developer schism. Army acquisition policy will have to be concerned with system life cycle from genesis to obsolescence to make full use of the synthetic environment.

Secondly, the proponency for new systems, now vested in the service branches, must grow to accommodate the resources of equipment and skilled personnel to understand the use of the synthetic environment. That is, to build virtual systems which represent their proponent interests in materiel, organizations, and battlefield functions. The synthetic environment will rapidly make clear the strengths and weaknesses of their requirements. Initial ideas will be challenged in short order. Branch biases will not stand. Institutional stagnancy will be the death of the requirement. No system will be evaluated alone, but rather in the context of all battlefield systems within the synthetic environment. We will see the contribution of any one system to the combined arms team.

This vision is feasible now and plausible within the next five years. It cannot replace hardware development, but there may come a time when the strongest justification for one requirement is not the Best Technical Approach, or the Cost and Operational Effectiveness Analysis, or the Mission Profile. The strongest case will be how it fared in the Battle for Mons Olympus, Mars.

*MAJ MARK E. SALESKY is the chief of Maintenance Proponent Systems in the Directorate of Combat Developments, U.S. Army Ordnance Center and School, serving in functional area 51 (R&D). He holds a master's degree in acquisition management from Florida Institute of Technology, and is a graduate of the Material Acquisition Management and Combat Development Courses.*

# YOU THINK YOU HAVE PROBLEMS WITH YOUR R&D PROJECT?

By Joe Sites

The following story is provided to insure that those of you who have had setbacks in R&D projects are aware that you are not alone. Further, no matter what your set-back may have been, there was probably a bright side to the story somewhere.

During my three years military service in Italy (graduate of their War College and member of an Italian speaking NATO staff), I became aware that the Italian Army was proud of their military equipment, and I learned that they had every reason to be. Their 105mm howitzer was light, easy to operate, accurate. In fact, it had all the attributes I would have liked to have seen in our American 105, M102. Their equivalent of our jeep was designed so that six people could sit comfortably in it. Their trucks were designed to carry the maximum loads, both by weight and volume. They were like big boxes, no wasted room and it seemed that they all ran well. On top of this, their operators got the most out of their equipment. We are all aware that the Italian, whether he has driven or not, is a born driver. The history of auto racing bears this out. Despite their pride in their equipment and natural abilities, however, they had a good sense of humor about possible failures. In a class on potential research and development failures I heard the following allegorical story which was told to drive home a number of points.

Shortly after World War I, one of the up and coming officers in the Italian Signal Corps had a brilliant idea concerning the delivery of messages. He would cross a carrier pigeon (picione) with a parrot (papagallo) to produce a new bird which he called the "papacione" (pronounced papa-chone-nay). The idea was that you could verbally give the message to the "papacione" who would fly to his destination and he would then speak the message. This was supposed to save time and would also provide a certain degree of security in case the "papacione" were to be shot down over enemy lines or otherwise intercepted. After a period of development, the great day arrived when the "papacione" demonstration was to be given at Headquarters Army General Staff. The demonstration took place at two sites; Viterbo and Rome. To maintain purity of the demonstration, a general at Viterbo was selected at the last moment to spontaneously give any message which came to his mind. Looking the "papacione" directly in the eye, the general sternly commanded; "seize hill 520." The "papacione" responded three times "seize hill 520." With this satisfactory performance, he was released and off he flew to Rome. Right on time, the "papacione" flew through the window of the General Staff building, and landed on the table which was surrounded by generals waiting to see this great technological break-through. The "Papacione" strutted down the table, turned, strutted back, looked at his audience and then began strutting again. The officer in charge commanded, "Give me your message." No response, the "papacione" continued to strut. In desperation, the officer in charge screamed "GIVE ME YOUR MESSAGE." The "papacione" seemed to shrink, hung his head to the side and ever so plaintively said; "I can't remember."

That was the end of the project. To the memory of all concerned it was not resurrected, not even under another name. The originator of the project soon left the army. It was rumored that the "papacione" later became the chief of the Signal Corps.

Twenty-six years ago I had to memorize lessons learned from this story. Now, that I am acquiring some of the faults of the "papacione" I think it is enough for me to have just remembered the story. You the reader, however, should draw some of your own lessons.

*JOE SITES is currently vice president, director of Defense Systems at Baum Romstedt Technology Research, Inc., Vienna VA, and a 1951 West Point graduate. During his 30 years active duty, he served in both the Korean and Vietnam conflicts. He also served nine years in Europe including assignment as a student at the Italian War College and as an operations officer on a NATO staff at Verona.*

# Where Should the Thrust of Army Acquisition Be in a Peacetime Economy?

**George E. Dausman**
**Acting Assistant Secretary of the Army for Research, Development and Acquisition**

The objective of the Army's acquisition program, whether peacetime or wartime, should always be to ensure that our combat troops are equipped, trained, and logistically supported with the most modern, most effective, military hardware that American ingenuity can provide. This equipment must be in the hands of our troops and they must know how to use it. Otherwise, we cannot provide assurance that future military conflicts will be decisively won, both quickly and with minimum U.S. casualties. Equipment not yet fielded, prototypes in testing, or R&D still in the laboratories (or on the shelf) cannot win wars. We must therefore pursue an acquisition program where laboratory R&D, DEM VAL efforts, product improvements, and new starts are balanced components of a strategy that is focused on fielding new capabilities.

The peacetime economy that we are now anticipating will place continued downward pressure on the defense budget with the acquisition appropriations being particularly hard hit. The challenge is therefore obvious—how do we modernize in the face of this? The answer is the Army's acquisition program must be smart and reflect an overriding concern with cost effectiveness.

What are the elements of a smart cost-effective acquisition program? I believe it's one where laboratory efforts are focused on technologies that have the highest potential for payoff in either new systems or the upgrade/modernization of existing weapon systems. It is evidenced where demonstration efforts are similarly focused on risk areas where the potential modernization payoff is high. And finally, it is engineering and manufacturing development programs where the desired capability is not only consistent with our modernization goals but also worthy of committing our scarce program funding resources.

The objective has not changed. The difference is that a peacetime economy will put an overriding emphasis on resources and demand that only winning efforts enjoy the deliberate commitment of scarce funding. Army acquisition officers must be as smart as they can be!

**MG Richard T. Travis**
**Commanding General**
**U.S. Army Medical R&D Command**
**Fort Detrick, MD**

Army medical research, development and acquisition is essential for sustaining Defense medical technological superiority. As in the past, today's medical RDA programs are focused in support of the Defense medical mission of providing, and maintaining readiness to provide, health services and support to armed forces during military operations. A large part of this mission extends beyond the popular view of combat medicine as related only to combat medics, dustoff missions, and field surgery. Although less costly and less glamorous than the weapons systems elements of the Defense RDA program, medical modernization is an important part of the national military strategy.

Battle and non-battle threats to the health of our armed forces have been changed little by the demise of the Soviet Union and the end of the cold war. Historically, sources of non-battle injury—naturally occurring infectious diseases, musculoskeletal strain and blunt impact, environmental conditions and extremes, operational pace and individual demands, as well as health hazards of our combat systems—have been a significantly greater cause of disease and lost operational effectiveness than battle injury. Accordingly, Army medical RDA programs are focused on minimizing casualties and disease from the full spectrum of battle and non-battle threats to health. This focus is provided through three goals: (1) protect operational capability by preventing disease, (2) sustain operational capability despite disease, and (3) provide state-of-the-art medical treatment of those who become casualties. Medical R&D programs are functionally aligned to focus development of medical countermeasures—vaccines, drugs and biomedical information—by threat category. Thus, the protection, sustainment and specialized treatment goals are addressed by functional R&D on: military disease hazards, combat systems and operational hazards, medical biological defense and medical chemical defense. The combat casualty care function addresses medical, surgical and maxillofacial (combat dental) warfighting capability issues for state-of-the-art treatment far forward on the battlefield. There must be a seamless integration of these functional capabilities in the provision of health support and services during military operations for this approach to be effective.

Sustained medical technological superiority is critical to the success of the national military strategy. In peace, it contributes to deterrence and non-proliferation of biological and chemical weapons; effective biological defense vaccines and chemical agent prophylaxis blunt the effectiveness, and thus the appeal, of these weapons of potential mass destruction. It bolsters the confidence of our coalition partners. Field medical treatment capabilities are an essential and highly visible element of humanitarian assistance missions. In crisis, medical technological superiority ensures that threats to the health of the force are not a limiting factor on military options normally open to the National Command Authority and CINCs. For example, vaccines and drugs will permit effective deployments into regions despite the presence of diseases, such as plague or hemorrhagic fever with renal syndrome, with high morbidity and mortality rates that would otherwise become "war stoppers." In war, it amplifies individual combat effectiveness, minimizes casualties, and diminishes death and disability rates of those who become casualties.

Defense medical RDA is unique. By international treaty and convention, medical RDA must be for the benefit of mankind. No other federal program is focused to support our soldiers during military operations; the Department of Health and Human Services and its research arm, the National Institutes of Health, are concerned with U.S. public health problems. Like our private sector counterparts, Army-developed medical products must comply with U.S. Food and Drug Administration regulations and product licensure requirements. Army medical R&D is the only DOD capability for development, in accordance with U.S. FDA requirements, of medical and surgical materiel, vaccines and drugs; USAMRDC develops medical materiel for all three military departments. U.S. FDA regulations have resulted in a tailored medical materiel life cycle system management model.

**Dr. Robert W. Shaw**
**Associate Director**
**Division of Chemical and Biological Sciences**
**U.S. Army Research Office**

Research must play a greater role in the process leading to Army acquisition as we move into a peacetime economy. By "peacetime" I refer to a world when the threat of massive war is diminished but military actions will continue. Below I outline two benefits of research: as a means of reducing final acquisition costs and, more important, as a means of providing the soldier with tools for the future battlefield.

In a normal R&D process moving on to acquisition, the cost of the first step in the process, research, is usually relatively small compared to the later steps of development. Research costs are much smaller than the costs of acquisition. On the other hand, the final, relatively large acquisition costs are mostly built in early in the process when the developers hand in the product design. It follows that adequate investment in early research leading to better designs will pay off in savings during the later steps of the acquisition process leading to a product.

Our preparation for the wars of the past has been partly based on the need to counter the threat of massive firepower. Firepower will, of course, remain important; but future battlefields will require units that are smaller, more mobile and more self-reliant with better information about their surroundings and communication with each other. Our soldiers will no longer require huge numbers of identical items. Rather, we must provide them with a variety of tools tailored to their special needs. Development and acquisition of those tools will require vigorous, high quality research.

**Dr. Kenneth J. Oscar**
**Deputy Commander for Research, Development and Engineering**
**U.S. Army Tank-Automotive Command**
**Warren, MI**

The biggest challenge facing the Army is how to shift from a very lethal, survivable, heavy-deployed force to a light, mobile, force projection Army while maintaining technological superiority, with the constraint of dramatically smaller Army budgets. The answer lies in shifting the thrust of Army acquisitions from sole dependency on performance to a balanced performance-cost approach.

Our past thrust on performance led to long, costly acquisitions. It caused little risk-taking, gold-plated and ever-changing requirements, duplicate research and development programs with redundant infrastructure costs, and a focus on next generation development at the expense of both continuing technology and improving existing equipment. Worst of all, our performance-only thrust, caused the creation of a totally separate and costly defense industry with little in common with commercial industry. The Army paid the entire overhead and infrastructure costs for this unique defense industry, rather than being able to share the burden with the commercial sector. This thrust on performance also denied the Army the use of more cost-efficient commercial practices which developed because of their emphasis on cost.

To change the Army acquisition thrust to a more balanced performance-cost approach, we must place more emphasis on cost throughout the acquisition cycle to completely overhaul and modernize the Army acquisition process. We must start by putting cost goals in our requirement documents, specifications, RFPs and contracts. A requirement document should no longer say we want the next tank to improve performance, but instead it should say we want the next tank to improve performance *and* be produced at 20 percent less cost per tank. This balanced approach would force modernization of our acquisition process by putting more emphasis on shorter acquisition cycles, increased use of simulation, flexible manufacturing and more use of commercial components and dual-use technology.

TARDEC has started down this road by challenging requirement documents to consider cost, creating a world class simulation and virtual prototype process, and focusing on dual-use technology with the creation of a National Automotive Center. The National Automotive Center has created three separate consortium; one with the automobile companies, one with trucking companies and one with construction/material handling companies. These consortium focus on education, joint pre-competitive research, common development agreements and manufacturing including flexible machining and virtual factories. With assistance from DARPA, we have tied these industries together with a high-speed computer net and world class simulation capabilities. We are helping defense industries, commercial industries, universities and government work together for lower costs and higher technology for all.

**Dr. Paul J. School**
**Chief, Fort Belvoir Field Element of the Army Research Laboratory Human Research and Engineering Directorate**
**Fort Belvoir, VA**

I believe the peacetime thrust should be preparedness and preservation of assets.

Conflict is very much a part of world history—peace is impermanent. Yet, when peace breaks out, some confuse fond hopes with reality.

At the end of the Second World War, on VE and VJ days, we danced in the streets. Defense plants switched to domestic products. Tons of war surplus items from nails to Norden Bomb sight parts flooded through stores that popped up all over town. Most felt future aggression was clearly out of the question because we had proved our superiority.

Five years later, we lost our nuclear secrets and we were fighting in Korea. Today, we have won the Cold War. We prevailed by meeting the threat move for move. However, I wonder if, "It's deja vu all over again." Superiority is ephemeral; maintaining superiority should be a thrust area.

We must also focus on preservation of assets by redirecting the Army's considerable resources to peace-oriented acquisition. Redirection preserves investments/assets and causes them to serve other purposes. Redirection serves needs as needs change.

Some confuse redirection with disassembly. Disassembly destroys flexibility and renders a potentially useful thing useless. Sometimes we can use the disassembled parts, but with complicated parts that can take a long time. Organizations have complicated parts called people.

Facilities, equipment, and other assets are of secondary value to an organization. People are the primary asset. The efforts and costs required to staff an effective organization are much more considerable investments than most realize. Good people are hard to hire; then you must train them extensively on-the-job. Developing trained people who possess corporate knowledge and function as team members takes a long time.

The Army has talented people. Some of them developed the smart bomb, the space rockets, and the first large electronic computer. An Army major invented FM radio. The Army has competencies that can serve peacetime use. Computing, energy use reduction, materials technology, signal processing and medical technology come easily to mind. Surely you can add to my brief list.

I believe that the Army thrust in peacetime should be maintaining preparedness. Shifting acquisition toward peacetime applications in areas that fit Army competencies will also maintain those competencies.

# Acquisition Officer Selection Board Results

In January 1993, the final FA 51 Acquisition Officer Selection Board (AOSB) convened and selected 101 officers for accession into the Army Acquisiton Corps. This action completes the process of integrating Functional Area 51 into the AAC. For officers not accessed, FA 51 has been removed from your files and you will be given an opportunity to request another functional area. For accessed officers, the PERSCOM Military Acquisition Management Branch will now manage your files and careers and assign you to positions on the Military Acquisition Position List. The following is a list of officers selected during the January FA 51 AOSB and other recent off-line accession boards. Congratulations on your selection for accession into the Army Acquistition Corps.

| Rank | Name | FA | BR | YG |
|---|---|---|---|---|
| CPT | ADAMS, Timothy Charles | 97 | CM | 84 |
| MAJ | AEILLO, Thomas Paul | 51 | FA | 79 |
| MAJ | ALEXANDER, Samuel Winston | 51 | IN | 76 |
| MAJ | BAKER, George Ronald E. II | 51 | EN | 79 |
| CPT | BARKER, Anne Forrester | 51 | QM | 83 |
| CPT | BARTOLOTTO, John Kenneth | 51 | AR | 83 |
| LTC | BEATTY, Timothy Jon | 51 | EN | 73 |
| CPT | BEDELL, Cynthia Mae | 51 | CM | 83 |
| LTC | BENO, Joseph Henry Jr. | 51 | OD | 71 |
| COL | BISKEY, Alan Delroy | 51 | SC | 68 |
| MAJ | BLAKNEY, Peter James J. | 53 | AR | 77 |
| MAJ | BONNER, Michael Bruce | 51 | MP | 78 |
| CPT | BONONES, James Anthony | 51 | OD | 84 |
| CPT | BOOTH, Ann Livingstone Byers | 97 | FA | 81 |
| MAJ | BOWMAN, Michael | 53 | FA | 79 |
| MAJ | BRAMBLETT, Howard | 51 | AV | 76 |
| MAJ | BREWSTER, Robert Ethan Jr. | 51 | AR | 80 |
| COL | BUBB, Ernest Eugene | 51 | AR | 69 |
| CPT | BUCKMAN, James Mitchell | 51 | IN | 82 |
| MAJ | BYRNES, Ronald Benton Jr. | 53 | SC | 79 |
| MAJ | CAMPBELL, Todd Ross | 51 | AD | 79 |
| CPT | CHETTY, Steven Leon | 97 | CM | 82 |
| COL | CROSS, James Burke | 51 | OD | 68 |
| CPT | DAVIS, Lyndal Ray | 53 | OD | 83 |
| MAJ | DAVISON, Alan David | 51 | AV | 77 |
| MAJ | DIMITROV, George Victor | 51 | AV | 79 |
| LTC | DODD, Mary Catherine | 53 | AG | 73 |
| CPT | DODSON, Walter Kevin | 97 | EN | 82 |
| LTC | DUCKWORTH, Roger Lee | 51 | AV | 71 |
| MAJ | EBY, David Harley | 51 | AR | 78 |
| CPT | ECONOMY, Anas Tommy III | 51 | AR | 81 |
| LTC | EHLY, William Erle | 51 | OD | 73 |
| MAJ | ESPOSITO, Richard Michael | 51 | AV | 80 |
| LTC | FANNING, Leo Norman Jr. | 51 | AV | 70 |
| LTC | FEUDO, Christopher Vincent | 53 | IN | 72 |
| CPT | FLORESCA, Michael Bundang | 51 | AD | 84 |
| MAJ | FOUNTAIN, Harrison Douglas | 53 | IN | 81 |
| LTC | FOWLER, Charles Sherrill | 97 | SF | 74 |
| MAJ | FRANK, Richard Foss Jr. | 51 | AR | 77 |
| CPT | GARMAN, Patrick John | 51 | AV | 82 |
| LTC | GEMAR, Charles Donald | 51 | AV | 79 |
| MAJ | GILMAN, Jerome Paul | 51 | CM | 81 |
| MAJ | GRIFFIN, Wesley Bernard | 51 | AR | 79 |
| MAJ | GROTKE, Mark Lyndon | 51 | AV | 79 |
| LTC | HANKS, Marvin Lynn | 51 | AV | 70 |
| MAJ | HARRELL, William David | 97 | AV | 78 |
| MAJ | HARTER, William Edward | 51 | CM | 78 |
| COL | HATTON, Sam Earl | 97 | OD | 69 |
| CPT | HAY, Ralph Garrick | 51 | OD | 82 |
| MAJ | HEMMINGER, Terry J. | 51 | IN | 76 |
| LTC | HERRICK, Charles Robert | 51 | IN | 74 |
| MAJ | HRDY, Russell James | 51 | AR | 81 |
| CPT | HUFFMAN, Eric Michael | 97 | FA | 81 |
| CPT | JESTER, Marvin Benjamin Jr. | 97 | EN | 82 |
| MAJ | JONES, Paul Fulton | 51 | AR | 79 |
| CPT | JONES, Raymond Dennis | 51 | AV | 83 |
| COL | JOZWIAK, Vincent Raymond | 51 | AD | 70 |
| MAJ | KAY, Bruce Groman | 51 | AR | 78 |
| CPT | KEY, David Jeffrey | 53 | FA | 81 |
| MAJ | KING, David Lawrence | 53 | FA | 80 |
| MAJ | KREKO, Zoltan John | 51 | FA | 79 |
| CPT | KRZISNIK, Gary Michael | 97 | EN | 84 |
| CPT | KUKES, Scott Dean | 97 | SC | 83 |
| CPT | LANE, Broderick Brian | 53 | SC | 84 |
| CPT | LANGHAUSER, Craig Gerard | 51 | AR | 82 |
| LTC | MAINWARING, John Charles | 51 | AV | 74 |
| MAJ | MAIR, Robert Scott | 51 | AV | 73 |
| MAJ | MAJOR, Edward Bernard | 51 | OD | 76 |
| MAJ | MANEY, Cornelius John | 51 | AD | 79 |
| CPT | MARSHALL, Edward Francis III | 97 | CM | 84 |
| LTC | MCARTHUR, William Surles Jr. | 51 | AV | 73 |
| MAJ | MCVEIGH, Joseph | 97 | TC | 78 |
| COL | MOODY, Steven Joe | 51 | AV | 70 |
| MAJ | MRSNY, Reid Kevin | 51 | EN | 79 |
| MAJ | MULHALL, Maureen McLeod | 51 | CM | 78 |
| CPT | MUTH, Barry William | 51 | AR | 81 |
| MAJ | NEUMAN, Jose Luis Jr. | 51 | QM | 76 |
| LTC | OBERHOLTZER, William Irving | 51 | IN | 72 |
| LTC | PARSONS, Steven Alan | 51 | FA | 75 |
| MAJ | PENA, John Ray | 51 | AR | 76 |
| CPT | PETERSON, Allen Leo | 51 | AV | 82 |
| MAJ | PETRO, Robert Owen | 53 | AR | 80 |
| CPT | PINIGIS, Dennis James | 51 | AV | 84 |
| CPT | PITTS, Michael Kennedy | 51 | AR | 83 |
| MAJ | POPE, Robin Merl | 51 | AR | 79 |
| CPT | PRESGRAVES, Donald Cawood | 51 | AV | 84 |
| CPT | PROCTOR, Craig Richard | 51 | AV | 84 |
| MAJ | RAUTENBERG, Lawrence Eric | 51 | IN | 76 |
| CPT | REYES, Diego | 53 | TC | 83 |
| COL | ROSS, David Arnold | 51 | AD | 68 |
| CPT | ROSSO, Daniel Charles | 97 | IN | 77 |
| COL | SALE, David Frand | 51 | AV | 69 |
| MAJ | SALESKY, Mark Edwin | 51 | MP | 79 |
| MAJ | SASEEN, Gail Ann | 97 | MP | 77 |
| CPT | SCHULZ, Robert Richard | 97 | AV | 83 |
| MAJ | SCHWAB, Joseph Richard | 51 | AR | 77 |
| MAJ | SEATON, Roy James | 51 | AR | 76 |
| CPT | SHAFFER, Brad Lee | 97 | EN | 82 |
| CPT | SHEFFLER, Carol Marie | 53 | TC | 83 |
| CPT | SHERLOCK, Nancy Jane | 51 | AV | 81 |
| MAJ | SHUBERT, Martin | 51 | AV | 79 |
| MAJ | SKAGGS, Michael | 51 | AV | 78 |
| COL | SMITH, Larry Gordon | 51 | AR | 66 |
| MAJ | SOBEY, Robert Leland | 51 | AV | 77 |
| CPT | SOLOMON, Dempsey | 51 | AV | 82 |
| MAJ | STEPHENSON, Mark William | 51 | AV | 80 |
| CPT | STIEFEL, Jeffrey Ira | 97 | CM | 84 |
| MAJ | STORMER, William Henry | 51 | AV | 78 |
| CPT | STRONG, Noah Kenneth | 51 | QM | 83 |
| CPT | SWEENEY, Joseph Francis | 97 | MP | 82 |
| LTC | TEAGUE, Gregory Dalton | 51 | IN | 73 |
| CPT | THIEL, John Steven | 97 | FA | 81 |
| LTC | THOMPSON, Michael Roderick | 51 | IN | 73 |
| MAJ | THORSON, Steven John | 51 | AR | 81 |
| MAJ | TILLMAN, Martin Rogers | 97 | EN | 81 |
| CPT | TOUSLEY, Bradford Clark | 51 | AR | 81 |
| CPT | TRANG, Jeffery | 51 | AV | 83 |
| CPT | TWIGG, Robert Joseph | 97 | AD | 81 |
| CPT | WARE, Walter Allen | 97 | EN | 83 |
| MAJ | WATERS, Henry James | 51 | EN | 79 |

| Rank | Name | FA | BR | YG |
|---|---|---|---|---|
| MAJ | WEAVER, Kurt Allen | 51 | AR | 76 |
| COL | WEEKLY, Terry Morris | 51 | OD | 67 |
| CPT | WHEELOCK, Douglas Harry | 51 | AV | 83 |
| CPT | WHITE, Karen Kay | 97 | AV | 83 |
| MAJ | WHITFIELD, Charles Nathaniel | 51 | IN | 79 |
| MAJ | WILSON, Bernard Cornelius | 97 | AD | 76 |
| CPT | WILSON, Fred Jerome | 51 | OD | 84 |
| LTC | WISMANN, Joseph Benedict | 97 | IN | 72 |
| MAJ | YAWN, Barbara | 53 | AG | 77 |
| COL | YERKES, William Nelson | 51 | FA | 69 |

## MAJ Promotion Results

Congratulations to the following Army Acquisition Corps (AAC) officers who were recently selected for promotion to major. Overall AAC average was 83.2 percent compared to the Army average of 71.1 percent.

| Name | FA | BR |
|---|---|---|
| ADDAS, James Edward | 97 | FA |
| BALDWIN, James Bradley | 51 | SF |
| BARBER, Wayland Patrick III | 51 | OD |
| BARISANO, Gregg Anthony | 51 | OD |
| BENTON, Jeffery Alonza | 97 | IN |
| BESCH, Thomas Murray | 97 | IN |
| BILLINGTON, Robert Bruce | 97 | IN |
| BLALOCK, James Herman | 53 | SC |
| BLODGETT, Donald John | 51 | OD |
| BOYAJIAN, Michael Anthony | 51 | AV |
| BRACKETT, Robert John | 51 | TC |
| BRADSHAW, Jerry Lee Jr. | 51 | AD |
| BREFFEILH, William Albert | 51 | OD |
| BREWER, Barry Wade | 51 | AR |
| BRIDGES, Jon Kerry | 53 | AG |
| BRIGHT, Kelvin Lavern | 51 | AD |
| BRISTOW, James Steven | 51 | SC |
| BRONAUGH, John Paul | 51 | AR |
| BROWN, Joseph David | 53 | SC |
| BROWNING, Jeffrey William | 51 | OD |
| BUELL, David Allen | 51 | FA |
| BURNS, Ronald Ray | 53 | IN |
| BURTNETT, Richard Joseph III | 97 | IN |
| BUSHEY, Martin | 97 | AR |
| BYRNSIDE, Henry Franklin | 51 | MP |
| CAMPBELL, Scott Alan | 51 | FA |
| CARLEY, Patrick Joseph | 51 | IN |
| CARROLL, David Kenneth | 97 | QM |
| CARROLL, Maxwell Glenn Jr. | 51 | FA |
| CHARLES, Sherman Louis | 51 | SC |
| CHASTEEN, Gregory Taylor | 51 | QM |
| CHETTY, Steven Leon | 97 | CM |
| COFFMAN, Thomas Dwayne | 51 | TC |
| COLE, Clinton | 53 | TC |
| COUTTEAU, Harlene Nelson | 51 | QM |
| CRUTE, Joseph David Jr. | 53 | OD |
| CURRY, Virgil Jr. | 51 | AD |
| CUTLER, Catherine Margaret | 51 | OD |
| DAGOSTINO, Mark Andrew | 51 | SC |
| DEAN, Demonia | 51 | SC |
| DODSON, Walter Kevin | 97 | EN |
| DONOHUE, Matthew Charles | 51 | OD |
| DOYLE, Norbert Silsbury Jr. | 97 | IN |
| EADY, Donald Phillip | 97 | AD |
| ELLERY, Allen Ross | 97 | EN |
| FAHY, Stephen Robert | 97 | IN |
| FIERKO, Francis Xavier | 97 | AR |
| FINAMORE, Michael James | 51 | AD |
| FINEMORE, Brent Clay | 97 | OD |
| FINK, James Victor | 97 | MI |
| FISCHER, Claudia Jean | 53 | MI |
| FISHER, David Pierce | 97 | OD |
| FITCH, John Jeffrey | 51 | OD |
| FLOWERS, Kenneth | 51 | SC |
| FORD, Steven Patrick | 97 | FA |
| CALLAGHER, Daniel Jose | 97 | OD |
| GARMAN, Patrick John | 51 | AV |
| GAZZANO, Lee Daniel | 51 | EN |
| GENUALDI, Dennis | 97 | AV |
| GIBSON, Donald Vincent | 53 | OD |
| GILBERT, Thomas Bryan | 51 | SC |
| GILBERT, Trent Lionell | 51 | FA |
| GODDETTE, Timothy Gerard | 51 | EN |
| GRAHAM, Steven Marcus | 51 | MI |
| GREEN, Larry Phillip | 51 | AD |
| GRIFFIN, Kurtz Felton | 51 | AD |
| HALLENBECK, Phillip Revere | 51 | AR |
| HALTERMAN, James Edwards | 51 | OD |
| HANSEN, Richard Donald Jr. | 51 | FA |
| HARRINGTON, Gale Alicia | 53 | SC |
| HARRIS, William Francis III | 51 | IN |
| HAZELWOOD, Donald Alexander | 51 | AV |
| HEATHCOCK, Robert Bruce | 51 | SC |
| HILLIKER, Craig William | 51 | IN |
| HOGER, Samuel Earl | 51 | SC |
| HOLLINGSWORTH, Larry Dale | 51 | IN |
| HUGHES, Daniel Peter | 51 | FA |
| HUNTLEY, Donald Allen | 51 | FA |
| HUTCHINS, Vincent Joseph | 51 | IN |
| JESTER, Marvin Benjamin Jr. | 97 | EN |
| JOHNSON, Audrey Howard | 53 | SC |
| JOHNSON, Wayne Wendell | 97 | OD |
| JONES, Luwanda Foster | 53 | QM |
| JONES, Raymond Dennis | 51 | AV |
| JOZWIAK, Edward David | 51 | IN |
| KELLEHER, John Henry Jr. | 53 | EN |
| KNAPP, Charles Leland Jr. | 51 | AR |
| KNUDSON, Ole Albert | 51 | FA |
| KOSTER, John Leo | 51 | IN |
| LANDERS, Michael David | 51 | AR |
| LANGHAUSER, Craig Gerard | 51 | AR |
| LANTZER, Paula Katherine | 51 | CM |
| LARESE, William Scott | 97 | AV |
| LEONARD, Robert Eric | 97 | FA |
| LIPSIT, Carl Alan | 97 | IN |
| LOPEZ, Steven Eric | 51 | FA |
| LOVETT, Robert Alan | 53 | AR |
| LUCAS, Gerald William | 51 | FA |
| LUMB, Mark Douglas | 51 | IN |
| LYONS, Reba Mae | 51 | SC |
| MAJEWSKI, Albin Richard | 51 | QM |
| MARSHALL, John Clark | 53 | FA |
| MCFARLAND, Bruce Freeman | 97 | IN |
| MCGLOWN, David Lawrence | 51 | FA |
| MCGUIRE, William Thomas | 53 | IN |
| MILES, Richard Zoe | 53 | FA |
| MILLER, Christopher Matthew | 51 | AV |
| MOLES, Joseph Bruce | 51 | OD |
| MULLIN, Edward Leroy | 51 | AD |
| NIPP, Robert Ferrell | 51 | FA |
| NIX, William Lonnie Jr. | 51 | FA |
| NORRIS, Curtis Randall | 51 | OD |
| NULK, Raymond Howard | 51 | OD |
| OFARRELL, Patrick Daniel | 97 | IN |
| OLLIFF, Kirk Barner | 97 | AV |
| ORR, Michael Lee | 51 | FA |
| PAQUETTE, Derek Joseph | 51 | AV |
| PARKER, Eric Steven | 53 | SC |
| PATTILLO, Stephen Prescott | 53 | IN |
| PENA, Sergio | 51 | AD |
| PENN, Bradley Eugene | 51 | MI |

| Name | FA | BR |
|---|---|---|
| PENNINGTON, Hozie Woodrow Jr. | 51 | SC |
| PETERSON, Allen Leo | 51 | AV |
| POTTINGER, John Mark | 53 | AD |
| POWNALL, Terry Lee | 51 | MI |
| PRENDERGAST, Timothy John | 51 | FA |
| QUIROZ, Toni Raul | 51 | SC |
| RANEY, Timothy Edward | 51 | OD |
| RAY, Marilyn Ann | 97 | QM |
| REESE, Toby Donald | 97 | QM |
| REICHELT, Richard Harry | 51 | AV |
| ROSS, Christopher Marshall | 51 | CM |
| ROTHLEIN, Arnold | 51 | FA |
| SEARS, George Albert II | 97 | CM |
| SHAFFER, Brad Lee | 97 | EN |
| SHARP, Charles Longstreth | 97 | FA |
| SHIRLEY, Randall Roy | 53 | AD |
| SISK, Marc Daniel | 51 | OD |
| SKINNER, Eugene Windfield Jr. | 51 | AD |
| SLAYTER, Walter Ray | 51 | SC |
| SMITH, Michael Davis | 51 | FA |
| SMITH, Robert Joseph | 53 | EN |
| SOLOMON, Dempsey | 51 | AV |
| STOLESON, Kevin Scott | 51 | OD |
| SWART, John Joseph | 53 | AR |
| SWEENEY, Joseph Francis | 47 | MP |
| THARPE, Leonard | 53 | SC |
| THOMAS, Kathrine Marie | 97 | QM |
| TOLLIVER, Zane Kevin | 53 | FA |
| TONG, Jeffrey Albert | 51 | AD |
| TRAN, Hieu Thomas | 53 | SC |
| TRENTANELLI, Stephen John | 51 | FA |
| VANLENGEN, Albert | 53 | FA |
| VAUGHN, John Kendrick | 51 | AD |
| WAJDA, Peter John | 51 | MI |
| WARD, Timothy Michael | 51 | AV |
| WASSMUTH, Richard J. | 53 | SC |
| WEATHERSBEE, Clarence Edward | 51 | AD |
| WHEELER, Kenneth Alan | 51 | IN |
| WILLIAMS, Curtis Ray | 53 | FA |
| WILLIAMS, Yancey Roger | 51 | AR |
| WOMACK, John Hewett | 97 | AR |
| WYNN, Milton Eugene III | 97 | AV |
| YOUNG, Carol Rudolph | 51 | OD |

## Army Acquisition Corps Command and General Staff College Selectees

Congratulations to the following individuals on their selection for Command and General Staff College. Officers previously selected for CSC were revalidated but not listed here.

| Name | Rank | FA | BR | YG |
|---|---|---|---|---|
| ALFORD, Kenneth | MAJ | 53 | AG | 79 |
| ANDERSON, Mark Christopher | MAJ | 51 | TC | 80 |
| BARBER, Wayland Patrick III | CPT | 51 | OD | 82 |
| BEATTY, Robert James | MAJ | 51 | FA | 79 |
| BEGEMAN, Paul Jeffery | CPT | 51 | AR | 81 |
| BESCH, Thomas Murray | CPT | 97 | IN | 82 |
| BRISTOW, James Steven | CPT | 51 | SC | 82 |
| BROWN, Joseph David | CPT | 53 | SC | 82 |
| BURKE, John Dennis | MAJ | 53 | SC | 79 |
| BURNEY, Michael Ray | MAJ | 97 | FA | 80 |
| CAMPBELL, Scott Alan | CPT | 51 | FA | 82 |
| CAREY, Philip Jeffry | MAJ | 51 | FA | 81 |
| COFFMAN, Thomas Dwayne | CPT | 51 | TC | 83 |
| COOPER, Stephan Philip | MAJ | 51 | IN | 80 |
| COTTER, Gerard Joseph | MAJ | 51 | QM | 79 |
| DAGOSTINO, Mark Andrew | CPT | 51 | SC | 81 |
| DONOHUE, Matther Charles | CPT | 51 | OD | 82 |
| DOWLING, Jon Nicholas | CPT | 51 | AD | 81 |
| EADY, Donald Phillip | CPT | 97 | AD | 82 |
| ESPOSITO, Michael Brian | MAJ | 53 | FA | 80 |
| FIERKO, Francis Xavier | CPT | 97 | AR | 83 |
| FINEMORE, Brent Clay | CPT | 97 | OD | 82 |
| FLEMING, Michael Brian | CPT | 97 | OD | 81 |
| FLORIO, Michael Angelo | CPT | 51 | FA | 81 |
| FLOWERS, Kenneth | CPT | 51 | SC | 82 |
| FOX, Steven Grant | MAJ | 51 | SC | 79 |
| GARMAN, Patrick John | CPT | 51 | AV | 82 |
| GIBSON, Donald Vincent | CPT | 53 | OD | 82 |
| GILBERT, Thomas Bryan | CPT | 51 | SC | 82 |
| GODDETTE, Timothy Gerard | CPT | 51 | EN | 82 |
| GORE, George Orie | MAJ | 51 | AV | 80 |
| GRAHAM, Steven Marcus | CPT | 51 | MI | 82 |
| HAMMELL, Robert Julius II | MAJ | 53 | SC | 79 |
| HANSEN, Richard Donald Jr. | CPT | 51 | FA | 83 |
| HARRIS, Gary Elliott | MAJ | 51 | SC | 79 |
| HAYNE, Ronald James | MAJ | 51 | AD | 80 |
| HILL, Monte Robbin | MAJ | 51 | SC | 79 |
| HINTON, Mark Winston | CPT | 53 | AV | 81 |
| HODGES, Georgia Beatrice | CPT | 53 | AG | 81 |
| HUGHES, Daniel Peter | CPT | 51 | FA | 83 |
| IRBY, Robert Julian IV | MAJ | 53 | EN | 80 |
| JONES, Raymond Dennis | CPT | 51 | AV | 83 |
| JOHNSON, Dan Allen | MAJ | 51 | FA | 79 |
| KELLEMER, John Henry Jr. | CPT | 53 | EN | 83 |
| KENDRICK, Robert III | MAJ | 97 | MP | 81 |
| KNUDSON, Ole Albert | CPT | 51 | FA | 82 |
| KWAN, Hon Cheun Jr. | CPT | 51 | SC | 81 |
| LOPER, Charlene Marie | CPT | 51 | MI | 81 |
| MAHANNA, Cory Wade | CPT | 51 | AV | 83 |
| MCBRIDE, Teresa Marie | MAJ | 51 | FA | 79 |
| MCDANIELS, Lloyd Edwin | MAJ | 51 | AD | 80 |
| MCMATH, Michael Lamar | MAJ | 97 | FA | 79 |
| MULLIN, Edward Leroy | CPT | 51 | AD | 82 |
| NEUMANN, Markus Ralph | MAJ | 97 | FA | 80 |
| NIPP, Robert Ferrell | CPT | 51 | FA | 82 |
| NULK, Raymond Howard | CPT | 51 | OD | 82 |
| PADGETT, Joseph Paul | MAJ | 97 | OD | 79 |
| PALLOTTA, Ralph George | MAJ | 51 | AV | 79 |
| PARKER, Wilber Anthony | MAJ | 51 | AD | 80 |
| POLCZYNSKI, Kennith Dean | MAJ | 97 | AD | 80 |
| POTTINGER, John Mark | CPT | 53 | AD | 82 |
| RALPH, James Robert III | CPT | 53 | SC | 81 |
| RAYMOND, Walter Russell Jr. | CPT | 51 | AR | 81 |
| RAYNOR, Cleon Wendell | MAJ | 51 | OD | 81 |
| RUST, Stephen Layne | MAJ | 51 | AR | 80 |
| SEARS, George Albert II | CPT | 97 | CM | 83 |
| SKINNER, Eugene Windfield Jr. | CPT | 51 | AD | 82 |
| SOLOMON, Dempsey | CPT | 51 | AV | 82 |
| SPILDE, Randy Doyle | MAJ | 51 | SC | 79 |
| STARKEY, Loretta Sue | MAJ | 51 | OD | 79 |
| SURMACZ, Eugene Steven | CPT | 97 | AR | 81 |
| TIDD, John Patrick | CPT | 53 | IN | 81 |
| TUDOR, Rodney Ezell | MAJ | 51 | AD | 79 |
| TURNER, John Nelson | MAJ | 97 | OD | 79 |
| ULSH, Gregory Jay | CPT | 51 | AV | 81 |
| VALDEZ, Max Justin | MAJ | 51 | FA | 79 |
| VAUGHN, John Kendrick | CPT | 51 | AD | 83 |
| WASHINGTON, Von Cheyenne | MAJ | 51 | AD | 80 |
| WEILAND, Peter Lawrence Jr. | MAJ | 51 | EN | 79 |
| WHEELER, Kenneth Alan | CPT | 51 | IN | 82 |
| WHITFIELD, Charles Nathaniel | MAJ | 51 | IN | 79 |
| WILLIAMS, Jeffery Nels | MAJ | 51 | AV | 80 |
| WOMACK, John Hewett | CPT | 97 | AR | 82 |
| YOUNG, Carol Rudolph | CPT | 51 | OD | 82 |

# Defense Systems Management College 1993 Courses

The following is a list of courses offered by the Defense Systems Management College during the remainder of FY93. Courses will be given at the main campus at Fort Belvoir, VA unless otherwise stated. For information about courses, call the registrar's office on DSN 655-2227 or commercial (703) 805-2227.

| COURSE DATES | LOCATION | COURSE NO. |
|---|---|---|
| **ACQUISITION BASICS COURSE** | | |
| May 17–Jun 11 | Huntsville | 93-10R |
| Jun 14–Jul 9 | | 93-11 |
| Jun 14–Jul 9 | | 93-12 |
| Jun 14–Jul 9 | St. Louis | 93-13R |
| Jul 12–Aug 6 | Boston | 93-14R |
| Aug 9–Sep 3 | St. Louis | 93-15R |
| Sep 7–Oct 1 | Huntsville | 93-16R |
| Sep 13–Oct 8 | | 93-17 |
| **ADVANCED INTERNATIONAL MANAGEMENT WORKSHOP** | | |
| May 10–14 | | 93-2 |
| **CONTRACT MANAGEMENT FOR PROGRAM MANAGERS COURSE** | | |
| Jun 14–18 | Huntsville | 93-4R |
| Jul 12–16 | | 93-5 |
| Jul 19–23 | St. Louis | 93-6R |
| Jul 26–30 | | 93-7 |
| Aug 23–27 | Boston | 93-8R |
| Aug 30–Sep 3 | | 93-9 |
| Sep 20–24 | | 93-10 |
| **CONTRACTOR FINANCE FOR PROGRAM MANAGERS COURSE** | | |
| Jun 1–4 | St. Louis | 93-4R |
| Jul 12–16 | Boston | 93-5R |
| Sep 13–17 | Los Angeles | 93-6R |
| **CONTRACTOR PERFORMANCE MEASUREMENT COURSE** | | |
| Jun 21–25 | Huntsville | 93-5R |
| Jul 26–30 | | 93-6 |
| Aug 16–20 | Los Angeles | 93-7R |
| **DEFENSE MANUFACTURING MANAGEMENT COURSE** | | |
| Jun 7–11 | | 93-4 |
| Jul 19–23 | | 93-5 |
| **EXECUTIVE MANAGEMENT COURSE** | | |
| Jul 12–30 | | 93-2 |
| Sep 13–Oct 1 | | 93-3 |
| **FUNDAMENTALS OF SYSTEMS ACQUISITION MANAGEMENT** | | |
| Jun 21–25 | Huntsville | 93-14R |
| Jun 28–Jul 2 | | 93-15 |
| Jul 19–23 | Huntsville | 93-16R |
| Aug 30–Sep 3 | | 93-17 |

| COURSE DATES | LOCATION | COURSE NO. |
|---|---|---|
| Aug 30–Sep 3 | Los Angeles | 93-18R |
| Aug 30–Sep 3 | Boston | 93-19R |
| **INTRODUCTION TO SOFTWARE MANAGEMENT ACQUISITION COURSE** | | |
| Jun 8–9 | St. Louis | 93-9R |
| Jul 27–28 | | 93-10 |
| Aug 17–18 | Huntsville | 93-11R |
| **MANAGEMENT OF ACQUISITION LOGISTICS COURSE** | | |
| Jun 14–18 | Boston | 93-7R |
| Jul 12–16 | | 93-8 |
| Aug 23–27 | Los Angeles | 93-9R |
| **MANAGEMENT OF SOFTWARE ACQUISITION COURSE** | | |
| May 17–21 | | 93-3 |
| Aug 2–6 | | 93-4 |
| **MULTINATIONAL PROGRAM MANAGEMENT COURSE** | | |
| Jun 14–18 | | 93-3 |
| Jul 12–16 | Bonn, Germany | 93-4R |
| **PROGRAM MANAGEMENT COURSE** | | |
| Jul 26–Dec 10 | | 93-2 |
| **SELECTED ACQUISITION REPORT COURSE** | | |
| Sep 13–17 | | 93-6 |
| **SYSTEMS ACQUISITION FOR CONTRACTING PERSONNEL COURSE** | | |
| Jun 7–18 | | 93-5 |
| Jul 12–23 | | 93-6 |
| Aug 23–Sep 3 | | 93-7 |
| **SYSTEMS ACQUISITION FUNDS MANAGEMENT COURSE** | | |
| May 10–14 | St. Louis | 93-5R |
| Jun 14–18 | | 93-6 |
| Jun 28–Jul 2 | Huntsville | 93-7R |
| Jul 12–16 | | 93-8 |
| **SYSTEMS ACQUISITION MANAGEMENT FOR GENERAL/FLAG OFFICERS COURSE** | | |
| Jun 1–4 | | 93-2 |
| **SYSTEMS ENGINEERING MANAGEMENT COURSE** | | |
| May 17–21 | | 93-9 |
| Jun 7–11 | Boston | 93-10R |
| Jul 19–23 | Huntsville | 93-11R |
| Sep 13–17 | St. Louis | 93-12R |
| **TECHNICAL MANAGERS ADVANCED WORKSHOP** | | |
| May 17–21 | | 93-3 |
| Aug 16–20 | | 93-4 |
| **TEST AND EVALUATION MANAGEMENT COURSE** | | |
| Jul 12–16 | | 93-7 |
| Sep 13–17 | Boston | 93-8R |
| **TOTAL QUALITY MANAGEMENT WORKSHOP** | | |
| May 12–13 | | 93-3 |
| Aug 4–5 | | 93-4 |

# CAREER DEVELOPMENT UPDATE

## Army Acquisition Corps Newsletter and Bulletin Board

The U.S. Army Personnel Command's (PERSCOM) Military Acquisition Management Branch has been transmitting an Army Acquisition Corps Newsletter via electronic mail for the past five months. The purpose is to inform Acquisition Corps personnel about ongoing changes. Numerous positive comments have been received from AAC personnel about newsletter content and, based on requests from the field, we have expanded the newsletter. Now, the newsletter routinely covers a wide range of subjects, including general corps information, promotion lists, promotion statistics, board convening dates and criteria, and corps certification requirements. If you are not receiving the newsletter and have an electronic mail address, you can be added to the distribution list by sending an e-mail message to MAJ Peggy Carson at PERSCOM, e-mail address CARSONP@HOFFMAN-EMH1.ARMY.MIL.

We also maintain an electronic bulletin board system (BBS) that anyone can access via modem. Copies of all previous newsletters and functional area specific information are posted to the BBS. The Military Acquisition Position List is posted by functional area and will soon show geographical location of each position. Additionally, assignment officers routinely post job openings with duty description, required grade, and location. The BBS can usually be accessed using one of three methods. (See accompanying figure.)

If you have any questions about how to execute these instructions on your particular system, contact your local Information Systems Management Office.

**BULLETIN BOARD SYSTEM ACCESS METHODS**

**OVER DDN**

- Telnet to 143.134.2.9
- Log in as "readbbs"

**USING A MODEM**

- Use the following modem settings:

| | |
|---|---|
| baud rate | 2400 |
| parity | none |
| data bits | 8 |
| stop bits | 1 |
| duplex | full |
| terminal emulation | vt 100 |

- Access the BBS at Commercial (703) 325-1900 or DNS 221-1900
- After your modem has established connection, you may have to press the "Enter" key a few times to get the login prompt
- Log is as "readbbs"

**OVER PERNET**

- Select OPENVT on your PERNET TPX menu
- Log in as "readbbs"
- To select a command, type the corresponding letter or number and press the F10 key

# AWARDS

## Army Honors Researchers For Work In Space Technologies

The Army Space Technology and Research Office (ASTRO) has recognized three researchers and an Army command for contributions in developing space technologies.

Robert H. Krieger Jr. and LTC John McMurray, both of the Army Space Command, Colorado Springs, CO, and Dr. Robert L. Norwood, National Space and Aeronautics Administration, Washington, DC, are recipients of the first individual Constant Victory Awards.

The Communications-Electronics Command, Fort Monmouth, NJ, received the group Constant Victory Award.

The Constant Victory Award recognizes individuals, groups or organizations that make extraordinary achievements which contribute directly to the ASTRO objective of developing superior space technologies to support the soldier in the conduct of Airland Operations.

Krieger was honored for his work the past three years with the development of software, procedures and processors which ensured the Army's topographical battalions, companies and detachments have access to digitized data from satellite multispectral sensors. He was also recognized for his work developing techniques to produce image maps from digitized data which was converted into tactical maps used by units during Operation Desert Storm.

McMurray, chief of the Army's Space Demonstration Program, was recognized for his contributions to the concept of image mapping which resulted in multispectral imagery to be used by commanders in support of joint operations during Desert Storm.

Norwood was credited as a principal architect of the Army space program. According to his citation, "His leadership and guidance materially enable the establishment within the Army of major portions of the Strategic Defense Initiative and the national anti-satellite program." Norwood is also credited with making possible the establishment of ASTRO and the beginning of full Army participation in national space activities.

The Space Systems Directorate of CECOM was recognized for its work in developing reliable satellite communications and devices, such as the Super High Frequency, Ground Mobile Terminals and the Ultra High Frequency Man Portable Satellite Communication Radio, which were used in Operation Desert Storm.

## Army Recognizes R&D Accomplishments

WES Commander COL Leonard Hassell and WES Director Dr. Robert Whalin hold up the Army Research and Development Organization of the Year Award presented by George Singley (right), Deputy Assistant Secretary of the Army for research and technology.

Four Army organizations were recently recognized for outstanding achievements during Fiscal Year 1991.

The U.S. Army Corps of Engineers Waterways Experiment Station (WES), Vicksburg, MS, was named the Army Research and Development Organization of the Year. WES was selected from a field of 41 other U.S. Army research organizations nationwide.

The award cited WES for support of Operations Desert Shield and Desert Storm, the development of a remote minefield detection system, research and development advances in the design of underground ammunition magazines, pioneering research on biocontrol of problem aquatic plants, and management and execution of the national Wetlands Research Program.

The Army R&D Organization of the Year Award is based on organizational effectiveness and mission impact; program, personnel, and resource management initiatives; and special accomplishments.

Recipients of R&D Excellence Awards were:

• The U.S. Army Armament Research, Development and Engineering Center (ARDEC), a leader in technologies related to electric armaments, liquid propellant gun launchers, lethal mechanisms, smart mines, and pollution prevention. Other ARDEC achievements were associated with total quality management, the Contractor Performance Certification Program for Design and Development, Surface Danger Zone methodology, and the Explosive Taggant Program.

• The U.S. Army Medical Research Institute of Chemical Defense (MRICD), the lead DOD laboratory in medical chemical defense. MRICD made significant contributions in preparing U.S. forces for the threat of chemical warfare during Operation Desert Storm; achieved developments in countermeasures against nerve agents, blister agents, blood agents and respiratory agents; and displayed excellence in program management with attention to safety and the environment.

• The Communications-Electronics Command (CECOM) Research, Development and Engineering Center (RDEC), which made technical contributions to Operations Desert Shield and Desert Storm, particularly night vision technology. The CECOM RDEC also participated in several leveraging and technology transfer accomplishments, and took management initiatives such as environmental safety management and sponsoring installation of the Automated Materiel Acquisition System at CECOM.

The R&D Excellence Awards are presented to top research and development organizations whose achievements are considered the best within the Army R&D community. Selection criteria include initiatives in personnel; program and resource management; organizational effectiveness and mission impact; and special accomplishments.

## Award Recipients Named

The following Army Acquisition Corps personnel are recent recipients of key awards. **Army Acquisition Executive Support Agency (AAESA):** 1LT John D. Henderson, Program Executive Office—Intelligence and Electronic Warfare (PEO-IEW), Army Achievement Medal (AAM); 1LT James J. Stepnowski, PEO-IEW, AAM; CPT Francisco Apontedones, PEO—Aviation, Army Commendation Medal (ARCOM); MSGT Leon M. Haynes, PEO—Aviation, Meritorious Service Medal (MSM); SGT(P) Cary L. Labonte, PEO—Aviation, ARCOM; MAJ Robert K. Griswold, PEO-Fire Support, MSM; CPT(P) James R. Machin, PEO—Fire Support, MSM; MAJ Robert S. Hoover, PEO—Armored Systems Modernization (ASM), MSM; COL Thomas D. Manula, PEO-ASM, Legion of Merit (LOM); BG Anthony C. Trifiletti, PEO-ASM, LOM; SPC Kevin Savage, HQ AAESA, ARCOM.

# Guest Editorials

***Sometime ago, the Army RD&A Bulletin staff discovered a broad-ranging collection of thought-provoking editorials written between 1969 and 1990 by Dr. Ralph A. Evans, a quality and reliability private consultant. These titillating bits of wit and wisdom were much too valuable not to pass on to our readers. Hence, with this issue of the bulletin, we begin sharing them and other editorial submissions with our readers in a new department titled "Guest Editorials." We hope you find this new feature stimulating. Although we cannot promise to publish all of your submissions, we do promise to evaluate them all.***

## WHEN YOU DON'T KNOW, SAY SO

By Ralph A. Evans
Quality and Reliability Consultant

Engineers are fed a diet of certainty from their earliest training. There are handbooks and textbooks that tell engineers exactly what the materials properties and engineering formulas are. Engineering is known as a hard science (as opposed to a soft science like sociology). Engineers are proud that they deal with facts; their whole tradition is one of being sure. The trouble is—many engineers get so they believe their own propaganda.

The truth is that there's a great deal we don't know in the engineering business, especially when we deal with new designs, new technology, or new materials. NASA spent lots of money to be surer about new things; and even they had many misfortunes, accidents and catastrophes; they had people-problems, horrible-hardware, and foolish-failures. The trouble engineers have rarely lies in the mathematical analysis of a model for a situation; rather it lies in the adequacy of the model itself and in the numbers used to evaluate the analyzed model. Good life data are hard to come by, except possibly on the average.

Safety and reliability, by their nature, often deal with rare events and with uncertainty—there's just a lot of things that aren't known. But engineers (and especially engineering managers), when pontificating on many controversial subjects, on many controversial subjects, are prone to sound as if they are positive about their statements. They speak as if they really do know what they're talking about—just leave it to us experts! They often delude themselves that they do know what they're talking about. Engineers need more training and practice in separating fact from opinion. They need to learn to distinguish between what they know for sure and what they hope is so. Then they must learn to communicate that difference to the public and to other engineers alike. (Lest this editorial be construed as anti-engineering, let it be said that non-engineers are often much worse than engineers in these matters.)

Nuclear power engineers and administrators have these same difficulties. The situation is harder for them because of the politics and adverse pressures involved. But there's still alot that's not known—so when you don't know, say so.

# YPG Opens New Weapons Accuracy Range

Yuma Proving Ground held a ribbon cutting ceremony late last year, officially opening the new Gun Position 20 Weapons Accuracy Range. Attendees included LTC William Weir, program manager, M1A1 Abrams Tank; Al Capparelli, chief of testing for the project manager for the Abrams Tank; COL Donald D. Loftis, YPG commander; Graham Stullenbarger, chief of the YPG Tank Automotive Division, and numerous others.

YPG has developed and fielded the automated tank accuracy range with the capability to collect and reduce multiple target accuracy data between rounds when firing vehicle mounted or ground mounted direct fire weapons. Although the range was designed to acquire data for trajectory analysis of large caliber, direct fire weapons, applications have been applied to vehicle and ground mounted small and medium caliber weapons (up to 40mm) with equal success.

The range design is a joint effort of MTD's Tank-Automotive, Test Technology, and Technical Test Support Divisions (TTSD) under the leadership of project engineer Cliff Haston. Systems integration of the range instrumentation, computers, and software was done by Michael Stoner (TTSD), Robert Vondell (TTSD), and Rich Gazda (Meterological Team).

Located at Gun Position 20 on the KOFA firing front, both the large caliber Tank Accuracy Range and the medium caliber range are controlled from the ballistically protected data acquisition building (Building 3443). This 14-meter square control building houses all personnel and necessary instrumentation.

All necessary instrumentation is provided to collect meteorological data, lay error, gun pointing direction, video scoring, time of flight, velocity versus range, tube pressures, muzzle velocities, action times, tube temperatures, shock, yaw, pitch, roll and data reduction. The collected data are sent to a jump analysis station where locally and Ballistic Research Laboratory developed software reduces the data for between round reports.

Utilities including power, communication, and a data network extend throughout the range. Data lines include a 50 pair cable, six bundles of fiber optics and three six pair cables to each target area. Target areas are located from 700 meters out to 3,200 meters with the potential to extend out to 17 kilometers line-of-sight.

Fixed permanent hardened target sites each provide an instrumentation shelter, transformer, meteorological tower, camera pads, and a 10-meter wide target. The variable target size and height are presently a 10-meter square target centered at the expected trajectory for several 105 and 120mm ammunition types on the large caliber range. Target size on the medium caliber range is currently 6-meters square at 500 meters and 10-meters square at 1,000 meters range.

Acoustic scoring technology is the primary data collection method. Microphone arrays are installed at each target location. Selection of a target at a different elevation during testing is accomplished from the control center by selecting


**An M-1 Abrams tank on the Kofa Firing Range at Yuma Proving Ground, AZ.**

different subsets of the total microphone array mounted on the poles. As the shock cone passes through the virtual target, each of the microphones are triggered. The first one to trigger is used to start timers for the remaining microphones.

YPG has developed a differential timing shock cone model to determine impact location. We have repeatedly and successfully measured X and Y impacts on a given plane and have errors of 0.2 percent of target size regardless of caliber or velocity of the projectile.

The shock cone model, developed by mathematician Dr. Paul R. Stallings has nine variables under consideration. They are the X and Y coordinate on a given plane, projectile speed, speed of sound, three components of the wind vector, fall angle of the projectile, and the horizontal approach angle of the projectile. The algorithm requires input of microphone locations, aimpoint location, muzzle location, speed of sound, wind speed, wind direction, fall angle of the bullet, and the differential microphone times.

An innovative approach is currently being studied to remove the human error from the system. A 16 microphone system in a cubic configuration is being studied. It is expected that all nine variables will be solved with input consisting solely of microphone times and locations. An increase in performance by an order of magnitude is expected.

This facility can support a diverse number of weapon systems (air and ground), ballistics measurement techniques, and research programs. Our goal is to provide quality firing data in near real time at a reasonable cost. These ranges have recently been used to support testing of combat vehicles firing production ammunition under development. Typically, scoring data is available for multiple target burst fire scenarios within five minutes of firing the burst. Built in quality assurance measures result in identifying and correcting problems as they occur during the project.

"This is an important step for YPG because it moves us into the complete systems testing of combat vehicles. We designed the range to get data that we have gotten before, but in only 10 percent of the time that it has taken in the past," said Graham Stullenbarger.

*The preceding article was written by Graham Stullenbarger, chief of YPG's Tank Automotive Division; Cliff Haston, a YPG mechanical engineer; and Yolanda Canales, YPG public affairs specialist.*

## NBC Mask Handbook Published

The availability of the *Worldwide NBC Mask Handbook* has been announced by the Chemical Warfare/Chemical and Biological Defense Information Analysis Center (CBIAC) in the Edgewood Research, Development and Engineering Center at Edgewood, MD. The CBIAC, a full-service DOD Information Analysis Center, was established in 1986 and serves as the DOD focal point for chemical warfare/chemical and biological defense technology.

This latest published resource is an asset to those in the NBC arena. The CBIAC has published the *Worldwide NBC Mask Handbook* by completing a worldwide survey of current NBC protective masks. The results of the survey have been compiled in a 400-page hardbound handbook. Descriptive and performance information is presented on nearly 100 current NBC masks and canisters from 22 countries, including NATO, former Warsaw Pact and neutral nonaligned nations. Detailed photographs, many in color, are available for every mask. For user convenience, the handbook contains equipment indices that are cross-referenced by country and manufacturer.

If you would like more information concerning this publication, contact Judi Shetterly at (410)676-9030 or datafax (410)676-9703.

## Electronic Industries Association Forecasts Stabilization Of DOD Budget

"The storm clouds should begin parting for defense contractors by the late-1990s," according to the *Electronic Industries Association (EIA) Ten-Year Forecast* released in San Diego, CA, recently. This authoritative annual forecast predicts the electronics market within the U.S. Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA).

"While the U.S. defense budget will continue to decline in real terms by over $80 billion from today's funding level, hardware procurement budgets for electronics are expected to remain relatively unchanged through the end of the century," says Linda Couture, chairman of the EIA Ten-Year Forecast and director of communications for Norden Systems, Norwalk, CT. "The bulk of spending reductions over the next 10 years will be made in military personnel and operations and maintenance. This means that defense contractors should see their order books begin to stabilize within the next few years," advises Couture.

The EIA study for fiscal years 1993 through 2002 identifies the political and military factors which determine DOD and NASA budgets and forecasts trends in procurement and research and development.

### Procurement Budgets Reach Bottom

EIA forecasts that the DOD budget, measured in constant FY 1993 dollars, will decline from $281 billion in 1992 to $197 billion in FY 2002. EIA predicts that defense procurement budgets will stabilize in terms of constant 1993 dollars beginning in the mid-1990s, with slight increases near the turn of the century. "As the military builds down in the wake of the Cold War, DOD will need to continue buying military equipment to replace obsolete and old systems. Our study indicates that with the 1997 budget, DOD reaches that minimum sustaining level of investment. Reducing defense spending below that level is unlikely, since to do so would mean abandoning a strong military posture—a situation which our research indicates the U.S. is not ready to accept," states Couture.

EIA forecasts that DOD science and technology funding will remain steady at about current spending levels as the Pentagon strives to maintain its technological lead. However, we will see programs currently in development transition into production with few new starts coming in behind them. The net result will be a reduction of almost $15 billion in RDT&E budgets over the next 10 years.

### Growth In Electronics

EIA forecasts that DOD will spend a total of $409 billion on electronic systems over the 10-year forecast period. "While this is still a very large marketplace, there will be changes. DOD will place a greater emphasis on commercial products and affordable systems. The defense electronics business is here to stay," says Couture.

"The winners in this forecast will be electronics contractors. Within this flat budget for defense procurement, there will be increasing purchases of electronic equipment. Production will be limited to our most advanced weapons systems and high technology will be inserted into existing equipment through modifications and upgrades. In addition, a majority of the investment made in research and development will be in electronics. As a result, suppliers of state-of-the-art electronic systems can expect modest growth in their defense marketplace," explains Couture.

### NASA Budget Growth Resumes

EIA forecasts modest real growth in the NASA budget toward the end of the decade after four years of funding reductions. Within NASA's budget there may be opportunities for new programs which will be high in electronic content.

"NASA will see its budget reduced in real terms by about eight percent over the next four years due to pressures on U.S. federal spending. However, NASA management is adjusting to these budget pressures and plans to pursue new programs that are affordable and relatively quick to accomplish. Assuming these efforts are successful, NASA should see its esteem—and its budgets—begin to rise again," explains Bob Hansen, chairman of the NASA Forecast and director of market development for Rockwell International.

EIA anticipates growth in NASA purchases of high technology electronic systems. "Smaller, more affordable exploration spacecraft will have more electronics than past programs on a cost basis. Thus, we see NASA as a promising, though smaller, market for electronics companies," says Hansen.

The EIA Ten-Year Forecast is based on statistical analyses and supported by extensive interviews with defense and aerospace experts from DOD, NASA, Congress, the Administration, "think tanks' and Wall Street. Budget forecasts are balanced against a bottom-up estimate of program costs and checked against a sophisticated numerical model of the U.S. defense budget. The resulting forecast is highly regarded by defense experts in government and industry.

*The preceding information was provided by Mark V. Rosenker, vice-president of public affairs, Electronic Industries Association. For more information concerning EIA's Ten-Year Forecast, contact Mark Rosenker at (202)457-4980 or Mary Lamb at (202)457-4943.*

## Human Factors Publication Available

Each February and August, the U.S. Army Missile Command publishes *HFAC Highlights* and distributes it to participants in the DOD Human Factors (HFAC) Standardization Program. Its purpose is to share information that will support and enhance the HFAC Program. *HFAC Highlights* informs the target audience, which consists of members, industry liaison representatives and advisors of the Tri-service Human Factors Standardization Steering Committee and other DOD and contractor personnel involved in the HFAC Standardization Program, and keeps them apprised of current actions and plans. *HFAC Highlights* is aimed at those who are conversant with the HFAC area; however, other human factors specialists might find the content useful, as well. If you are interested in receiving *HFAC Highlights*, contact Glenda Rogers at DSN 746-6980, or commercial (205)876-6980.

## AATD Fields Aviation Foot Lockers

In November 1992 the Aviation Applied Technology Directorate, Fort Eustis, VA, delivered eight Aviation Foot Lockers (AFL) to A, B, C, D, and headquarters companies of the 1-101st Aviation Regiment, Fort Campbell, KY, for field evaluation testing.

AFL is designed to increase aircraft safety, increase tool accountability, decrease tool foreign object damage, and provide quality tools. It replaces and includes elements of the Aviation Unit Maintenance (AVUM) I shop set, or the "hot dog stand."

The AFL will interface with and support maintenance actions by the Aircraft General Mechanics Tool Kit and the AVUM II shop set.

The three phase evaluation tests include a pilot operational test during an FTX at Fort Campbell; evaluation tests at the National Training Center, Fort Irwin, CA; and Phase III tests at Fort Campbell. The 1-101st is tasked with data collection.

"We want to lock in on the best of tools before we go out and buy them," said Paul Pantelis, AATD project engineer.

## TARDEC and Air Force Exchange Artificial Intelligence Technology

The U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI, last year was one of only two Army research agencies to participate in a technology exchange project involving the Artificial Intelligence Centers of Excellence within the Army, Navy and Air Force.

Representing TARDEC in the project was Coryne Rabine, an electrical engineer in the VETRONICS (vehicle electronics) Technology Center and one of only two artificial intelligence specialists at TARDEC. Rabine spent four months at Griffiss Air Force Base in Rome, NY, where she worked with AI researchers at Rome Laboratory.

The effort falls under the Federal Technology Transfer Program. This program has two objectives: first, it encourages federal laboratories and R&D centers to exchange technology among themselves. It also urges these organizations to enter into agreements with either state and local governments or industrial concerns that allow them to use technologies developed by federal agencies that might otherwise go unused.

During her four-month assignment, Rabine worked on a joint project involving Rome Lab and General Electric Aerospace to develop an Advanced Artificial Intelligence Technology Test-Bed. The test-bed is a flexible artificial intelligence tool featuring a simple interface that enables engineers to evaluate stand-alone computer programs used in artificial intelligence such as mission planners and vehicle route planners.

"The test-bed is designed to play 'what if' games," Rabine explained. "For example, you could compare two route planners by setting up a simulated mission in which planes would fly, say, from former West Germany to Czechoslovakia, and see which route planner would plan the best route. Or you could use it to evaluate software that calculates other aspects of a mission such as the ground support services needed to fly it successfully."

Rabine said one of her most important findings while at Rome Lab was that only a few modifications to the test-bed would be necessary to make it suitable for Army research. "At TARDEC," Rabine said, "we are developing a VETRONICS simulation facility, and we want to use the test-bed to integrate different artificial intelligence technologies into the VSF."

According to Rabine, TARDEC continues to work closely with Rome Lab and GE to provide TARDEC with the Advanced Artificial Intelligence Technology Test-bed, which she said should be operational by the end of the current fiscal year.

When asked to assess the value of serving in the Federal Technology Transfer program, Rabine said: "It was a rewarding experience. I made invaluable contacts in the AI community during my search for Army applications of the test-bed, and I think these will prove to be important in the long run."

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

# Central Tire Inflation May Cut O&S Costs

Army engineers have begun research to determine if integrating a central tire inflation system (CTIS) into the HMMWV (High Mobility Multipurpose Wheeled Vehicle) would reduce the vehicle's operating and support costs.

A CTIS automatically changes the area of the tire's footprint by maintaining any tire pressure that the driver selects from inside his vehicle to achieve maximum traction under various driving conditions. In the Army's CTIS-equipped M939A2 5-ton truck, for example, there are four tire-pressure options: 60 pounds for highway operation, 35 pounds for cross-country travel, 25 pounds for mobility on sand or other soft terrains, and 12 pounds for maximum traction during an emergency. The CTIS currently being designed for the HMMWV will be capable of adjusting to any tire pressure and will be accurate to 0.1 pounds per square inch.

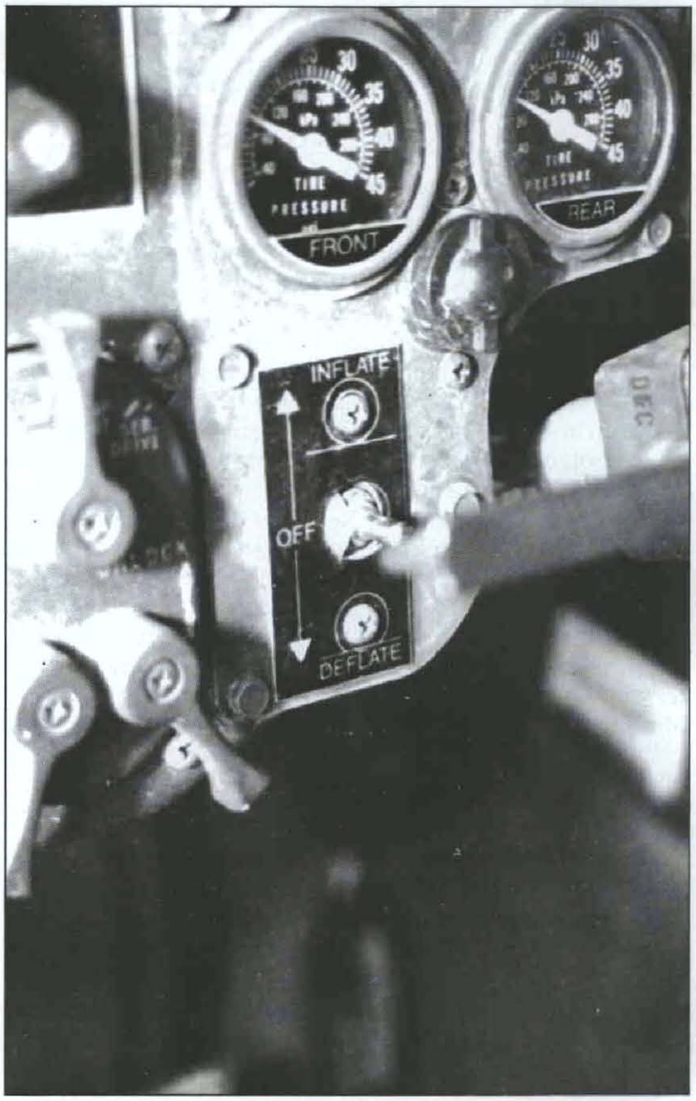
The M939A2 is the only vehicle in the inventory now equipped with a CTIS. Since its introduction in 1990, the system has proved to be an excellent mobility aid during Operation Desert Storm—its performance often exceeded user expectations. Now, engineers at the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI, hope a CTIS may reduce above-average O&S costs in HMMWVs at the U.S. Army National Training Center, Fort Irwin, CA. NTC uses the HMMWVs in military maneuvers on rocky, mountainous terrain and soft soil. This results in a large number of cracks in vehicle frames and cross members, as well as numerous failures in tires, shock absorbers and other suspension components.

In an effort to solve the problem, the U.S. Army Transportation School, Fort Eustis, VA, turned to TARDEC for help. Last June, the agency asked TARDEC to conduct an engineering analysis to compare NTC HMMWV component failure trends, maintenance records and cost data with those of other HMMWV users, and propose a plan for solving the problem. TARDEC's Albert Dunfee, who headed the analysis, said the study concluded that a side-by-side comparison test of CTIS-equipped and standard HMMWVs should be conducted to determine if a CTIS would extend suspension component life enough to offset the added cost of equipping vehicles with the system.

"The reason we think that it will save money," said Dunfee, "is because tire pressure is a critical factor directly related to the shock and vibration that a vehicle must endure. In a tire with normal pressure, about 90 percent of the shock and vibration is transferred vertically into the vehicle suspension. But when you reduce the tire pressure, the larger footprint of the tire increases defraction, which causes the shock and vibration to be translated in a more horizontal manner.

"We have an idea that the reduction in these forces would not only help the suspension components last longer, but also be beneficial for the cargo and crew," Dunfee added.

Dunfee said if the Army Transportation School approves the TARDEC-proposed evaluation plan, the tests will probably be conducted at NTC and include two groups of vehicles: one with radial-ply tires, and the other with the CTIS and radial-ply tires. He said the tests will consist of operating the vehicles side-by-side over the same types of terrain and performing the same kinds of training maneuvers. He added that the tests will cover some 20,000 miles and take up to two years to complete.




**HMMWV Dashboard showing the control panel for the Central Tire Inflation System.**

When asked whether the Army would consider upgrading its entire fleet of HMMWVs if the test results are favorable, Dunfee said, "I don't know of any plans to do all vehicles at this time. Right now, our mission objective is to deal specifically with NTC's environment. We recommend that if the Army wants to consider upgrading the entire HMMWV fleet, we should conduct tests at several other sites that would include all facets of the environment and not just rocky, mountainous terrain and soft soil."

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

## New Storage Solution Could Revolutionize Blood Banks

Letterman Army Institute of Research (LAIR) Blood Research Division researchers have developed a solution that will allow thawed frozen blood to be stored longer than its present shelf-life of 1-3 days. Now, with the human trial complete, they know the cells can be stored for 21 days.

Eight years ago the Armed Forces Blood Program decided to store several hundred thousand units of blood frozen for reserve in case of a major land war in Europe. Red blood cells can be frozen in glycerine and stored for up to 20 years. The problem has been that once the blood is thawed it must be processed and used quickly.

The system is used by the Red Cross for rare blood types and occasionally to help individuals store their own blood, but it is cumbersome and expensive. So far, large scale use of the system has not been successful.

Scientists of LAIR's Blood Research Division recognized the problem eight years ago and began work to invent a better way to handle and store the blood after thawing. Dr. Gerald Moore, who invented the new system, is proud of its simplicity.

"The solution is like normal blood storage solutions," Dr. Moore said, "but contains additional phosphate and sugar. The hardest part was all the paperwork required to get permission to conduct the testing in people," he added.

*The preceding article was written by COL John Hess, MC, chief, Blood Research Division at Letterman Army Institute of Research.*

## Center for Strategic Leadership To House Integrated Information System

The Army has awarded a $15.8 million contract to E-Systems, Garland, TX, to design and install an integrated information system for the Center for Strategic Leadership, under construction at Carlisle Barracks, PA. The information system will include visual, data and voice subsystems.

The visual information subsystem will include a briefing and display capability that can be switched to rooms throughout the 155,000 square foot facility. The visual information subsystem will also connect with the U.S. Army War College's educational television system and its videoteleconferencing facility.

The data subsystem will include several local area networks, will operate at three discrete but reconfigurable security levels, and will interface with various government command and control systems.

The voice subsystem will include a secure intercom system, a technical control facility and will house an existing remote radio equipment facility.

The schedule for installing the information system is closely linked to the construction schedule for the Center for Strategic Leadership facility, said Herman Bartlin, who is managing the project for the program manager for Army Information Systems/U.S. Army Information Systems Management Activity (AIS/ISMA). "The information system will be fitted hand-in-glove into the new structure as it is built," said Bartlin.

The information system design is scheduled for completion in early 1993, with installation of a cable system to support the voice, data and visual subsystems slated to begin at that time. When the structure is complete in October, 1993, installation of the three subsystems will start.

The system will be tested in early 1994 and will become fully operational in March 1994, in time to support Army War College wargaming exercises scheduled for that time.

## USARIEM Studies Soldiers' Heat Strain

U.S. Army Research Institute of Environmental Medicine (USARIEM) scientists and test volunteers from the Natick Human Research Platoon traveled to Fort Bliss, TX, to conduct a $P^2NBC^2$ sponsored study of soldier performance during simulated 12-mile approach marches in MOPP-0, MOPP-1, MOPP-4 clothing ensembles in August of 1991.

The physiological responses of subjects were measured as they attempted a 12-mile simulated approach march while carrying a 49-pound fighting load during both day and night conditions were studied. The study also encompassed measurements of simulated marksmanship performance in MOPP-0 and MOPP-1.

The primary purpose of the study was to collect data to evaluate and/or partially validate a USARIEM heat strain model which uses environmental conditions, soldier activities, and clothing to predict maximum safe work time, water requirements, and the optimal work-rest cycle for sustained activity based on the predicted increase in soldier core temperatures.

The model is based on a combination of "first principles" concepts and empirical relationships derived from the USARIEM database of field studies, climatic chamber studies and manikin clothing tests. Under $P^2NBC^2$ sponsorship, the basic USARIEM model has been refined into a Heat Strain Decision Aid (HSDA) for use by field units. Prior to general release, USARIEM is soliciting responses from potential users within the Army research and development community and building an independent database for model validation.

Prior to traveling to Fort Bliss, test volunteers were partially acclimated by controlled exposure to heat while treadmill walking in the Natick Environmental Test Chamber. Also measured was each subject's peak $VO^2$max, maximum heart rate and body fat content prior to traveling to Fort Bliss. At Fort Bliss an attempt was made to continue acclimation and familiarization with both day and night practice exercises, but adverse weather curtailed those efforts.

The test objective was to complete a 12-mile (6-hour) march during each of the five test sessions. Volunteers wore MOPP-0 and MOPP-1 levels of chemical protection during both day and night test sessions, as well as MOPP-4 level protection during one daytime session. Volunteers walked for 24 minutes, then stopped and participated in a marksmanship related test during their six minute rest break. Volunteers did not participate in a marksmanship tests in MOPP-4.

During the actual test runs, physiological data were collected for eight volunteers as they walked on a paved nine-mile track at 2.5 miles per hour while carrying a 49-pound fighting load. As part of his load, each volunteer carried a battery powered data-logger on the outside of his pack. The logger measured and recorded rectal temperature, surface skin temperatures and heart rate. The digital displays of rectal temperature and heart rate were checked and recorded each lap. Medical monitors and staff accompanied the volunteers at all times and observed their physiological parameters more frequently as the physiological strain increased. Water consumption was recorded and weights were taken to calculate body water loss.

An on-site meteorological station recorded air temperature between 1.5 and 6.5 feet, ground and track temperatures, black globe temperature, global and diffuse solar radiation, net radiation, relative humidity and barometric pressure. In addition, there were three WBGT monitors positioned along the track.

"Ground truth" WBGT data were collected and satellite imagery was obtained for a larger area which included the primary study site at Fort Bliss (Logan Heights) and five additional sites at McGregor range. These data will be used to develop methods which allow the integration of a heat strain model with satellite data to map zones of potential heat stress.

The investigators have summarized their methods and results in a technical report completed in September, 1992. The physiological data and on-site meteorological observations will be entered into the Soldier Performance Database.

*The preceding article was written by William R. Santee and William T. Matthew, Biophysics and Biomedical Modeling Division, Environmental Physiology and Medicine Directorate, U.S. Army Research Institute of Environmental Medicine.*

## In Memoriam

The *Army RD&A Bulletin* staff is sad to inform its readers of the Feb. 18 death of Art Reardon, former public affairs specialist at Natick RDE Center, Natick, MA. Employed at Natick since 1956, Reardon was a long-time contributing author to the bulletin, and had more than 47 years of federal service.

# CONFERENCES

## Operations Research Symposium Announced

About 300 government, academic, and industrial leaders are expected to participate in the 32nd Annual U.S. Army Operations Research Symposium (AORS XXXII), Oct. 12–14, 1993, at Fort Lee, VA. A social and registration are scheduled for the evening of Oct. 12.

"The Expanding Role of Modeling and Simulation in Military Operations Research" is the theme of this year's symposium. The purpose is to exchange information and to relate experiences on recently completed or ongoing significant Army analyses, with a view of enhancing Army analysis and exposing practitioners to a constructive critique.

Attendance is limited to invited observers and participants. Papers addressing the symposium theme are being solicited. Selected papers and presentations will be published in the proceedings.

The U.S. Army Materiel Systems Analysis Activity (AMSAA), directed by Keith A. Myers, is responsible for overall planning and conduct of AORS XXXII. For the 20th consecutive year, the U.S. Army Combined Arms Support Command and Fort Lee, commanded by LTG Samuel N. Wakefield, and the U.S. Army Logistics Management College, commanded by COL Thomas C. Wakefield, will serve as co-hosts.

Inquiries pertaining to the symposium should be directed to: Director, U.S. Army Materiel Systems Analysis Activity, ATTN: AMXSY-DA, Aberdeen Proving Ground, MD 21005-5017, or call Margie Stidman, DSN 298-3580, commercial (410) 278-3580, or Glenna Tingle, DSN 298-6576, commercial (410) 278-6576.

## Frequency Control Symposium

The 1993 IEEE (Institute of Electrical and Electronics Engineers Inc.) Symposium will be held June 2–4 in Salt Lake City, UT. This symposium is sponsored by the IEEE and the Ultrasonics, Ferroelectrics and Frequency Control Society, with the participation of personnel from the Army Research Laboratory, Fort Monmouth, NJ. Topics of discussion will include resonator processing techniques; surface acoustic wave devices; atomic and molecular frequency standards; and sensors and transducers. An exhibit area of products, equipment and information will also be featured. For additional information, write Michael Mirarchi, Synergistic Management Inc., 3100 Route 138, Wall Township, NJ 07719; or call (908) 280-2024.

# LETTERS

*The following comments are in response to a letter published in the March-April 1993 issue of Army RD&A Bulletin.*

**Dear Sergeant McNees:**

I certainly wish that an AMC-FAST Science Adviser had been stationed in Germany when you successfully designed and built a portable M1 tank engine analyzer back in 1984. I agree with you that a need exists for a briefcase sized analyzer to augment the operation of the STE/M1. You were right on track with your understanding of the need for a portable analyzer and your solution was indeed very similar to the idea given to the III Corps Science Adviser, Dr. Pat Easton, in December 1989 by two of your fellow tank maintenance NCOes. If Dr. Easton had seen your idea in 1984 he would certainly have helped you develop it into the successful product the M1 Tank Engine Analyzer is today.

The frustration you felt at having a good suggestion turned down because "there was no need" is one of the essential reasons Science Advisers are now stationed at the major troop command locations worldwide. Science Advisers have the discretion to develop ideas that have no formal requirement document, conduct troop demonstrations of the product, and help the commander's staff write an Operational Needs Statement (ONS) to start a formal requirement or accelerate one being considered by TRADOC.

To bring you up-to-date, engineers at the Harry Diamond Laboratories (now part of the Army Research Laboratory) refined the design and built a prototype briefcase sized engine analyzer to engineering specifications. Like you, the engineers at ARL are full time Department of the Army employees, so there was no outside contract or special pay for the engineers to design, build, and test the Engine Analyzer.

In late 1991, a coordinated Tank Automotive Community evaluation of the briefcase sized engine analyzer was completed and a decision was made at that time to pursue an advanced diagnostic program called the Close Combat Vehicle Integration Diagnostic (CCVID) Program. The goal of this program is to provide enhanced diagnostic capabilities for soldiers maintaining our fighting vehicles. Engine analyzer capabilities you and the ARL engineers developed and demonstrated are to be incorporated in the CCVID program.

I think it is superb that you designed and built a successful engine analyzer and am delighted that your analyzer has worked well for you during the past seven years. FAST is very interested in suggestions like yours that improve the readiness of our forces. Congratulations for your accomplishment.

**Sincerely,**
**Richard E. Franseen**
**Director, AMC-FAST**

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*Professional Bulletin of the RD&A Community*

## WRITER'S GUIDELINES

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**PURPOSE:** To instruct members of the RD&A community relative to RD&A processes, procedures, techniques and management philosophy and to disseminate other information pertinent to the professional development of the RD&A community.

**SUBJECT MATTER:** Subjects of articles may include, but may not be necessarily limited to, policy guidance, program accomplishments, state-of-the-art technology/systems developments, career management information, and management philosophy/techniques. Acronyms should be kept to an absolute minimum and when used, must be written out and explained.

**LENGTH OF ARTICLES:** Articles should be approximately 1,500 to 1,800 words in length. This equates to 8-9 double-spaced typed pages, using a 20-line page.

**PHOTOS:** Include any photographs or illustrations which complement the article. Black and white or color are acceptable. We cannot promise to use all photos or illustrations and they are normally not returned unless requested.

**BIOGRAPHICAL SKETCH:** Include a short biographical sketch of the author/s. This should include the author's educational background and current position.

**CLEARANCE:** All articles must be cleared by the author's security/OPSEC office and public affairs office prior to submission. The cover letter accompanying the article must state that these clearances have been obtained and that the article has command approval for open publication.

Authors should include their address and office phone number (DSN/autovon and commercial) when articles are submitted.

In addition to printed copy, authors should submit articles on a 5 1/4-inch floppy disk in ASCII format.

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