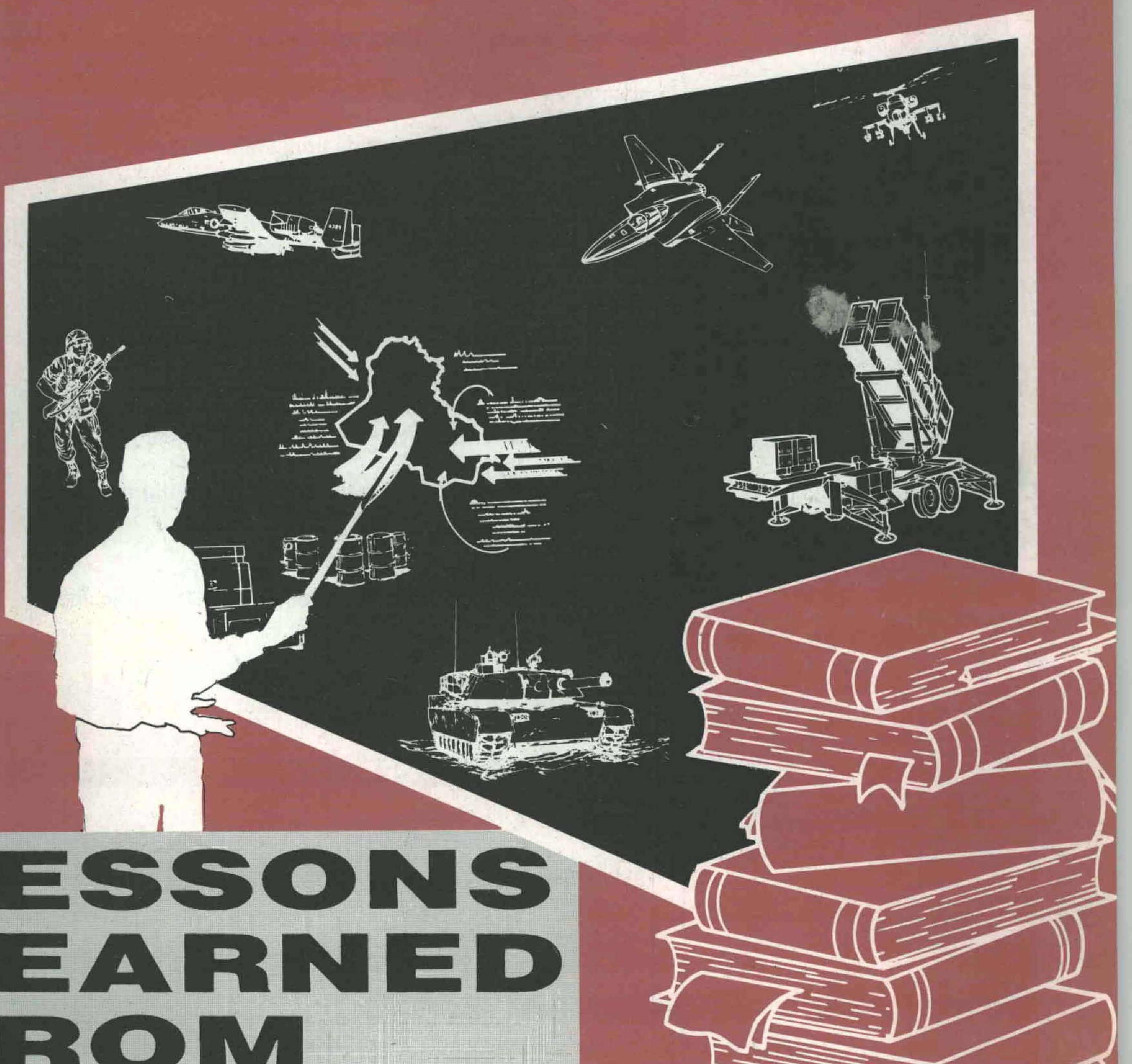
Headquarters Department of the Army
PB 70-91-6

NOVEMBER-DECEMBER 1991

ARMY RD&A BULLETIN



LESSONS LEARNED FROM THE GULF WAR

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Army RD&A Bulletin (ISSN 0892-8657) is published bimonthly by the Army Acquisition Corps Proponency Office. Articles reflect views of the authors and should not be interpreted as official opinion of the Department of the Army or any branch, command, or agency of the Army. The purpose is 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. Private subscriptions and rates are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or (202) 783-3238. Second class official postage paid at Alexandria, VA and additional offices. POSTMASTER: Send address changes to Editor, *Army RD&A Bulletin*, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001. Articles may be reprinted if credit is given to *Army RD&A Bulletin* and the author. Unless otherwise indicated, all photographs are from U.S. Army sources. Approved for public release; Distribution is unlimited.

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ARMY RD&A BULLETIN

Research Development Acquisition

Professional Bulletin of the RD&A Community

FEATURES

DEPARTMENTS

COVER

The collective expertise of a 55-member team from the Center for Strategic and International Studies has provided an in-depth analysis of the military lessons learned from the Gulf War. Cover designed by Joe Day, DOIM Graphics Section at HQ AMC.

MILITARY LESSONS LEARNED FROM THE GULF WAR

An Analysis from the Center for Strategic and International Studies

By CDT Jason T. Hoffman

Since the end of the Gulf War in March, the U.S. Military has tasked itself with assessing its performance in the war. After action reports such as these are standard procedure for the modern military. While those on Uncle Sam's payroll busied themselves with studying the war, the Center for Strategic and International Studies (CSIS), a Washington based think tank, also began looking for lessons to be learned from the conflict in the Persian Gulf. CSIS published what is perhaps the first in-depth analysis of the war conducted by a non-governmental organization.

The report, entitled *The Gulf War: Military Lessons Learned,* is the interim result of a six month long study that drew upon the collective expertise of a 55 member team, and will eventually be published as a book. The study group, headed by Jim Blackwell, Mike Mazarr and Don Snider, was composed of CSIS analysts and subject area experts from industry, government and the military. The report outlines seven major lessons that will impact future decisions regarding force structure and defense procurement.

Lesson one sets the tone for the rest of the report. In summary, it states that there are severe limitations on our ability to draw conclusions based on the Gulf War, because it was in fact a unique war:

> *All wars are unique, but this war—its enemy, its terrain, and a host of other features was even more distinctive than most. Whether any major, long-term lessons can be drawn at all from the Gulf War is in fact questionable.*

This note of caution is not meant to diminish the value of information that has been and will continue to be collected with respect to the performance of allied troops and equipment in battle. It simply means that the distinctive nature of the Gulf War places constraints on our ability to draw lessons.

The idea of the U.S. being dependent on it allies for military security is disturbing to many. However, because there is great instability in the international security system as it moves away from a condition of bipolarity, the project

Despite some changes for the better, the brunt of U.S. Defense Strategy is still inappropriately focused on countering the Soviet threat.

found that the war demonstrates, "The U.S. is both politically and logistically dependent upon its friends and allies." This dependency is the substance of the second major lesson discovered by the study group. This dependence means that, "The option of 'going it alone' simply does not exist, and all foreign and defense policy decisions must be made with this realization."

The study group found that the use of high tech weapons in war was the result of a "revolution in warfare." This revolution, it is argued, brought about a corresponding change in tactics and strategy. The study group had this to say in the report:

> *New tactics might resemble guerilla warfare writ large: smaller, agile, stealthy units stage hit-and-run raids with tanks, armored cars, artillery, and helicopters integrated with tactical air support.*

The fourth lesson of the report is one that is often obscured by the debate over weapons systems and defense acquisition. It is, quite simply, that the quality of military personnel is what matters most in any military force. The wonders of technology were celebrated on television nightly during Desert Storm, but the fact remains that these weapons are useless unless deployed in the hands of capable and well-trained people. The overall pre-combat proficiency of American military personnel in Desert Storm was higher than that of any previous war. The trouble is that such training is costly. Realistic training requires continuing allocations of resources such as time, money, and equipment.

For the four Cold War decades, the U.S. shaped its armed forces and designed its weapons systems with an eye towards the Soviet Union. Since 1989, the relationship between the superpowers has warmed significantly. The fifth lesson is that, despite some changes for the better, the brunt of U.S. defense strategy is still inappropriately focused on countering the Soviet threat. Other threats, such as Iraq, will present a different kind of challenge for the future.

The sixth lesson has to do with the theory of deterrence. The Persian Gulf crisis provided a model for studying perceptions in communications between belligerent nations. A message intended to convey deterrence may not always be perceived as intended if even received at all. Subtleties in language, culture and regional politics prevent signals from not always being received as intended from across national boundaries.

The seventh and final lesson enumerated in the report has clear implications for the future of defense related planning. As established in the first point of the report, the war in the Persian Gulf was, in many ways, very unique. It was an unforeseen conflict on a rather large scale. Other recent military operations, such as Urgent Fury in Grenada and Just Cause in Panama, were of short duration and required the deployment of distinctly different forces than Desert Storm required. Understanding the variety of missions and potential contingencies that might arise, a "balanced defense investment strategy" becomes imperative in defense decision making.

The combined weight of the lessons enumerated in the CSIS report calls for an immediate plan for adapting our nation's defense. In the coming months, decision makers in Washington will make a multitude of decisions which will lay the foundation for the U.S. military capabilities well into the twenty-first century. Recognizing this situation, the study group has synthesized a list of 10 principles to guide defense investments in the near future:

• **Place greatest emphasis on the quality of military personnel.** Although modernization in weapons technologies has always and will continue to change the nature of warfare and strategy, it is competent, well-trained servicemen and leaders that ultimately win the wars. Defense investment strategies should be shaped around this principle.

• **Logistics wins wars.** This is a lesson that has been repeatedly forgotten and relearned by countless armies throughout history. Rommel had incredible strike capabilities with his blitzkrieg tactics in the desert, but his army outran its supply trains. Without beans and bullets, they became vulnerable to allied forces. In Operation Desert Storm, the U.S. staged the largest airlift of troops and equipment in history. But it still was too little too slow. If the situation had been slightly different and Iraq had attacked the 82nd Airborne soon after deployment, the light rapid deployment forces would have served as little more than a speed bump for the then-massed Iraqi army.

• **Given U.S. political, logistical, industrial, and economic dependencies, forming international coalitions will be necessary for victory in any major contingency operation.** This discovery may disappoint those who had neo-isolationist hopes for U.S. foreign policy in the post Cold War era. This century has seen increasing connectivity among states politically, culturally and economically. Multitudes of cross-state ties have developed through innovations in communications and transportation. In Desert Storm, we relied on the help of our allies for political support through the United Nations. We were logistically dependent on them for food, supplies and fuel to keep our troops and equipment running.

• **Tactical ballistic missiles will continue to pose a significant political and military threat to U.S. interests and military forces.** Iraq's use of the primitive SCUD missile system to terrorize the Israeli and Saudi populations demonstrated the political impact that even a rudimentary missile system, employed in relatively few numbers, can have. The proliferation of nuclear weapons and ballistic missiles will pose a growing threat to U.S. interests.

• **Emphasize improvements in carrier-based aircraft.** Although carrier aircraft were used successfully in the Gulf War, they lacked the precision "smart" weapons that many Air Force aircraft were equipped with.

• **Emphasize improvements in mine countermeasures.** Ground forces were able to employ some quickly-fielded anti-mine equipment with an amazing degree of success. The Air Force used "Daisy Cutter" bombs to help to clear the way for ground forces. These efforts should continue to be developed so that they can be employed when needed in the event of another conflict. At sea, it was discovered that mines, even of the World War II vintage, were tying up terrible amounts of naval resources that could have been otherwise more strategically occupied. The U.S. Navy must develop more modern and efficient systems to detect and dispose of sea emplaced mines.

• **Maintain amphibious assault capabilities and sufficient expeditionary forces.** The Marines have long been and will continue to be essential to defense planning as an expeditionary force. The mere threat of a sea landing was enough to tie up more than 10 Iraqi divisions during Desert Storm.

> Tactical ballistic missiles will continue to pose a significant political and military threat to U.S. interests and military forces.

• **Exploit the revolution in information technology with command, control, and communications systems, integrated into a battle management architecture, interoperable throughout the theater, as one of the key military systems of the future.** The fledgling JSTARS and the time tested AWACS proved to be invaluable in the Gulf War. Used in conjunction, the systems greatly aided in providing real time data to those who needed it on the battlefield.

• **The participation of U.S. Army national guard and reserve combat units in contingency operations must be re-examined.** The combat support and combat service support units were deployed with little difficulty in enough time to allow them to provide the much needed logistical support to operations Desert Shield and Desert Storm. The plan to use "round-out" units to complement active duty combat units proved difficult to implement in the Gulf War. Units which were intended to be fleshed-out with reserve or national guard components were not called up in time to deploy with their active divisions. Those divisions instead had to be reinforced with other active duty soldiers while the "round-out" units, when finally activated, were sent off to training centers to be trained to combat standards. Desert Storm demonstrated the infeasibility of some aspects of the present reserve/national guard mobilization plan for responding to immediate, large-scale conflicts.

• **The ability to employ military space capabilities in support of theater and tactical operations proved vital in the Gulf War.** Satellites proved indispensable from the strategic level down to the lowest tactical level. Small unit leaders on the ground depended on the Global Positioning System for accurate positioning data. Intelligence generated from reconnaissance satellites gave commanders at the brigade level and higher a "God's-eye view" of the battlefield.

There are three major forces which, when combined together, will drastically change our ability to respond effectively to a potential threat to our national security or to international stability. As mentioned earlier, due to the advent of new weapons and command and control technologies, the nature of warfare has changed dramatically. Also, because of the warming between the United States and the Soviet Union, and the simultaneous rise of regional powers, the nature of the potential threat to our national security has changed as well.

Finally, because of political and economic considerations, both internationally and within our own country, our ability and willingness, as a nation, to field and finance a military force, of the scale that has been maintained for the duration of the Cold War, is no longer up to Cold War levels. These forces will indeed change our ability to ensure security, for our own nation and the international community.

JASON T. HOFFMAN is a first class cadet (senior) at the U.S. Military Academy at West Point. Cadet Hoffman spent several weeks this summer as a research analyst at the Center for Strategic and International Studies (CSIS), a Washington based think tank. He intends to be stationed overseas as a combat arms officer.

PHYSICAL SECURITY EQUIPMENT MANAGEMENT

A New Challenge for AMC

By Emmanuel J. Nidhiry
and LTC Larry J. Petcu

On Oct. 13, 1989, the assistant secretary of the Army for research, development and acquisition appointed MG Joe W. Rigby, deputy chief of staff for development, engineering, and acquisition, Army Materiel Command (AMC), as the Army executive agent for physical security equipment (PSE). This appointment brought with it a new challenge for AMC to establish a central management structure for Army PSE.

Background

During recent years, Congress developed a perception that the military services were duplicating PSE programs, resulting in unnecessary expenditures. As a result, the Department of Defense issued Directive 3224.3 which assigned specific responsibilities for PSE research, development and acquisition (RDA) to the services and the Defense Nuclear Agency (DNA). The Army was assigned responsibility for interior PSE, barriers, security lighting and command and control systems. The Navy was tasked with overseeing shipboard and waterside physical security systems, explosive detection systems and anti-compromise emergency destruct systems. Exterior PSE, aerial intrusion detection systems and entry control systems responsibilities were assigned to the Air Force. The Defense Nuclear Agency (DNA) was given responsibility for all PSE-related technology base exploratory development (6.2) work.

Beginning in 1989, Congress consolidated all PSE Research, Development, Test and Evaluation (RDT&E) funding at the DOD level. Accordingly, PSE RDT&E programs were removed from the normal review and prioritization process of the military departments and put under the direct control of the Office of the Secretary of Defense (OSD). A DOD PSE Action Group (PSEAG), chaired by an OSD staff assistant along with a number of subgroups, was formed from elements of OSD, the services and the DNA to coordinate DOD PSE RDA efforts and to disburse PSE RDT&E funds.

On Feb. 17, 1989, OSD reissued DoDD 3224.3, substantially broadening the scope of this directive. Among other things, it established a DOD PSE Steering Group (PSESG) consisting of general/flag officer-level representatives from various DOD components to provide oversight for DOD PSEAG actions. Also, DoDD 3224.3 required the military services to identify a single point of contact for PSE who would address and manage PSE programs and represent the services at the DOD PSESG. The Army responded to this direction by appointing MG Rigby as the executive agent.

Army PSE Action Group (APSEAG)

The APSEAG was established by MG Rigby in October 1989 to advise and support him in centrally coordinating and managing the Army PSE program. Mirrored after the DOD PSEAG and chaired by MG Rigby's staff, the APSEAG includes all key operational, as well as RDA, PSE activities of the Army. Primary members of the APSEAG are:

- The Security Force Protection and Law Enforcement and Nuclear Surety and Management Divisions of the Office of Deputy Chief of Staff for Operations and Plans, Headquarters, Department of the Army (HQDA);
- Office of Deputy Chief of Staff for Logistics, (HQDA);
- U.S. Army Training and Doctrine Command;
- U.S. Army Corps of Engineers;
- U.S. Army Military Police Operations Agency;
- Project Manager, Nuclear Munitions; and
- Project Manager, PSE.

Army PSE Program Thrusts

In a 1990 address at the American Defense Preparedness Association's Sixth Annual Joint Government-Industry Symposium on Security Technology, MG Rigby outlined four primary evolving thrusts for the Army PSE Program. These thrusts are:

- **Infuse emerging technologies such as artificial intelligence and robotics.** This is the key for solving our current expensive dependency on manpower to accomplish our security tasks;

• **Buy commercially-developed products.** This is a good common sense approach as our RDT&E budget shrinks.

• **Centralize acquisitions.** Again, this is a common sense strategy to realize savings and economies of scale associated with large procurements. Centralized acquisitions by our commodity commands and sister services should be the rule of the future.

• **Build moveable, transportable PSE systems.** This is a lesson learned from recent developments in Europe. We have made substantial investment there in fixed site physical security facilities. Because these facilities were not designed to be removed and transported, we will be forced to abandon many of them as we execute our force withdrawal plans.

The APSEAG has progressed on a number of actions to translate these evolving thrusts into viable Army PSE RDA efforts.

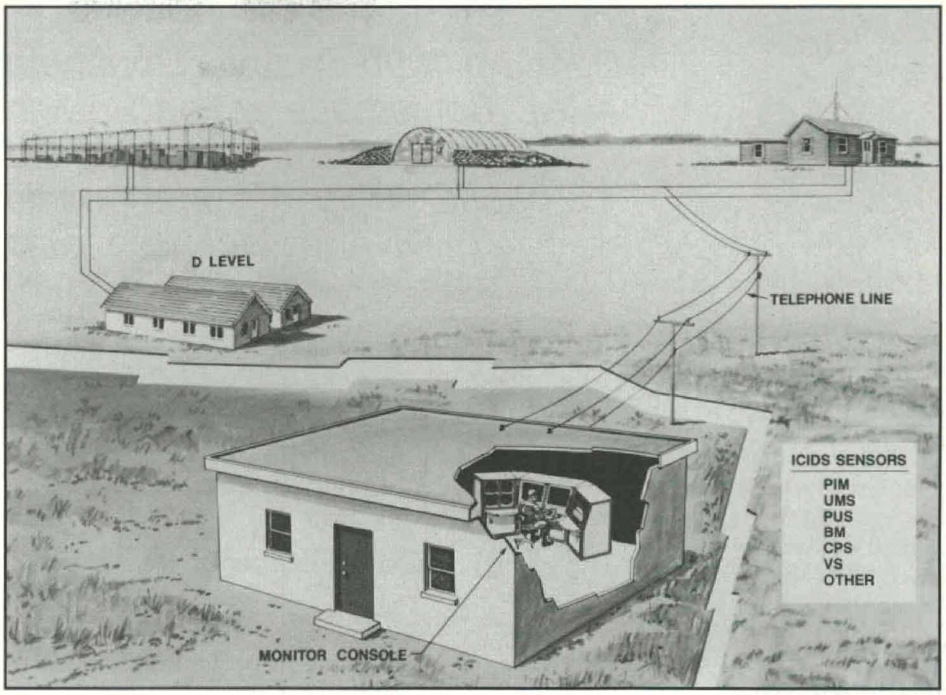

Figure 1.
Integrated Commercial Intrusion Detection System (ICIDS) Deployment in a typical Army installation.

Integrated Commercial Intrusion Detection System (ICIDS)

The ICIDS is a non-developmental item acquisition intended to meet the joint service requirements for all security applications. The program is designed to take advantage of rapid advances in the commercial state-of-the-art technology in intrusion systems. It will provide DOD installation commanders with a standardized, fully evaluated, centrally procured turnkey intrusion detection system. This system will consist of commercially available sensors, control units, assessment and entry control devices, command and control consoles and additional equipment. Components will be employed in varying quantities and configurations depending on the unique physical security requirements and operational and environmental characteristics of individual sites. Figure 1 is a representation of the ICIDS deployment in a typical Army installation.

The ICIDS contracting strategy is for a firm fixed price, indefinite delivery/indefinite quantity, competitive procurement including associated site survey validation, site specific design, installation, contractor logistic support, and training efforts. A contract award and the first unit equipped are scheduled for completion by mid-1992. The first unit equipped will be subjected to all the required technical and user testing and the remaining systems will be ordered only if the outcome of these tests are satisfactory. Substantial procurement commitment for the ICIDS has already been received from the Air Force. Also, potential ICIDS system applications have been identified by the Navy.

Mobile Detection Assessment Response System (MDARS)

MDARS will apply robotic and artificial intelligence technology to intrusion detection systems to enhance physical security. It will consist of fixed and mobile robotic sensor platforms interfaced with an intrusion detection console and will conduct the tasks of detection, assessment, intrusion delay, response and communications in interior and exterior environments. This will be achieved through the application of interoperable mobility, artificial intelligence, sensor, communications, weapon, mechanical and electronic technologies. Figure 2 is an artist's concept of MDARS deployment in a weapon storage site.

MDARS will be developed in three phases. Phase I will begin with an alarm/barrier/product assessment capability of a unit that follows a preprogrammed or tele-operated patrol path. Its primary function will be assessment. Phase II will expand these capabilities to include local human intruder detection, autonomous movement to areas in alarm, operator-controlled non-lethal response, and entry/inventory control. Phase III completes the expansion with capabilities to recognize evidence of intrusion, navigate via natural landmarks, delay intruders and respond under operator-control with lethal force as rules permit.

The fabrication and evaluation of prototype Phase I MDARS are currently underway. During 1993-95, 13 to 15 systems are planned for production and deployment.

Barrier Applications Systems (BAS) Programs

The BAS programs are envisioned to enhance the Army's nuclear weapons security and reduce manpower requirements through the use of state-of-the-art delay techniques for various conventional and non-conventional weapon storage configurations. One of

During a 1990 Security Concepts R&D Conference at Fort Belvoir, VA, the Army presented a prioritized list of 16 proposals to DNA for inclusion in its 1992-97 PSE 6.2 program.

the projects being pursued under the BAS programs is the Sticky Foam Dispensing System (SFDS). The SFDS will supplement the Weapons Access Delay System which has been the Army's primary nuclear weapons delay system since 1983. Shown in Figure 3, the basic component of this system is a commercially available product commonly called "sticky foam" which is kept in a pressurized vessel and when perforated or ruptured, either on command or by forced penetration, expands the product into a sticky foam mass 34 times the volume it occupied under pressure. Developmental efforts concentrate on new applications of this foam.

SFDS is a continuation of the DNA 6.2 effort. It was transitioned to the Army for advanced development in mid-1990; a developmental prove-out model test is scheduled in early 1992 and the eventual production of about 30 systems during 1993-94.

Tactical Force Protection

The Army's Tactical Force Protection Technology (TFPT) program seeks to enhance the protection of U.S. forces deployed worldwide, particularly in a low-intensity conflict or in rear area environments through the development and production of rapidly deployable and disbandable security equipment packages, The thrust of the TFPT program is to provide the user with a selection of ever-evolving technology in the tactical protection environment, particularly against a terrorist threat.

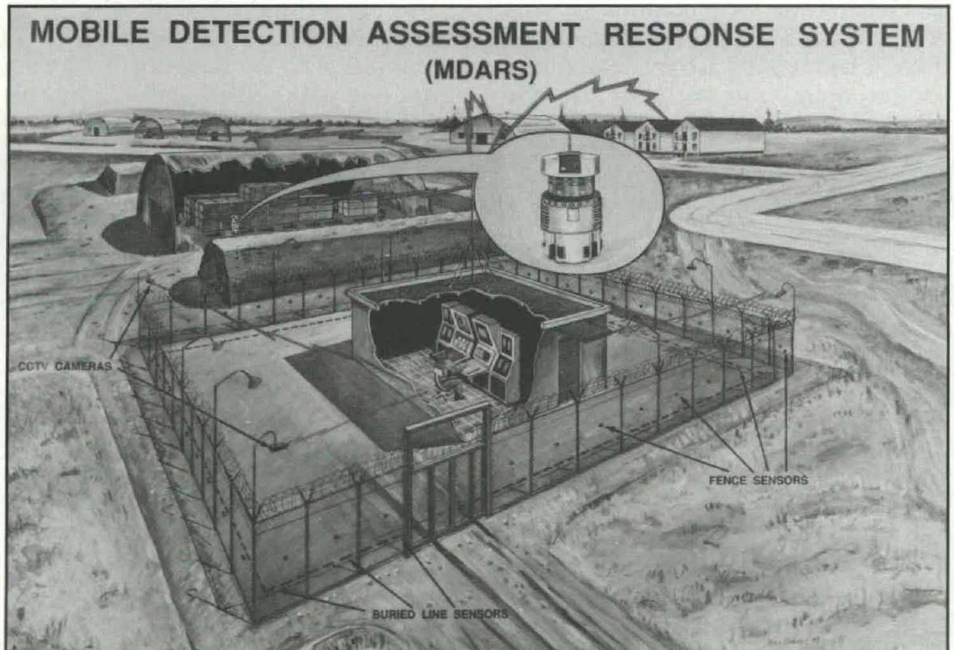

Figure 2.
An artist's concept of the Mobile Detection Assessment Response System (MDARS) deployment in a weapon storage site.

Security and Force Protection

The Security and Force Protection Enhancement Resources (SAFER) package is a Limited Procurement (Urgent) production program that evolved from the Army TFPT effort. It is an integrated system of commercial and military equipment using manpower, equipment and procedures to detect, assess, delay and respond to personnel attempting to gain unauthorized access to U.S. sites.

A typical company-size SAFER package, which takes no more than four hours to set up or tear down, includes: passive and active infrared sensors, seismic and microwave sensors, razor tape concertina sensor and barrier, light intensifying closed circuit television cameras for remote assessment, night vision devices for enhanced manual assessment, hand-held radios for secure communications, electronic call-to-arms alarm, and portable display consoles for rapid response decision making.

Initial production of the SAFER package started in August 1989. Since then, 11 company-size packages were produced and deployed worldwide, including a few in support of Operations Desert Shield and Storm. Lessons learned from these deployments are used to enhance the system as part of the SAFER pre-planned product improvement plan. The Miniature Intrusion Detection System, a component of SAFER, is a potential candidate to replace the Army standard Platoon Early Warning System that is in extensive use for platoon level tactical perimeter and rear area protection.

PSE Exploratory Development

During a 1990 Security Concepts R&D Conference at Fort Belvoir, VA, the Army presented a prioritized list of 16 proposals to DNA for inclusion in its 1992-97 PSE 6.2 program. Some of the technologies that will be investigated under these proposals are:

- the non-lethal uses of low frequency sound and/or pulsed laser systems as delay devices;
- inventory macro-anomaly recognition;
- application of presence and/or point sensing and advanced object

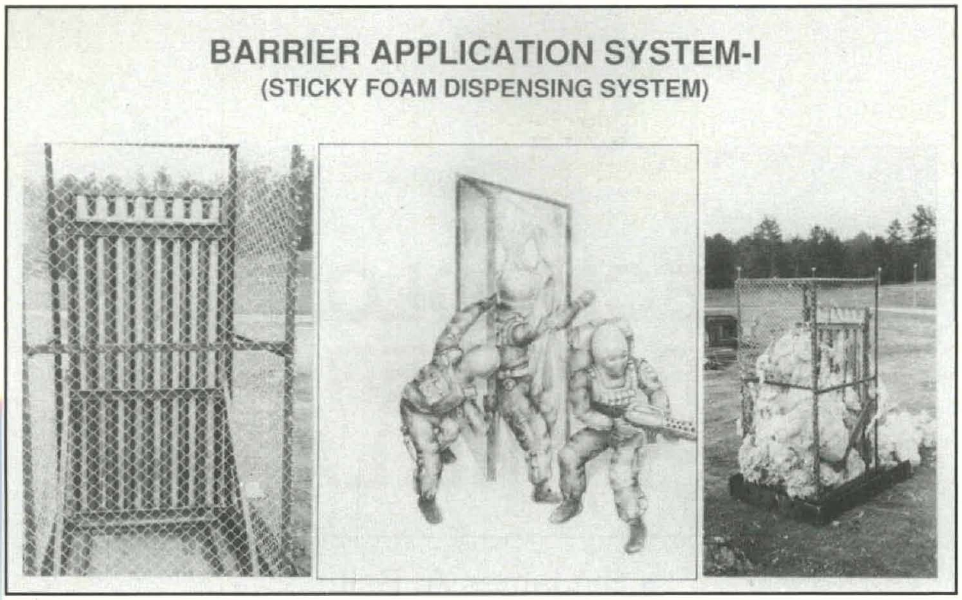

Figure 3.
The basic component of the Barrier Application System-1, "sticky foam" is a commercially available product which is kept in a pressurized vessel and can be expanded into a mass 34 times its pressurized volume.

recognition technology to identify human intruders;

- advanced tagged material detection/position locator;
- platter charge and air-intrusion countermeasure systems; and
- applications of digital signal processing, ultrasonic pulses, artificial neural network technology and cover, concealment and deception to enhance physical security, etc.

It is anticipated that these technologies, when they mature during the late 1990s or early 2000s, will remedy the present vulnerabilities of our physical security systems against ever-increasing threats.

DOD Security Operational Test Site (SOTS)

This unique facility is totally dedicated to the test and evaluation of security systems, concepts and doctrine in a realistic environment. Located in a remote 130-acre maneuver area 12 miles away from the Fort McClellan cantonment, the DOD SOTS is the only facility available for the military services to determine how well PSE can stop or delay a ground or airborne attack using real weapons and explosives against our most sensitive facilities. Initially built by DNA in 1983 to support all services, the DOD SOTS consists of:

- a complete special weapons storage facility which includes NATO standard fencing/lighting, a site security control center, a maintenance and assembly building, two earth-covered storage bunkers, a free-standing headwall for blast test, and two towers;
- an operations building for on-site administrative support personnel and staff; and
- an extensive network of underground conduit and fiber optic data link for remote data collection.

DOD SOTS is unique because of its availability of the replica of a fully-operational small nuclear storage site, and its capability to conduct live-fire testing, and the ability to close access to direct view for classified testing. In October 1985, DNA transferred DOD SOTS to the Army and, since then, it has been operated by the U.S. Army Military Police School with Training and Doctrine Command (TRADOC) oversight.

Even though the importance of DOD SOTS to the PSE RDA mission is without question, it was not immune from the effects of the ongoing budget reductions. Current fiscal realities forced TRADOC, whose primary mission does not include test and evaluation, to lower the DOD SOTS resourcing package to the bottom of their priorities. Consequently, it remained unfunded and faced potential shut down by the fall of 1991. Alarmed at this, the APSEAG sought and obtained resource commitments from DOD PSE Action Group for the continued operation of this facility. Actions are underway to transfer the oversight responsibility of the DOD SOTS from TRADOC to AMC.

Future Actions

The APSEAG plans to meet at least quarterly to build a consensus on Army PSE issues. The overall objective is to continue efforts to ensure that quality PSE is acquired and made available to the Army user, consistent with the program thrusts outlined by MG Rigby.

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LTC LARRY J. PETCU is the product manager for physical security equipment. He holds a B.S. degree from the U.S. Military Academy, and an M.S. degree in nuclear engineering from Georgia Institute of Technology. He is a member of the Army Acquisition Corps.

TECHNOLOGY TRANSFER — IT'S THE LAW

By James A. Ball

Introduction

To many in the military community, the term "technology transfer" conjures up visions of military espionage that results in American technology winding up in the hands of our adversaries. In the recent past, U.S. computer-assisted manufacturing technology has enabled the Soviet Navy to produce more silent submarine propellers. The Soviet space shuttle and front line Soviet aircraft bear a striking resemblance to our own; and the Iraqis almost got away with buying new high-tech furnaces that they intended to use to make nuclear weapon devices. But this was not the kind of technology transfer on the minds of laboratory directors and their legal and technical staff, who assembled recently in Washington, DC, for the Army's first Domestic Technology Transfer Conference. The topic of concern was how to better move technology developed in Army programs and laboratories to the commercial marketplace, thus using Army technology to benefit the American economy and enhance our international competitiveness.

For more than 10 years, the Congress has become increasingly concerned about our loss of leadership in technology areas, especially when so much of our national budget goes for R&D. Of special concern is the technology which comes from the military share of R&D (over 60 percent) which has applications to commercial products, but is perceived as difficult for the commercial sector to access.

Because of these concerns, Congress has passed several pieces of legislation to make it the mission of all federal laboratories to find ways to transfer their technologies to the private sector for commercial purposes. Principal among these laws is the Stevenson-Wydler Act of 1980, which was "beefed up" by the Federal Technology Transfer Act of 1986 and subsequent legislation. The bottom line to all of this is that technology transfer is now "the law" for federal R&D activities; not a punitive law, but rather one that will benefit the R&D community, the Army, and the nation.

Because technology transfer is now the law, the Army has moved forward to incorporate all of the many responsibilities, policies, legal implications, and procedures into a newly issued regulation (AR 70-57). The Army Domestic Technology Transfer Conference was triggered by the release of this regulation. Cliff Lanham, Army program manager for domestic technology transfer, served as the principal host. The conference objective was to provide a uniform concept of the Army's response to Congressional legislation and to review proactive Army policy on these issues.

Army Technology Transfer Policy

The first day of the conference was devoted to an overview of technology transfer policy, its legal ramifications, and the mission of Army laboratories. Army laboratory directors were exposed to a full spectrum of issues ranging from direct mission responsibilities and importance, to legal issues, requirements, and procedures.

Bruce M. Fonoroff, deputy chief of staff for technology and management, U.S. Army Materiel Command, opened the conference with welcoming comments. He emphasized the importance of technology transfer to both the Army mission as well as the national economy. Dr. Daphne Kamely, director for research and laboratory management, Office of the Assistant Secretary of the Army (Research, Development and Acquisition) delivered the keynote address. She maintained that military technological preeminence must be coupled with contributions of federally-funded science and technology to the successful commercialization of new products.

The Congressional viewpoint was provided by James Turner, staff director, Subcommittee on Technology and Competitiveness, U.S. House of Representatives. Turner discussed Congressional concerns for domestic technology transfer, and the need to implement the technology transfer statutes as a way to shield against foreign competitors commercializing federally-funded technology before American companies. According to Turner, Congress has the federal laboratories under a microscope with respect to funding vs. productivity and,

TECHNOLOGY TRANSFER IT'S THE LAW!

while support for technology transfer must come from the top levels of government, the real work lies with the laboratory personnel supported by their laboratory directors.

Dr. Loren C. Schmid, chairman of the Federal Laboratory Consortium (FLC), presented an overview of the FLC's background, functions, and mission. He stressed the importance of cooperation and networking among the Army Office of Research and Technology Applications (ORTAs) and other FLC members to promote and facilitate technology transfer.

The assistant secretary for technology policy, U.S. Department of Commerce, provided the first day luncheon address. Deborah Wince-Smith's remarks clearly focused on the challenge of improving our ability to use the assets of knowledge and technology that reside within our federal labs. She stated that if we can effectively use these assets, we will be able to maintain our national competitiveness. Her comments supported the fact that, according to recent studies by the White House and the Department of Commerce, military technologies are vitally important to the future economic growth of the nation. She stressed the concept of "concurrent utilization" of new technology in parallel applications which can help speed the commercialization process and emphasized the important role that the laboratories could have in this process.

Anthony T. Lane, intellectual property counsel of the Army, Office of the Judge Advocate General, gave an overview of new authorities and legal issues of technology transfer that reside in the Technology Transfer Act of 1986. He stressed that laboratory directors must see that ORTAs become a full-time, priority activity at each laboratory. He also said that maintaining the difficult balance between the main mission and technology transfer mission will be a major challenge for laboratory managers, but one that must be met.

The first day's formal sessions concluded with an executive overview of the job of the laboratory ORTAs. The overview provided the laboratory directors with a full view of the difficulty of the job and the need for their full support. The day concluded with Lucy Reilly, senior staff reporter for *Washington Technology* who spoke at dinner about federal laboratory technology transfer, industry and competitiveness.

New Authorities and Legal Issues

The second day of the conference focused on intellectual property and legal issues of technology transfer. Saul Elbaum, assistant command counsel for intellectual property law, U.S. Army Materiel Command, discussed *Intellectual Property and How It Is Protected.* He addressed the right to exclusivity and the stringent requirements for adequate descriptions of new technology. He also discussed the aspects of intellectual property applicable to technology transfer, including trademarks, copyrights, and patents and the distinctions among them.

The key provisions of the Technology Transfer Act of 1986 and its new authorities were explained by Earl T. Reichert, deputy division chief, Intellectual Property Law Division, Office of The Judge Advocate General. His presentation left no doubt that technology transfer responsibilities of R&D activities are well established in the law.

Troublesome issues on conflict of interest were addressed by MAJ Murray B. Baxter, intellectual property attorney, Intellectual Property Law Division, Office of the Judge Advocate General. Conflict of interest issues involved in technology transfer include participation of inventors in negotiations, structures of small corporations involving the inventors, inside information issues and dealing with technology brokers. Baxter made it clear that there were rewards for successful transfer, but the process had to be "squeaky clean."

Michael Zelenka, chief, Intellectual Property Law Division, U.S. Army Communications-Electronics Command Legal Office, spoke about Licensing, including grant requirements, export control, and infringement. His presentation touched on the problems of providing enough information to facilitate *domestic* technology transfer while inhibiting the flow of militarily critical technology offshore. This is a difficult act to balance, yet there are mechanisms in place that make this process easier than most realize.

Cooperative Research and Development Agreements or CRDAs are a major element of the new technology transfer regulation, and were discussed by Kathy A. Kurke, assistant chief counsel for research and development, U.S. Army Corps of Engineers. Kurke examined CRDAs partnerships, the purpose of CRDAs, the legislation that shaped them, and the regulations affecting them. Her presentation was followed by a panel of four government representatives who provided the audience with details of their experience with CRDAs and the knowledge gained in developing and implementing them. Closing out day two was Barry G. Beringer, Republican general counsel, Committee on Science, Space and Technology, U.S. House of Representatives, who spoke at dinner on *Changes in Copyright Law - Legal and Political Issues.* The second session clearly demonstrated the need for a close working relationship between the ORTAs managers and their legal counsel in managing technology transfer actions.

The Job of the ORTAs

The third and final day of the conference was devoted to the ORTAs managers and their difficult job of fostering technology transfer in an environment that may not initially be receptive to the task. Cliff Lanham defined the mission of ORTAs managers by exploring and examining such issues as technology identification and assessment; managing the internal laboratory process and motivating laboratory personnel; publicizing availability of new technology through outreach resources such as state, local, and professional networks; understanding the commercialization process; and providing technical assistance to entrepreneurs.

The role of state and local economic development organizations as a vital element in the technology transfer infrastructure was discussed by Dr. Walter Plosila, president, Suburban Maryland High Technology Council. State and local organizations of this type play a key role in effective two-way communication with the nation's small businesses and entrepreneurs and must be a part of any successful technology transfer program.

The conference concluded in an upbeat mode, with a summary of progress and a charge that all Army R&D personnel must make technology transfer a conscious part of their daily activities. In the past four years, the Army has accomplished nearly 100 CRDAs and has a dozen new licensing agreements on new technology with many more in process. The new laws and regulations will most surely contribute to successful technology transfers; creating new products and processes, royalties to inventors and laboratories, and a positive impact on jobs and economic growth.

New Priorities

As the dust settles from Desert Storm, new priorities are emerging for America and one of the sectors most affected could be military R&D. The linkages between military R&D and the commercial sector needs are well established. A recent White House report on critical technology has made it clear that military strength clearly depends on the health of the nation's commercial industries, and that competitiveness and national security are intertwined through their mutual need for "dual use" technologies.

At no time in the past has it been any more propitious to turn our national attention to maintaining a strong technology base in the interest of national security as well as national economic strength. A major factor in this effort is the leverage of technology from military laboratories to commercial applications, and that is what the Army Domestic Technology Transfer program is all about. Technology transfer—it's not only the law, it's the future.

JAMES A. BALL is the senior program manager for technology development with Systems Engineering and Management Associates, Inc. A retired Air Force colonel, with bachelor's and master's degrees in aerospace and mechanical engineering, he has extensive experience in R&D and technology transfer. He is the former director of technology applications for the Strategic Defense Initiative Organization.

ETDL INVENTOR RECEIVES $10,000 FROM PATENT FEES

By Carol A. Widmaier

The Army and its inventors are starting to reap rewards as a result of the 1986 Technology Transfer Act. A government inventor recently received a check for $10,000 as his portion of initial licensing fees paid for his invention under the act. The subject invention, a "Dual Mode Quartz Thermometric Sensing Device," is expected to generate substantial royalties for the inventor, Stanley Schodowski, and the Electronics Technology and Devices Laboratory (ETDL), U.S. Army Laboratory Command, with licenses being held by three major corporations and four small businesses.

Schodowski's invention provides more than an order of magnitude improvement in frequency stability that is crucial for low-power, high accuracy timekeeping and frequency control applications. It has wide-ranging commercial applications such as in communications (satellite, cellular phones and pagers); navigation (Global Positioning System); telecommunications (digital), and highly accurate digital thermometers. Schodowski was also selected for the New Jersey Inventor of the Year Award and inducted into the New Jersey Inventor Hall of Fame for the invention of his dual mode sensor.

Under the guidelines of the Technology Transfer Act, as implemented by the Department of Defense (DOD), an inventor receives 20 percent of licensing fees and royalties, up to the sum of $100,000 annually, with the laboratory where the invention was conceived receiving the remainder. Licensing income is used to further the laboratory's technology transfer program and to reward top scientists and engineers.

Government scientists and engineers who generate patents related to their work assign the rights to their patents over to the government. Prior to the Technology Transfer Act, the only remuneration received was $100.00 upon invention disclosure and $300.00 upon patent issuance. Today, these fees have increased to $300.00 and $500.00 respectively. Potentially millions of dollars in patent royalties and fees were lost by the government and its inventors prior to the act.

ETDL is in the process of negotiating patent license agreements for the Planar Doped Barrier (PDB) Semiconductor Device which could provide licensing fees and royalties income to the inventor and to the laboratory. This device, a major advance in solid-state device technology, was invented at ETDL by Roger J. Malik, a former ETDL employee. It was modeled and fabricated in ETDL's molecular beam epitaxy and fabrication facility and has led to several new solid-state devices for millimeter-wave radar and communication components and systems.

ETDL has been aggressively marketing its patents, and under the direction of Richard Stern, ETDL's technology transfer and small business manager, has developed and implemented a variety of marketing plans including advertisement in the *Federal Register* and direct mail. As a result, the laboratory has received $36,000 in licensing fees to date, and is negotiating several additional licenses.

ETDL has taken the lead in implementing the Technology Transfer Act and related guidance. This high technology research and development government laboratory is responsible for the development of 85 percent of the electronics in the U.S. Army's military systems. ETDL is one of seven laboratories of the U.S. Army Laboratory Command, Adelphi, MD., and is located at Fort Monmouth, NJ.

Under the dynamic leadership of Dr. C. G. Thornton, the laboratory director, this outstanding Army laboratory has set the pace for technology transfer,

Protecting Your Invention

In today's fast paced technology race, it is more important than ever for scientists and engineers to maintain good laboratory notebooks, document their results, and file invention disclosures. This should all be followed by a patent application, and publication within "one year."

When an inventor wants to protect his invention, whether for a new process, machine, manufacture or composition of matter or to improve an old device or process, he is granted a utility patent. If a scientist or engineer believes he has a patentable item, he should immediately prepare an invention disclosure form and meet with a government patent attorney. The attorney reviews the documentation, helps search for prior patents, and advises if the invention should be forwarded to the Invention Evaluation Committee.

The next step is preparation of a patent application which the attorney files with the U.S. Patent and Trademark Office. From the date of the application, there is a "patent pending." However, this provides no protection. When the Patent Office issues a patent, then and only then, is the invention protected. The patent application must be filed within one year of the first public disclosure (publication or presentation), sale or offer for sale of the invention. This procedure is unlike that used in Japan or Europe where public disclosure is an immediate statutory bar with no grace period.

There are many reasons for inventors to protect their inventions, including credibility, potential financial gain, peer respect, and personal recognition. It also protects the government from law suits for infringement and generates income for our government laboratories.

One has only to follow the Texas Instruments (TI) court fights over patent infringement to see how important filing disclosure can be. According to their newsletter *TekBriefs*, TI would be showing huge losses if not for patent royalties they are collecting from Japanese and American companies.

due partly to a cultural change and its "open laboratories program" that has created a complementary environment for innovation.

ETDL's "open laboratories program" strongly encourages academic and industrial personnel to engage in on-site cooperative efforts with ETDL scientists and engineers at ETDL's Technology Centers of Excellence. Up to 150 students, professors and other scientists and engineers from academia and industry work part-time for the laboratory on projects of mutual interest. The laboratory, which has 170 scientists and engineers on staff, and produces between 35 to 55 patents annually, (this is 20 percent of the patents produced by the total Army), has successfully negotiated eight patent licenses to date.

The laboratory holds significant patents in the following technology areas: magnetics, ferrite devices, crystal oscillators, optical switches, nanoelectronics, batteries, displays, millimeter-wave photonics, surface acoustic wave (SAW) devices, and infrared (IR) detectors.

The laboratory, in concert with other government laboratories and agencies, expects to continue to develop technological seed patents and transition 30 to 50 new electron devices and military technologies each year into developmental systems.

ETDL has been recognized nationally for its initiative and leadership role in technology transfer as well as by the Federal Laboratory Consortium (FLC) and DOD. ETDL's Richard Stern was selected as the 1991 FLC representative of the year from over 700 competing government laboratories, and has testified before the House Subcommittee on Science and Technology on ETDL's innovative technology transfer techniques. ETDL was also cited in a Secretary of Commerce Report to the president and Congress for its implementation of the Technology Transfer Act.

ETDL has also been successful in effecting Cooperative Research Development Agreements with industry (CRDAs) and has legally negotiated 12 CRDAs to date, with several more pending. CRDAs are a new and innovative method of operation. Participants are able to leverage their manpower, facilities and financial resources by working together as a team to solve common technological problems. The government, industry and academia all benefit as the technology base grows and the technology is more effectively and efficiently transferred to the commercial sector. Many of the CRDAs are targeted at small businesses.

The U.S. Government took a major step toward helping the U.S. regain its technical leadership position and the respect of the world-wide scientific community with passage of the Stevenson-Wydler Technology Innovation Act of 1980, the follow-on Technology Transfer Act of 1986 and the related executive order. These sweeping changes were necessary to meet the ever increasing, competitive global market, and to improve the economic, environmental and social well-being of the United States.

The Technology Transfer Act encourages cooperative efforts among academia, industry and federal laboratories. Included under this umbrella are Cooperative Research and Development Agreements, and the licensing of government-owned inventions through patent licensing agreements.

According to Anthony T. Lane, Intellectual Property Council of the Army, "The number of inventions from federal laboratories has increased by 68 percent (since the Technology Transfer Act) with 3,619 disclosures in FY90 alone."

The act has created a WIN-WIN situation for both the government laboratories and its patent holders.

CAROL A. WIDMAIER is an information specialist with the U.S. Army Electronics Technology and Devices Laboratory where she heads up the Plans, Publications and Presentations Branch of the Tech Plans and Programs Office. She holds a degree in communications and is currently pursuing an advanced degree in journalism.

ENVIRONMENTAL CLEAN-UP OF EXPLOSIVES CONTAMINATED SOILS

By LTC Larry A. Sparks
and MAJ Craig A. Myler

Background

The U.S. Army is now actively pursuing ways to clean up explosives-contaminated soils in an effort to preclude any adverse impact on the environment. Past solutions for the treatment of contaminated water from explosive processing operations did not address the problem of contaminating underground aquifers, which are underground reservoirs of water used for drinking purposes. Production plants, load, assemble, and pack facilities and washout operations discharged explosives-laden waste streams to lagoons and settling basins, which contributed to current contamination problems. Over time, explosives accumulated in these waste pits and eventually migrated into the groundwater. Only recently has the Army discovered the problems caused by these lagoons and settling basins.

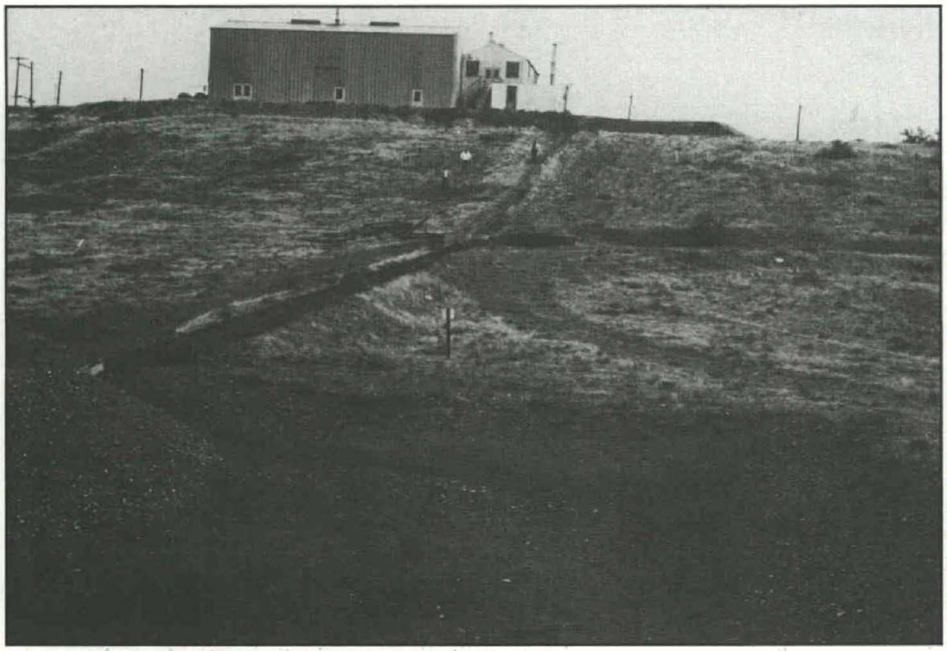

Figure 1.

Umatilla Depot Activity Explosives Washout Facility and Explosives-Contaminated Lagoons.

A major concern in accomplishing the Army's clean-up mission is the cost of remediating the soil contamination at such sites. While incineration of the explosives-contaminated soils has been proven effective, it is also costly and not always readily acceptable to the public. One alternative to incineration of contaminated soils is composting, which offers a potentially cheaper, more acceptable method of clean-up.

The concept for composting explosives-contaminated soils started as a project to investigate treatment of off-specification manufactured explosives. Studies sponsored by the Army in the mid-1970s demonstrated the ability to treat the explosives TNT, RDX and HMX. In the early 1980s, after identifying a need to treat explosives-contaminated soil, the U.S Army Toxic and Hazardous Materials Agency (USATHAMA), located at Aberdeen Proving Ground, MD, initiated research into ways to accomplish soil remediation. Immediately, incineration was developed as a way to treat contaminated soil. Other technologies were reviewed, but composting was selected to undergo continued testing, based largely on the work done with pure explosives.

Bench scale studies conducted in test tubes and flasks were followed by pilot-scale composting performed in large tanks. Success at the pilot-scale prompted a demonstration test of the technology. During demonstration testing, three percent soil by volume was mixed with horse manure, wood chips and horse feed then allowed to compost in static piles. Explosive degradation was extensive and toxicological testing of the finished product indicated it was safe to replace on the land. The demonstration was successful as a proof-of-principle, but design of a full scale implementation required additional operating information.

Site Selection

To acquire this information, an optimization study was developed. The objective of the study was to establish operating parameters for a remedial action using composting to treat explosives-contaminated soils. Since explosives-contaminated sites are not restricted to a particular climate, the optimization study had to reflect operations under severe climatic conditions to establish the operability of systems at any location. Umatilla Depot Activity (UMDA) in Hermiston, OR, was the site selected for the study.

In the 1960s, a facility for recovering explosives from unserviceable munitions was operated at UMDA (Figure 1). Steam was used to melt explosives out of munition bodies, and upon cooling, the explosives were substantially recovered for reuse or for sale. Large quantities of water were used in this operation and when contacted with the explosives, the water became contaminated. The contaminated water was discharged into two settling basins. Explosives contained in these waters consisted of TNT, RDX and HMX. Contamination levels currently approach 10 percent in some areas of the two settling basins. Explosives have migrated 50 feet downward to the water table and pose a potential threat to the environment. The site was placed on the EPA's National Priorities List in 1987.

UMDA experiences temperatures between 115 degrees and -25 degrees Fahrenheit, has an average annual rainfall of 9 inches, and is subject to very high winds. These conditions are most detrimental, because composting requires biologically generated heat and high moisture at all times. Unprotected compost piles are subject to dispersion by wind. The optimization had to account for this harsh climate.

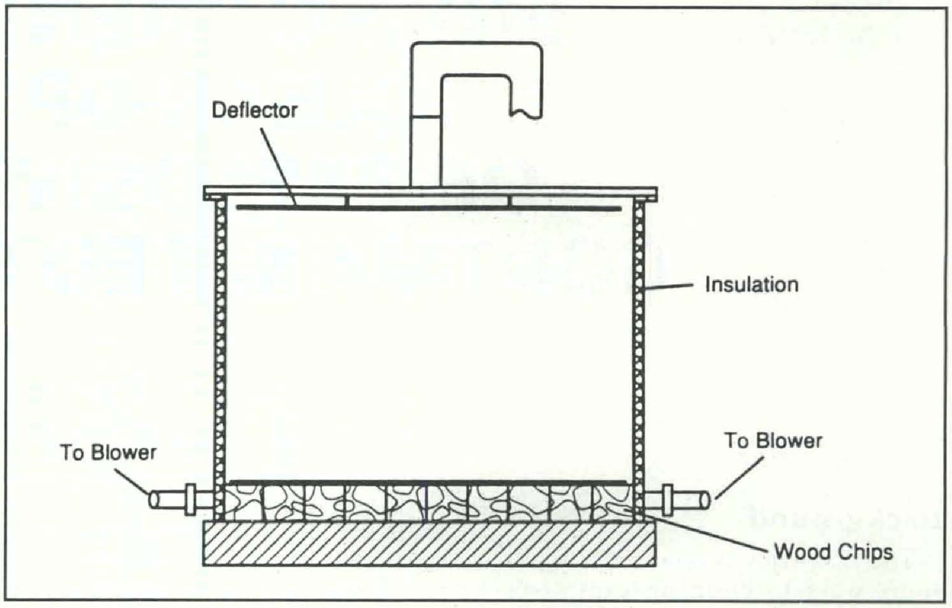

Figure 2.
Schematic of Aerated Static Pile Reactor.

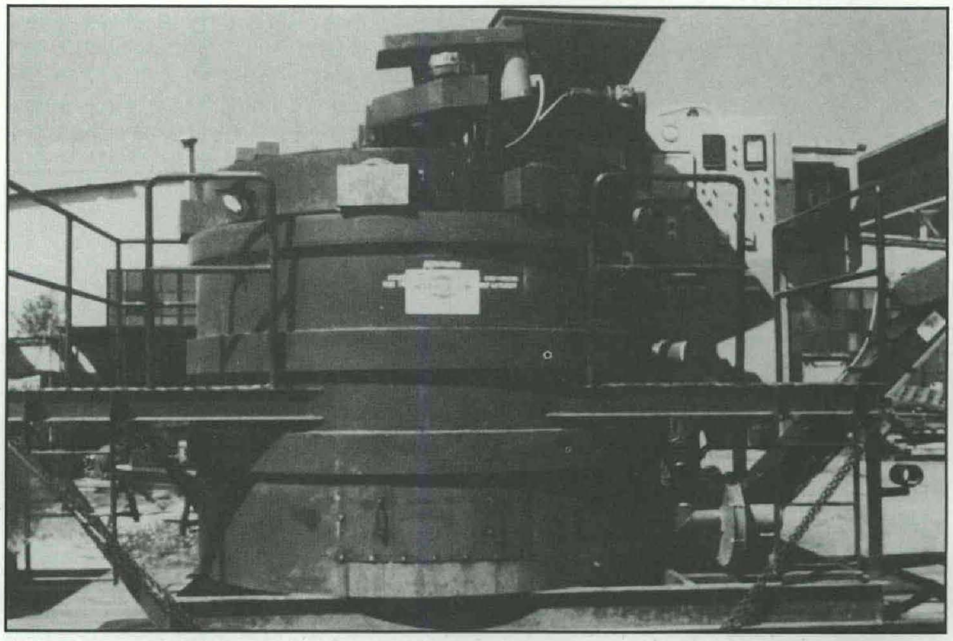

Figure 3.
Pilot Scale Mechanical Composter.

Optimization Study

To conduct testing, the parameters to be studied had to be selected. Cost analysis demonstrated that the two most significant parameters for composting explosives contaminated soil were the rate at which explosives were metabilized and the amount of contaminated soil in the compost mixture. Initial tests were designed to establish operating limits for these two parameters as well as to obtain operating data pertinent to full scale design.

Since bench scale testing could not be directly applied to full-scale operations and full-scale testing was cost prohibitive, a pilot scale test was selected.

Two separate types of composting were used to investigate a broad range of conditions. Aerated static piles were used to determine the maximum possible soil loading. The simple design of static piles allowed multiple systems to be operated concurrently (Figure 2). To conduct kinetic rate optimization studies, a specially fabricated mechanical composter was acquired (Figure 3). Composts containing up to 40 percent soil by volume were used to determine the rate of explosives degradation, the temperature profiles within each system, the moisture content, pH, oxygen level and water consumption.

A computer-based data acquisition and control system was used to regulate the reactions in each of the eight compost systems. The computer automatically sampled temperature, oxygen, and moisture levels and recorded the data electronically. A schematic of the computer control system is shown in Figure 4.

Implementing the Technology

Results from the optimization study at UMDA are being used to develop a design for full scale remediation at UMDA. Half lives of less than 10 days in the well-mixed systems indicate economic viability at the 20 percent soil loading. Other environmental factors such as moisture and temperature control are still being evaluated but pose no special difficulty in designing a full scale treatment system for UMDA.

The decision to use composting for full scale remediation is expected in 1991. This implementation will be the first full-scale application of biotechnology for the treatment of explosives contaminated soils.

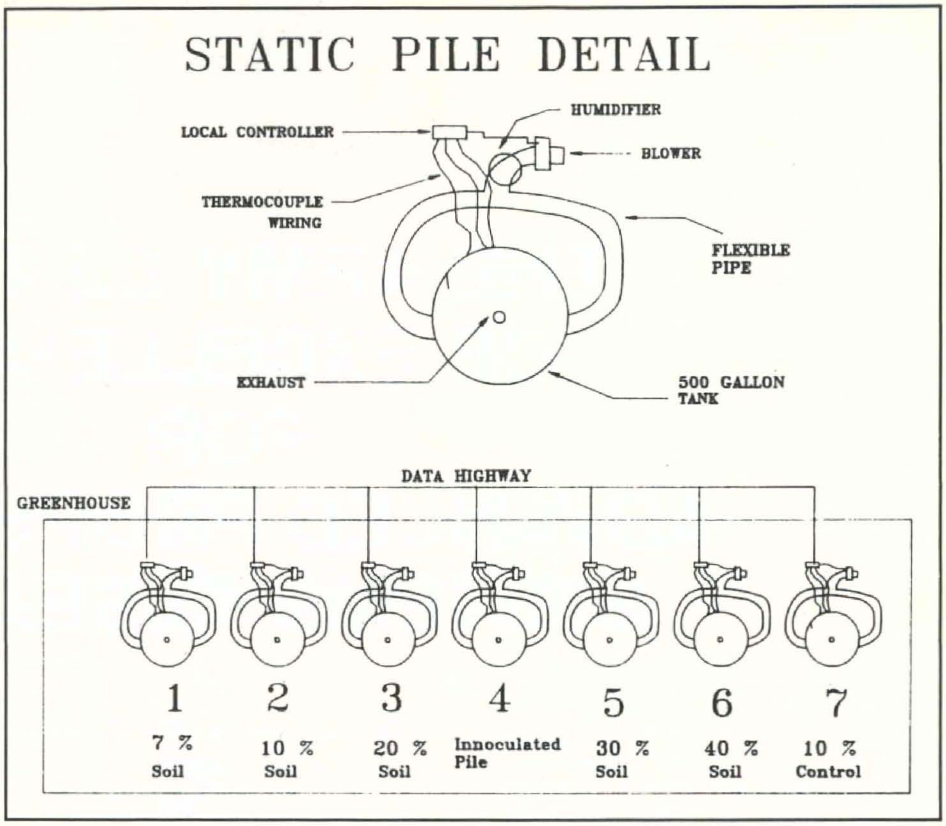

Figure 4.

Composting Optimization Study Static Pile Computer Data Acquisition and Control System.

Conclusion

Results indicate that composting can be a cost effective alternative to incineration for remediation of explosives-contaminated soils, even under the harshest conditions. Estimates of Army-owned explosives contaminated sites indicate the potential for several million tons of contaminated soil requiring treatment. In addition to treating explosives-contaminated soils, the Army is prompting increased development by the private sector in using composting as a means to treat hazardous wastes. Composting of explosives is one program which maintains the Army as a leader in environmental action through improved technology while reducing the burden on installation restoration resources.

LTC LARRY A. SPARKS is the commander of Umatilla Depot Activity in Hermiston, OR. He holds a bachelor's degree in chemistry from Ohio University and a master's degree in logistics management from the Florida Institute of Technology. He is a resident graduate of the Command and General Staff College.

MAJ CRAIG A. MYLER is a chemical engineer and recently worked in the Research and Technology Development Branch of the U.S. Army Toxic and Hazardous Materials Agency at Aberdeen Proving Ground, MD. He is currently assigned to the chemistry department, U.S. Army Military Academy, West Point, NY. He has a bachelor's degree in chemistry from the Virginia Military Institute and master's and doctorate degrees in chemical engineering from the University of Pittsburgh. MAJ Myler is a member of the Army Acquisition Corps.

THE ARMY CENTER OF EXCELLENCE FOR ADVANCED PROPULSION SYSTEMS RESEARCH

By Dr. Gary Borman, Dr. Phil Myers and Dr. David Mann

Introduction

The Army has hundreds of thousands of vehicles driven by diesel engines. In addition, there are approximately 150,000 generator sets, some diesel and some gasoline. Gasoline is being replaced by diesel because, in the European theater, all Army engines must be capable of using JP-8 as a fuel.

Tactical vehicles use commercial diesel engines but combat vehicle engines are typically developed for a special application. Engine power density is a major factor in vehicle design, especially for combat vehicles. Furthermore, in combat, the ability of an engine to use any available fuel is a desirable attribute. Thus, the availability of compact, high power density, fuel efficient and fuel tolerant engines, both on commercial and on a specialized basis, is crucial to the Army.

In order to provide the basic information needed to develop such engines, as well as to provide trained manpower for industrial and Army laboratories, the Army decided to establish a center for advanced propulsion systems research. One of the Army centers supported by the DOD University Research Initiative, The Center of Excellence for Advanced Propulsion Systems was, after national competition, established at the University of Wisconsin-Madison in 1986.

The center at Madison is a continuation and consequence of engine research at Wisconsin which has been ongoing since construction of the Mechanical Engineering Building in the 1930s. Prior to World War II, Professors G.C. Wilson and R.A. Rose pioneered work on pressure pickups and diesel fuel additives to reduce ignition delay.

During World War II, Phil Myers in the Department of Mechanical Engineering and Otto Uyehara in the Department of Chemical Engineering developed instrumentation capable of measuring the rapidly varying combustion temperatures in diesel engines.

During the two decades following World War II, research on engines was conducted by a total of some 100 graduate students in a "temporary" building, T-25. In 1969, the research moved to expanded facilities in the newly-constructed Engineering Research Building. These are the facilities used by the center. In 1964 Gary Borman, the director of the Engine Research Center (ERC), joined the faculty. Today, 13 faculty members and their associated 35 to 40 graduate students participate in the ERC.

With core funding provided by the Army Center of Excellence, the ERC has grown through the continuation and expansion of many of the research projects under way at the time the center was established. Funding for these efforts has come from other Army and government agencies. General Motors, Chevron, Mercury Marine, Intevep S.A. Venezuela, Komatsu, Chung Chen Institute of Technology, KIA Motors, and Outboard Marine have provided partial support typically in the form of student stipends or fellowships. Cummins, Ford, General Motors and Navistar have donated equipment. Cray Research and the San Diego Super Computer Center have supplied valuable computer time.

Program Objectives

To help meet Army needs, the center has three primary objectives. The first is to develop and systematize information on basic processes that occur in engines so this information can be used during engine design to rapidly produce more compact power systems. Obtaining this basic information on engine processes is difficult because the phenomena being studied cover wide ranges of pressure and temperature, occur in milliseconds, and are encased in thick, high-pressure containers (engine cylinders) penetrated only by the various mechanisms essential for engine operation. Because of these factors, lasers and optical diagnostics, essential to obtaining needed experimental information, require special techniques when applied to practical engines. At the same time, the development of super computers permits more sophisticated simulation programs which, when modified and validated

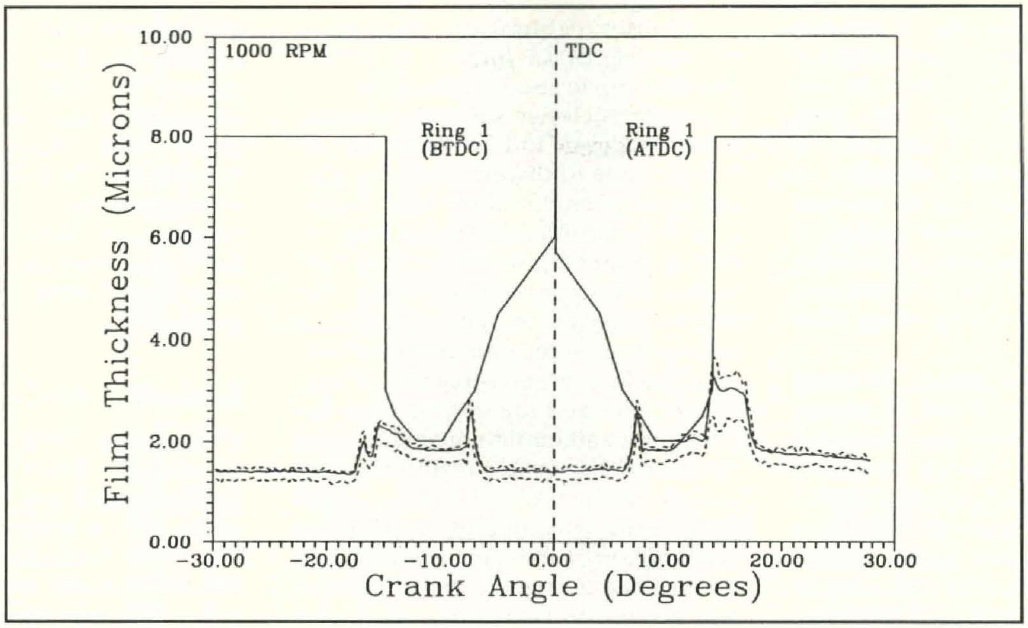

Figure 1.
Oil Film Thickness for Ring 1 Near Top Center. The upper solid line represents the ring-wall clearance. The lower traces are measured film thickness: The solid line is the average of 20 cycles, while broken lines are maximum and minimum values.

by experimental data, should help to speed up the engine design process.

The second objective is to provide trained employees, knowledgeable about engines, for government, industry and universities. There is evidence that the most effective transfer of technology from university research labs occurs through the employment of graduates, trained in the latest approaches and techniques, by government and industry. Army laboratories must have personnel who understand the strengths and weaknesses of new design tools and the way they can be used to obtain more compact power systems for Army vehicles. Industry must have knowledgeable personnel to use, during the engine design process, new diagnostic instruments, and sophisticated simulation codes.

The third objective is to ensure the availability, when needed, of a reservoir of persons who can advise and assist the Army in making judgmental decisions regarding future engines and vehicles. This is achieved through the exposure of the center faculty to the performance demands of Army engines and the exposure of Army personnel to the latest tools and findings in engine research. Through the combination of such exposure, plus the basic research projects, the center's faculty expands its expertise and becomes a valuable resource for consultation on Army problems.

Developing Basic Information

Research projects conducted by the center cover such diverse topics as in-cylinder modeling, engine combustion, fuels and emissions, in-cylinder and heat exchanger heat transfer, spray dynamics, lubrication, materials, and design. Results of this research are available to the general technical public through professional society presentations and publications, through special workshops at Madison, and through visits to Army labs. Since it is impossible to describe all of these projects in detail, only two projects, cold starting and cylinder lubrication, are discussed to illustrate center activities.

Cold Starting. Engines in Army vehicles are required to operate under arctic as well as desert conditions. Diesel engines are difficult to start at low temperatures when it becomes hard to reach the high in-cylinder temperatures and pressures necessary for autoignition of the fuel during cranking. Special starting kits, which are bulky, are currently fitted to diesel engines to assure starting at temperatures below -10 C. Any approach that can lower the unaided starting temperature, and reduce the need for the starting kits, would be of great benefit. Consequently, the ERC has conducted analytical studies of cold starting in an attempt to determine the controlling factors during cold start. Two different analytical approaches were used. The first was thermodynamic cycle analysis and the second was three dimensional, multiphase, computational fluid dynamics (CFD) calculations of in-cylinder gas and fuel spray properties during and following fuel injection.

Four different strategies to reach higher peak, mass-averaged cylinder temperatures were studied. These were: heating of coolant to increase intake manifold and cylinder metal temperature; increased cranking speed; inlet air heating; and using the "filling" process to produce higher gas temperature at the start of compression. A combination of the last three items seemed to be the most effective approach.

The most significant finding of the study was that low fuel vaporization rates seem to be responsible for the failure to achieve starting. However, the contribution of normal changes in fuel volatility to fuel vapor concentration is small. The study confirmed that fuel mass reaches the crevice regions during cold starting, adding to the fuel amount in the chamber for successive cycles. Also, the high blow-by at low cranking speeds reduces the peak temperature of the cycle and removes fuel from the combustion chamber. An important future task is to use the modeling to improve understanding of experimental cold starting data (being obtained at Wayne State University under TACOM and ARO sponsorship).

Cylinder Lubrication. Cylinder friction accounts for about 40 percent of total engine friction. Low heat rejection engines, which are of interest to the Army because of potential reductions in power system volume, have higher cylinder wall temperatures which decrease the viscosity and increase the consumption of the lubricant. Oil control is of increasing interest in meeting low particulate exhaust emission standards. Thus, understanding cylinder lubrication phenomena is of design interest for both commercial and combat vehicle engines.

Two different studies of lubrication were conducted at the ERC. The first study measured oil film thickness at top ring reversal location using three 0.64mm diameter capacitance probes. The probes were separated by 120 degrees. The study also measured heat transfer using three surface thermocouples located adjacent to the capacitance probes. A later study used a 50 micron fiber optic to guide laser light through the liner to the oil film. The laser light caused the oil to fluoresce at a different wavelength than the laser with an intensity related to the volume of oil fluorescing. Thus, the intensity of the light returning through the fiber is a measure of the oil film thickness.

The capacitance probes showed differences in thickness and variation of thickness of the oil film at the three different locations. The oil film thickness was unexpectedly insensitive to normal changes in oil viscosity, cylinder pressure and engine rpm. However, there was a considerable change in film thickness over a single cycle, with the oil film thickness much larger on the exhaust stroke than the compression stroke. This may provide a source of high oil-generated emissions.

Static tests using the oil fluorescence technique showed that temperature and additive packages affect fluorescence. This indicates a need for an in-cylinder calibration. The fluorescence signal was linear with oil film thickness up to about 40 microns. The engine tests clearly show the passage of the ring pack and, in many cases, it was possible to discern both the profile and movement of the ring. Figure 1 shows experimental data for ring 1 in the top center region under fired conditions. The upper solid line shows the ring-wall separation. The lower traces show the measured film thickness with the solid line representing the average of 20 cycles and the dashed lines the maximum and minimum values. Note that in the top center region the ring still covers the probe. The ring profile appears distorted because it is shown as a function of crankangle, not of time or distance along the ring, and the velocity of the ring varies. Also note that the bottom profile of the ring appears in the top center region while the top profile appears at earlier and later crankangles.

Analyzing only the data repeated from cycle to cycle, the trends observed on a motored engine with the head removed did not follow trends predicted by theory. The trends with speed followed theory in the fired engine, but other data showed abnormal behavior. The unique data obtained in this study will guide the development of reliable models for the analysis of engine lubrication, leading to improved engine reliability and durability.

Providing Trained Personnel

Center support for training of graduate students came in the form of research assistantships and a separate graduate fellowship program. Both have been essential in recruiting and training students. The graduate fellowship program was especially helpful in recruiting top U.S. Ph.D. candidate students for the program by providing a competitive stipend with a three year guarantee of support.

To date, 19 master's degree (four of these continued on at Wisconsin towards the Ph.D. degree) and 17 Ph.D. degree students have graduated from the program. Twenty-five of these 36 students have gone to industry, one to government, and two to academic research.

Via short visits, the faculty has increased considerably its understanding of the demands placed on Army engines. In addition, Army personnel exposed to center research have increased their understanding of advanced instrumentation and simulation programs and how the results might be used to improve Army engines. A joint program with researchers at TACOM has been instituted to obtain two-dimensional maps of piston surface temperature.

Technical Assistance

When the Army makes decisions regarding new research, new developments, new engines, new programs, etc., it is extremely helpful to have input from persons who understand both Army needs and potential future engine developments. The center's program has helped to develop persons to fill this need. Center faculty members have made approximately 40 trips to Army laboratories in connection with this. They have also participated in the Board on Army Science and Technology and Strategic Technologies for the Army study and served the Navy, NASA and DOE in a similar capacity.

Summary

The Army Center of Excellence for Advanced Propulsion Systems has provided an infusion of personnel and equipment to solve basic engine system problems. The center has achieved this through training and the transfer of information on engine research to engine designers and manufacturers. The Army, the engine industry and the educational system have all benefitted through the resulting increase in understanding between Army personnel and center faculty.

DR. GARY BORMAN is the director of the Engine Research Center.

DR. PHIL MYERS is the assistant director of the Engine Research Center.

DR. DAVID MANN, who is with the Army Research Office, is technical monitor for the Center of Excellence for Advanced Propulsion.

IMPLEMENTING THE IN-PLANT QUALITY EVALUATION PROCESS

By CPT William J. Belknap

According to the Secretary of Defense's *Defense Management Report* to the President, July 1989, "a series of major studies since the Packard Commission have documented an alarming erosion in the U.S. defense industrial base, including: a decline in the total number of defense suppliers; accelerating import penetration and growing dependency on foreign sources for vital components and subassemblies; and decreasing returns on fixed assets, declining capital investments, and lagging productivity in key defense sectors." These trends over the long term will significantly affect our national security readiness. To combat this situation, commanders in the Defense Logistics Agency (DLA) decided to adopt Total Quality Management (TQM).

TQM principles include stimulating innovation and reducing variation of processes in the defense industry. The government quality section's new system to promote these changes is In-Plant Quality Evaluation (IQUE).

Defense industrialists, DLA senior executives, and military officers with procurement specialties will have an interest in the implementation of IQUE.

Beginning in January 1990, senior officials at the DLA directed the initiation of classes to train personnel on the procedures of this new system. To what degree have the Quality Assurance Representatives (QARs) at a Defense Plant Representative Office (DPRO) implemented IQUE and is the government achieving its objectives? This article includes a retrospective analysis of whether the goals of IQUE are materializing. Also, there is a discussion on the events that preceded IQUE implementation (old system), the DPRO missions, a discussion of IQUE foundations, and an analysis of factors associated with the implementation of IQUE. These factors include contractor and DPRO teamwork, openness, flexibilities of the DPRO, resistance to change, job security, and quality section tools.

Old System

To ensure that DOD funds of more than seven hundred billion dollars were effectively spent, the government previously used Contractor Quality Assurance Program (CQAP) methods. These methods focused on the standard American industry principles of production and discipline. Specific instruments used by the government were product inspection at rigid intervals, emphasis on telling the contractor how to conduct processes, and actions in a policeman's role.

Looking at the success of Japanese industry, the DLA understood that the old way of administering defense contracts was not conducive to promoting internationally competitive organizations nor the principles of TQM. Before discussing what has changed, it is helpful to describe briefly the missions and structure of the DPRO.

DPRO Missions

The DPRO is collocated with the contractor. Its major missions are ensuring that the contractor ships only quality products to the government, monitoring contractor performance to facilitate efficient operations, overseeing compliance with contract terms, and providing the best possible support to the program managers and procuring activities.

The DPRO includes a contract section, a quality section and an engineer section. IQUE implementation is the responsibility of the quality section. What follows is a synopsis of IQUE foundations.

IQUE Foundations

The foundations of IQUE are congruent with the major principles of TQM. Two of the most important are using statistical analysis to determine if processes are in control (a process is in control when, after statistical sampling, it conforms to the upper and lower control limits as agreed upon by the contractor and the government) and encouraging continuous improvement. The QAR achieves these goals through several methods. They include proofing contractor processes, conducting product audits, performing data collection and analysis, and completing corrective action requests (CAR) and continuous improvement opportunities (CIO).

Proofing the adequacy of the process

includes determining how well the contractor blends inputs (people, machines, tooling, materials and methods) to achieve the desired outcome or product.

Periodically, the QAR conducts product audits and performs detailed data analysis to ensure that the processes are still in control. This is done by various data collection means and then using statistical analysis for confirmation. Processes that are not in control are remedied by informing the contractor through corrective action requests. In addition, if any procedures can be improved, then the QAR submits a CIO to the contractor. These actions form the basis for IQUE.

Greater motivation in supporting the tenets of IQUE and Improved Productivity would result from assuring the QARs that they have job security.

Contractor and DPRO Teamwork

The goals of IQUE implementation are customer satisfaction, continuous process improvement, improved product quality, and reduced overall costs. Primary vehicles to achieve these goals are teamwork between the government and the contractor, flexibilities within contract administration, and the knowledge of whether processes are in control. This knowledge requires an openness by the contractor in providing information for analysis to the government, trusting that the government will not use the information in a negative way.

As Rosabeth E. Kanter, a professor at the Harvard Business School, purports in the *Change Masters*, both organizations to achieve TQM goals must "reduce rancorous conflict and isolation between (them); and create mechanisms for exchange of information and new ideas across organizational boundaries; and ensure that multiple perspectives will be taken into account in decisions; and provide coherence and direction." What occurs is similarity of focus by both of the organizations. And, unit energies are not solely directed to protecting self interests. Instead, resources are more efficiently used to improve joint quality goals. Besides improved quality, cost reduction is a major goal.

Statistical Process Control

To reduce costs in a product, there must be less time spent on reworking failed or flawed processes (thus reducing labor costs), more efficient use of materials (thus requiring the contractor to purchase less), and devoting more time to improving the product (thus making the contractor more competitive and offering competitive prices).

With statistical process control procedures, the government and contractor can jointly discover what is causing variations in the process and then seek ways to reduce the variations. These situations demand openness between both parties. Previously, the QAR was responsible for identifying non-conforming materials and products and ensuring they were not delivered to the government. The contractor was on his own to correct the deficiencies. Now, with the advent of IQUE, the QAR is part of the solution.

During a discussion with a software specialist at a major defense contractor, he stated "under the new system I can inform the QAR of many more of my problems and know he will assist in improving the process."

Although the contractor is still responsible for the end product, the QAR will facilitate correcting deficiencies and exhibit more patience before elevating the deficiencies to senior level management.

Another indicator of openness occurs with the transfer of information to the government. Data from some automated machines is fed directly into government offices. The government can now receive information on the performance of the machines the same time that company managers receive it. Two examples of this exist in a contractor's plant in the northeastern United States. These two machines record data on thousands of processes and express the data on yield charts. One machine alone is responsible for producing over 5,000 antennae elements for the Patriot Radar System. With this information, the QAR spends less time inspecting end products because the machine conducts an inspection and sends the information to government terminals automatically.

Flexibility

This openness leads directly into the subject of flexibility. Gone are the rigid schedules of inspection. Now, the QAR only conducts a product audit if a process is not in control. This again saves

Use of continuous improvement opportunities directly translates into conforming with one of the major tenets of IQUE—continuously improving processes and saving money.

the contractor labor hours because he now spends little time preparing for inspections. Fewer labor hours result in a less expensive price. Likewise, more capital can be spent on automation such as with an automatic inspection machine. This programmable machine inspects printed circuit boards at a rate 10 times greater than what a human could accomplish. The machine is almost infallible. Process variation is reduced and a higher quality product is produced because there is less variation between individual commodities. Furthermore, because rework is minimized, the products are produced at a lower cost. Simultaneously, the government is kept informed on the status of the process.

Resistance to Change

A factor hindering IQUE implementation is resistance to change from experienced QARs. QARs are still held accountable for the acceptance of the commodity. Some have relied on the inspection process for over 20 years. They know there will still be some (although minimal) variation in the products. The IQUE initiative has only been on-going for 20 months. Adapting to cultural changes requires time. Thus, it will probably take several years for these cultural barriers to breakdown. Job security is another issue affecting implementation.

Job Security

Some QARs believe they are contributing to the demise of their job. Other than the already-in-place tenure system, there has been little said about job security or promotions. This hinders the full implementation of IQUE. As Kanter explained, "When everything is highly uncertain . . . it is difficult to invest in or to believe in change, or even to stop worrying long enough to have the extra energy it requires." More information from DLA senior officials on job security would assist in this change process.

Greater motivation in supporting the tenets of IQUE and improved productivity would result from assuring the QARs that they have job security.

QAR Tools

Another significant facet of the implementation is the tools the QAR uses to induce the contractor to increase innovation and productivity. These are corrective action requests (CARs), and continuous improvement opportunities (CIOs). The QAR uses CARs to motivate the contractor to keep processes under control. With a CAR, the contractor must indicate what action he will take to correct a deficiency.

Many contractor actions were to inspect more. These "solutions" however, were incongruent with TQM principles. Now when this occurs the government requires the contractor to identify what changes will occur to improve the flawed processes. This helps shift the contractor's focus from conducting more inspections to achieving controlled processes with minimal variations.

Another tool is the continuous improvement opportunity, whereby the contractor is notified of an opportunity to improve a process. The QAR forwards it to the manager involved and to the plant manager. CIOs are not mandatory—the contractor may choose to adopt or disregard these suggestions. The government works more as a team member to improve the efficiency of the processes, not as a policeman diverting valuable time from the contractor. Use of continuous improvement opportunities directly translates into conforming with one of the major tenets of IQUE-continuously improving processes and saving money.

Conclusion

Most Quality Assurance Representatives fully support the tasks associated with the adoption of the program. There is much evidence to suggest that the new system of IQUE is motivating contractor results. These results include improving contractor processes, reducing costs, developing teamwork between the government and contractor and developing flexibilities allowing the QAR to conduct product audits when necessary. There are still some challenges to overcome. These include more education, defining more succinctly what comprises a successful program and what needs to be improved, and providing greater job security.

With the successful outcome of these challenges the reduction of variation and continuous improvement will proceed at an even greater rate.

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CHEMICAL WEAPONS TREATY VERIFICATION

By Richard W. Hutchinson,
Robert E. Lentz,
and Stephen L. English

Introduction

In 1984, Vice President Bush introduced a draft Chemical Weapons Convention (CWC) to the 40-nation Conference on Disarmament. This U.S. proposal supported a verifiable worldwide ban on the use, stockpiling and production of chemical weapons (CW). This document served as a baseline from which subsequent versions of the CWC draft text have evolved. Negotiations continue to finalize the draft text. More recently, the U.S. entered bilateral negotiations with the USR. In June 1990, the countries signed an agreement calling for the cessation of production and the destruction of existing stockpiles to a 5,000-ton residual ceiling.

Verification is a key U.S. concern for both the CWC and the U.S.-USSR bilateral agreements. U.S. negotiators need to know how and to what extent the CWC and bilateral agreements can be verified in order to produce CW agreements favorable to U.S. interests. The U.S. Army Chemical Research, Development and Engineering Center (CRDEC) has the technical lead within the Department of Army for CW treaty verification R&D, and is executing a major portion of the DOD CW treaty verification program. The Defense Nuclear Agency (DNA) is the executive agent for the overall DOD program.

This article presents a discussion of the CW verification problem, the R&D program addressing the problem, and preliminary findings.

CW Verification Problem

The parameters of CWC verification have two main components: the first is the verification requirements and aims of the CWC, and the second is the technical and physical constraints within which those requirements must be applied. This article is limited to technical aspects, recognizing that political and national security considerations do and will have a major impact on the verification procedures ultimately implemented.

The CWC requires the destruction of existing CW stockpiles and production facilities over a 10 year period, and prohibits CW developments, production, acquisition, stockpiling, assistance to others, and use. The CWC will establish a technical secretariat with a staff of international inspectors to perform verification inspections.

The CWC identifies three schedules of chemicals and assigns different control, reporting and verification measures to each schedule. Schedule 1 chemicals include known CW agents, related compounds, binary agent components, and two toxins, ricin and saxitoxin. It permits production of one metric ton per year of Schedule 1 agents to support CW defense, medical, and other non-CW research. Schedule 2 chemicals are precursors for producing Schedule 1 agents. A majority of these are also produced commercially for purposes not associated with CW. Schedule 3 chemicals are industrial chemicals such as phosgene that might be used for CW purposes. These are called "dual use" chemicals.

The CWC provides for verification activities for 10 situations or "scenarios" to ensure that the overall objectives are met. (Table 1). The first five verification scenarios in Table 1 deal with declared CW facilities and stockpiles. The CWC requires that signatory nations declare their CW stockpiles and production facilities. The worldwide number of such facilities is thought to be less than 100.

Thus, the scope of the verification problem for declared CW facilities is bounded by the relatively small number of facilities.

Verification of permitted Schedule 1 CW agent production is also limited in scope because each country can have only one declared facility that produces up to one metric ton per year of agent. These quantities of agent are not considered militarily significant.

Verification of the declared commercial production of Schedule 2 CW precursors and Schedule 3 dual-use chemicals must consider hundreds of commercial chemical plants operating within the U.S. and possible thousands operating worldwide. The CWC provides for periodic inspection of Schedule 2 facilities and an annual production declaration for Schedule 3 producers. Since the production of Schedule 2 and 3 chemicals is allowed, the thrust of verification is to detect diversion of these chemicals into CW through records review. However, the ease with which records can be falsified is a critically limiting factor in considering how effectively these scenarios can be verified.

Scenario 9 involves the use of challenge inspections which investigate possible noncompliance at "suspect sites." Here lies the most difficult verification problem of the CWC. Signatures of CW activities are very limited and a CW munition often looks identical to a high explosive round. A CW stockpile could be hidden underground or placed in a warehouse presenting no external signature. Chemical process equipment required to produce CW agents is not unique and is found in many commercial chemical production facilities. A CW production facility could be hidden within many of the world's 10,000 commercial chemical plants and not be apparent from a plant tour. How can CW activities, i.e., "suspect sites," be identified within such a broad universe of potential sites?

Consensus is that the technical secretariat will have limited assets to conduct challenge inspections at suspect sites. Furthermore, it seems unlikely that it will have the ability to identify suspect sites. Therefore, national intelligence assets will need to be used to detect possible cheating and focus challenges on suspect sites. Upon request, the technical secretariat would then use challenge inspections to investigate whether cheating has occurred.

This last step is not straight forward. There is evidence that a CW agent production facility could be cleaned up and switched to a legitimate commercial product within 12 hours. Traces of CW agents, intermediates, or degradation products may not be detectable

TABLE 1

VERIFICATION SCENARIOS

I.	Elimination of Existing CW Stocks and Production Facilities.	
	Scenario 1.	CW Stockpile Declaration
	Scenario 2.	Movement of CW Stocks to Destruction Facility
	Scenario 3.	Destruction of CW Stocks
	Scenario 4.	CW Production Facility Declaration and Closure
	Scenario 5.	Destruction (Conversion) of CW Production Facility
II.	CW Related Activities Not Prohibited by Treaty	
	Scenario 6.	Production of (<1000 kg) Schedule 1 (CW Substances)
	Scenario 7.	Production of Schedule 2 Materials (CW Precursor Substances)
	Scenario 8.	Production of Schedule 3 Materials (Dual Use Chemicals)
III.	Fact Finding Missions	
	Scenario 9.	Challenge of Facilities and/or Stocks
	Scenario 10.	Challenge or Investigation of Use

after several days. Conversely, a 1,000-ton CW stockpile could be moved within 2-3 days. Thus, the ability to confirm cheating is dependent on the speed with which challenge inspections can be conducted.

A goal of the CWC verification R&D program underway within DOD is to evaluate verification procedures and equipment that could realistically be employed by the technical secretariat given the realities of the CW verification problem discussed above. Some of the effort applies to the problem of identifying suspect sites, but that objective is being addressed within the intelligence community and is not further discussed here.

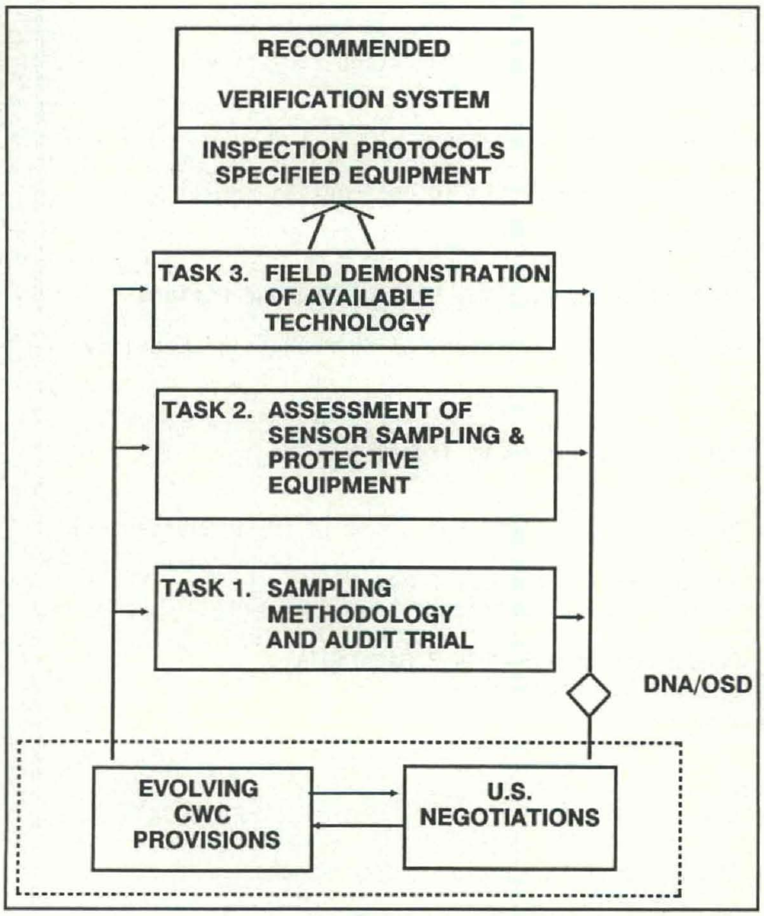
Treaty Verification R&D Program

The overall structure of the CRDEC effort is depicted in Figure 1. The foundation of the program is the provisions of the CWC draft text which serve as requirements for CW verification. Results from the program are provided through DNA and the Office of the Secretary of Defense to the U.S. negotiators. This dynamic feed-back loop provides technical assessments to the CWC negotiators and verification requirements to the R&D program.

Because of the difficulty and scope of the CW verification problem, CRDEC requested assistance from a wide array of U.S. research organizations. Five Department of Energy National Laboratories are participating in field testing and other specialized areas. The U.S. Army Medical Research Institute of Infectious Disease is working on toxin analysts and Dugway Proving Ground is assisting in field testing. In addition, EAI Corporation is assisting CRDEC with data integration, field testing and equipment surveys.

Existing sampling equipment, methods, and draft protocols are being evaluated for on-site and off-site sample analysis, and a shipping container for chemical samples is being fabricated for possible use by CWC international inspectors. Evaluation of configurations and detailed requirements for international and national laboratories to support the CWC are also underway. These tasks, taken together, will evolve into recommendations on a sampling and analytical system needed to implement the CWC.

Figure 1
Program Structure



An international market survey is being conducted to identify off-the-shelf equipment appropriate for inspections under the CWC. The equipment selected for evaluation includes chemical sensors, physical measuring devices, physical protective equipment, tags and seals, monitoring devices, and medical support kits. For practical use, these are being integrated into air-transportable systems.

The third task, field demonstration of available technology, provides the opportunity to field test verification procedures, equipment and systems under Tasks 1 and 2. Verification concepts are developed for each verification scenario, and are based on the CWC draft text. A project team then takes the concepts to a model U.S. site, a CW stockpile for example, and conducts a baseline survey to refine the verification concepts. The survey results are used to prepare a first order estimate of verification effectiveness, cost and intrusiveness for a range of verification concepts.

The equipment selected from market surveys is then tested in an equipment field trial at a model U.S. site to determine its suitability. The recommended equipment from this field test is integrated into air-transportable verification modules and tested as a total system in a system field demonstration. National trial inspections (NTIs) are conducted by the Arms Control and Disarmament Agency (ACDA) to exercise U.S. policy in areas such as the diplomatic procedures for entering country, provision of escorts, and translators, etc., in addition to inspection procedures and equipment. The CRDEC has played a key role in the four U.S. NTIs conducted to date. This iterative testing process will provide fully demonstrated verification systems and procedures for each verification scenario.

Preliminary Findings

Preliminary verification concepts were identified for each of the 10 scenarios. The concepts provide a range in effectiveness, intrusiveness

SITUATION	INITIAL DECLARATION	LONG TERM SECURITY
Verification Aim	Confirm accuracy of declaration	Ensure no undetected removal
Operational Concept	100% stack count Sample boxes/containers Sample agent (100 items) On-site analysis Non-destructive Test Physical measurement	Re-inventory 50%/6 mo. Spot sample agent
Cost*	1.2 Million	1.4-2.0 Million

* Five Year Cost

Figure 2.
Recommended Verification System for CW Stockpile.

and cost in order to provide flexibility to U.S. negotiators as they develop treaty provisions.

Preliminary verification concepts were taken to Tooele Army Depot, a major U.S. CW stockpile site, and refined with the input of site personnel and observations. The refined operational concepts were evaluated for effectiveness, intrusiveness and cost. These three factors were balanced and a recommended verification system was proposed (Figure 2). The recommended approach is the lowest cost option that achieves a reasonable effectiveness in meeting verification aims and a moderate level of intrusiveness to site operations and security.

Findings from the Tooele baseline survey were used to evaluate the provisions of the CWC draft text. At the detail level, a number of the current CWC provisions were found to require possible modification. These findings were provided to the Office of the Secretary of Defense in a timely manner for use in CWC and bilateral negotiations. To date, baseline surveys are completed on Scenarios 1 through 8. Equipment field trials are underway.

Conclusion

Verifying the CWC is a daunting challenge. The unbounded number of potential cheating sites and lack of unique signatures precludes absolute verification of compliance. A rational fall-back position is to use verification as a deterrence to cheating by creating some risk that a cheating state party would be caught. To achieve this objective the verification measures must be credible and practical — they must have a reasonable effectiveness at an obtainable cost and acceptable level of intrusiveness.

Based on program progress to date, the extent to which the CWC can be verified could be estimated within a year. This information will provide a technical basis for the very difficult policy decisions that lie ahead in reaching a final Chemical Weapons Convention.

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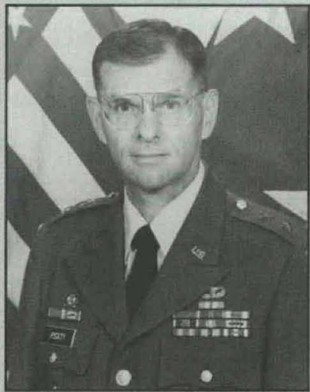
COMMANDING GENERAL
U.S. ARMY TACOM



MG Leo J. Pigaty

MG Leo J. Pigaty was commissioned a second lieutenant through the ROTC program upon graduation from Lafayette College in Pennsylvania, where he earned a bachelor's degree in civil engineering. MG Pigaty also received a master of science degree in logistics management from the Air Force Institute of Technology. His military education includes the Basic and Advanced Officer Courses at the Ordnance School, U.S. Army Command and General Staff College, U.S. Army War College, and the Joint Chiefs of Staff Capstone Course. Other important command and staff positions he has held include: logistics officer, Office of the Deputy Chief of Staff for Logistics, Headquarters, Department of the Army, Washington, D.C.; commander, 1st Maintenance Battalion; chief, 800th Materiel Management Center, and assistant chief of staff for materiel, 2d Corps Support Command, VII Corps, U.S. Army Europe; commander, Anniston Army Depot, Anniston, AL; deputy commanding general for research and development at the Troop Support Command, St. Louis, MO; and commander, Defense Industrial Supply Support Command, St. Louis, MO; and commander, Defense Industrial Supply Center, Defense Logistics Agency, Philadelphia, PA.

Mission and Organization

The U.S. Army Tank-Automotive Command (TACOM) is a major subordinate command of the U.S. Army Materiel Command. TACOM's mission is integrated commodity management of tanks, automotive ground vehicles, construction equipment, materials handling equipment, and other assigned materiel. Other mission areas include research and development, design, acquisition, engineering, safety, materiel readiness, integrated logistics support, sustainment, and security assistance services.

The command conducts basic and applied research and related technologies for assigned vehicle systems and other associated developmental programs. TACOM manages the RDE Center for all tank science and technology and executes assigned missions in support of other AMC or DOD elements worldwide.

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M1-SERIES ABRAMS TANI

The M1-series Abrams tank is an impressive performer and is more r
tanks of the past. Its 1,500 horsepower gas turbine engine accelerat
20 mph in seven seconds. Gun stabilization advanced fire control an
main-gun accuracy that has been successfully demonstrated repeate
tions and exercises.

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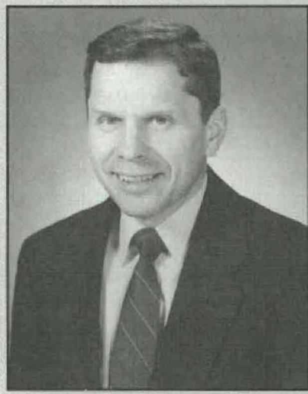
TACOM DEPUTY COMMANDER FOR RESEARCH, DEVELOPMENT AND ENGINEERING AND DIRECTOR, TARDEC



Kenneth J. Oscar

Dr. Kenneth J. Oscar holds a B.S. degree in physics from Clarkson University and M.S. and Ph.D. degrees in physics from American University. His previous positions include: director, Combat Engineer Support Laboratory, Belvoir RDE Center; associate technical director for research and development, U.S. Army Troop Support Command; and assistant deputy chief of staff for development, engineering and acquisition, HQ, Army Materiel Command. At the beginning of Operation Desert Shield in 1990, Dr. Oscar was temporarily assigned as TACOM acting deputy commander for procurement and readiness, where he served until the conclusion of the Persian Gulf War.

Mission and Organization

TARDEC is the Department of Defense (DOD) lead agency for research, development and engineering of the U.S. Armed Forces' ground mobility fleet and is one of three CRAY supercomputer sites in the Army. More than 550 of the center's 925 employees are engineers and scientists.

In addition to maintaining close interface with TACOM's commanding general, deputy commander for procurement and readiness, and Army program executive officers, TARDEC engineers and scientists also work closely with their counterparts throughout the U.S. Army Materiel Command, other Army agencies, and DOD.

Committed to excellence, TARDEC has implemented a Total Quality Management (TQM) program with a bias for action. By encouraging employee participation in every aspect of its operations, TARDEC's TQM program has unleashed the creative forces of the center's personnel in improving processes ranging from technical data package generation to the acquisition and management of lab equipment.

Customer identification and satisfaction are a vital part of TARDEC's TQM philosophy. The TARDEC Business Plan is an innovative marketing strategy that revolves around customer needs. AMC has recognized TARDEC as being one of the first RDE Centers to develop a comprehensive Business Plan.

The Business Plan contains the strategy by which TARDEC manages resources, increases quality, and pursues new customers. TARDEC actively interacts with its customers through customer site visits and an annual customer conference. This bold program identifies TARDEC as a leader among Army RDE Centers.

TARDEC has a strong commitment to promoting equal opportunity in the workplace, as well as in the local community. The center is presently establishing a pre-engineering and science program for Detroit area high school students. The students will be brought to TARDEC to work on a variety of engineering projects to stimulate their interest in the field of science and engineering. The center has also formed a recruiting team that visits minority colleges and universities throughout the country to interview students interested in pursuing federal employment. Additionally, an annual Engineering Open House affords entry- and journeyman-level minority and female engineers and scientists the chance to join the TARDEC work force.

TARDEC conducts research and development of new technologies in the following areas: vehicle electronics, survivability, ground propulsion, simulation, track and suspension, robotics and technical integration. These technologies, with those developed in other DOD laboratories and RDE centers, industry and friendly foreign countries, are integrated at the appropriate time into new, combat-ready fielded systems.

TARDEC not only assists in the development of systems but also supports all ground-vehicle systems throughout the full-scale development, production and fielding phases.

Continued on page 28

Looking Ahead

An important objective at TARDEC is to develop new, more combat-effective systems capable of surviving the rigors of tomorrow's battlefield. To help meet this goal, TARDEC is focusing attention on several key technological areas:

• **VETRONICS (VEhicle ElecTRONICS).** A long-term VETRONICS program is under way to develop a computer-controlled electrical and electronic system with common hardware and software modules that will support both combat and tactical vehicles planned for introduction during the mid- 1990s and beyond. The design of this system is known as the Standard Army VETRONICS Architecture (SAVA).

Current sophisticated vehicle designs use separate electrical and electronic components to handle specific tasks, which results in significant duplication of electronic functions and an overwhelming number of controls and displays for the crew. The SAVA will partition a vehicle according to functions rather than subsystems, thereby making it possible to provide for common functions such as data processing, memory, and multifunctional controls and displays that can be shared by several vehicle subsystems. This reduces the size and weight of the vehicle electronics and makes it easier for the crew to operate. A first-generation vehicle SAVA was tested in FY92 in the new M1A2 tank, and the results are a leap ahead in battlefield performance.

•**Survivability.** TARDEC's priority technical objectives include revolutionary, non-traditional approaches toward surviving on highly lethal future battlefields. Emphasis is on improving signature-reduction materials and techniques, fire suppression, advanced armor technologies and integration, and crew and system reaction techniques.

In two major thrust areas, TARDEC is actively developing countermeasures to protect U.S. combat vehicles against acquisition and targeting. First, it is developing engineering models that aid in the design of vehicles with minimum infrared, acoustic, millimeter wavelength and radar signatures. TARDEC is also striving to develop models in the visible area of the spectrum. These models are being provided to all vehicle system contractors and are being used to aid in the design of the Armor System Modernization vehicle family.

The second signature thrust area is in the modification of existing combat vehicles through the application of signature suppression materials and designs. This effort aids in the evaluation of the impact of various levels of signature reduction against smart munitions and target acquisition, and in the definition of requirements for new vehicle systems.

In "hit avoidance" countermeasures (where threat weapons can be interrupted at some point in their delivery), TARDEC's efforts are directed toward modular integration of electronic warfare threat warning receivers and countermeasure reactions. This is accomplished through incorporation of the U.S. Army Communications-Electronics Command's Vehicle Integration Defense System (VIDS). VIDS utilizes the SAVA VETRONICS architecture, including the central processor, the communication busses and the crew controls and displays to identify and prioritize threats and select and initiate the optimum countermeasure reactions.

TARDEC is working with the U.S. Army Ballistic Research Laboratory to develop various armors in support of the Army's Armored Systems Modernization Program. This program requires the development of armors for all applications to the armored family of vehicles, in both the medium and heavy threat categories. TARDEC's damage reduction efforts include work in spall protection, fuel and ammunition fire suppression, and in directed energy hardening. Fire-suppression and laser-hardening technology and systems have been developed and fielded in the current combat vehicle fleet.

• **Mobility.** TARDEC has a world-class ground-vehicle propulsion, track and suspension and vehicle design capability. Its supercomputer is netted throughout the command to rapidly integrate the U.S. Army Missile Command's missiles and the U.S. Army Armament, Munitions and Chemical Command's guns into sophisticated, new vehicle designs.

• **Composites.** In a long-term research program under way to fill a growing need for lightweight, air-transportable combat vehicles suitable for rapid deployment anywhere in the world, TARDEC plans to develop a Composite Armored Vehicle Advanced Technology Transition Demonstrator (CAV ATTD). This vehicle will help engineers evaluate advanced lightweight composite materials, survivability, and two-man- crew technologies required to meet future sophisticated battlefield threats.

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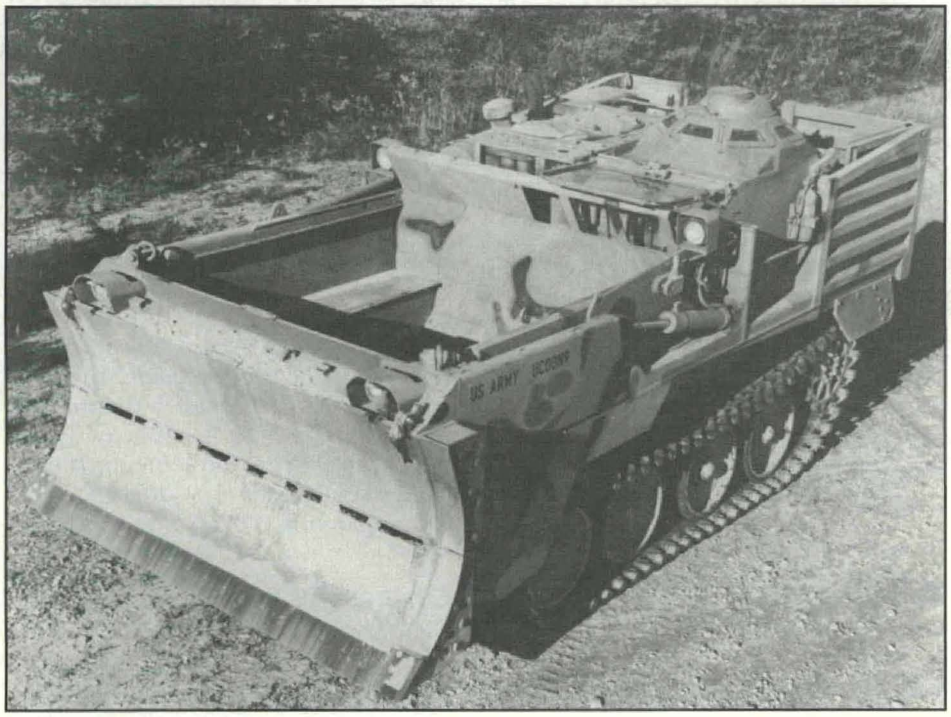
M2/M3 BRADLEY FIGHTING VEHICLE (BFV)

More than just an armored personnel carrier, the Bradley represents the first armored vehicle to allow the American infantry squad to fight while moving at high speed. The BFV fleet first added the dimension of infantry fighting-from-under-armor when it replaced M113 series APCs at the 2nd Armored Division in 1983. The Bradley fleet consists of M2-series Infantry Fighting Vehicles designed for a nine-man infantry squad and M3-series Cavalry Fighting Vehicles designed for a five-man cavalry squad serving in armored cavalry units and as scouts for mechanized infantry and tank battalions.

M998-SERIES HIGH-MOBILITY MULTIPURPOSE WHEELED VEHICLE (HMMWV)

In the early 1980s, facing changes in battlefield technology, the Army focused on the need for a high-mobility, light truck capable of performing a variety of missions. The Army needed an air-transportable, reliable, maintainable and survivable vehicle to fill cargo-carrier, troop-carrier and armament requirements, as well as certain ambulance and shelter-roles in the 1/4-ton to 1-1/4 ton range. The HMMWV meets all of these requirements.



M9 ARMORED COMBAT EARTHMOVER (M9 ACE)

The Army's M9 ACE digs as fast as the most efficient bulldozer, travels 30 mph cross-country, is air-transportable and offers armor protection equal to that of the M113-series armored personnel carrier (APC). The M9 enhances the ability of engineer platoons and divisional engineer battalions to perform vital support missions. These include constructing antitank ditches, digging in infantry, artillery and armor, and tasks once handled by many different pieces of slow-moving civilian construction equipment that lacked the armor protection needed to survive in combat.

M977-SERIES HEAVY EXPANDED MOBILITY TACTICAL TRUCK (HEMTT)

This truck, which performs cross-country military missions, carries payloads up to 11 tons and performs well both on and off the road. The design objectives gave prime consideration to industry-proven heavy-duty truck components, ease of maintenance, and interchangeability of major parts within the vehicle series. The truck is used for direct re-arming of the multiple Launch Rocket System, transport of Patriot erector/launchers, resupply of field artillery ammunition and forward area re-arm vehicles in armor, cavalry and infantry units, refueling of tracked and wheeled vehicles and helicopters in the forward areas, and recovery of disabled wheeled vehicles.

THE ARMY INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM

By Eddie Japzon

The IMIP focuses on factory-wide or single product or process line improvements by analyzing the total business environment and by considering well established and state-of-the-art technologies.

Introduction

Since the fielding of quality weapons systems to American soldiers is dependent on industry's ability to produce them, a strong industrial base is a key element in the U.S. acquisition process. One effort to achieve a strong industry base is the DOD's Industrial Modernization Incentives Program (IMIP) which assists military contractors in manufacturing quality products.

IMIP offers incentives to contractors so that they can modernize their facilities and improve the defense industrial base. It entails a structured engineering analysis and creates a more cost-efficient defense production capability for weapon systems, equipment and material. Under the IMIP—which is implemented through a "business agreement," the government offers contractors certain incentives for financing capital investments to expand their industrial productivity when market forces are normally insufficient to motivate such expansion.

The IMIP focuses on factory-wide or single product or process line improvements by analyzing the total business environment and by considering well established and state-of-the-art technologies.

The IMIP evolved from the Air Force Technology Modernization (TECHMOD) Program and the Army Industrial Productivity Improvement (IPI) Program. In 1982, DOD integrated these separate programs into the IMIP to enhance and revitalize the defense industrial base. In 1985, policies regarding the IMIP were implemented under the DOD Directives 5000.44 and the accompanying DOD Guide 5000.44G.

Objectives

Short-term objectives are to increase productivity; shorten lead times; improve product quality, maintainability and reliability; and reduce costs. The long-term objectives are to maintain a strong defense industrial base which meets current defense needs and to respond to surge and mobilization requirements.

Accomplishments

During the 1980s, the Army's IMIP efforts were primarily centered at the Stratford Army Engine Plant (SAEP) and the General Dynamics Land Systems

(GDLS) Division facilities. These facilities produced and assembled the Ml tank engines and the tank main frames respectively. These facilities permitted the Army to motivate contractors to invest approximately $1.70 for every $1.00 of Army investment. This Army-contractor effort resulted in FY87 through FY91 savings of approximately $153 million which were passed on to the Army in a reduced cost of the Ml tank. These savings translated to a return on investment of $4.25 for every $1.00 of Army investment.

Some of the modernization projects undertaken at SAEP were:

• **Group Technology Concept Manufacturing** guided the rearrangement of the factory into manufacturing cells that machined groups of similar parts. It also guided the layout of the factory into a logical process flow, with incorporation of an advanced material handling system.

• **Master Planning and Control System** computerized all decisions and activities regarding material flow and allocation of resources while integrating these activities with design and process development. Examples of subsystems were: master schedule, contract material planning, design engineering, inventory control, manufacturing engineering, shop floor control and capacity requirements planning, tool inventory management system.

• **Manufacturing Equipment Modernization** initiated the rebuilding of some equipment if the cost to rebuild was less than 65 percent of the cost of the new machine and acquired new equipments, i.e., gear grinding using cubic boron nitride, cutting and drilling sheet metal using a laser beam, deburring of machined metal parts using a robotic system, and stamping the Inconel 624 recuperator disks using a four press system with automatic part transfer.

• **Material Handling Modernization** integrated, by computer, receiving, receiving inspection, and inspection buffer storage to enhance the receipt of dock-to-stock material handling; through the use of automated guided vehicles that transport the material to pick up and drop off points inside the factory; and through a computerized high rise/high density storage area for finished parts.

These modernization efforts at SAEP resulted in a 50 percent reduction in the number of production machines; an 85 percent reduction in rework and scrap; tripled output; a 20-day cut (from 25 to five) from dock-to-stock, and a 50 percent increase in factory efficiency.

Long-term objectives are to maintain a strong defense industrial base which meets current defense needs and to respond to surge and mobilization requirements.

The Army, in 1984, also supported a factory engineering analysis at four GDLS facilities — Lima, Detroit, Scranton and Sterling—which enabled the contractor to benchmark operations and to identify and prioritize a broad range of "target of opportunities" for productivity improvements. This analysis resulted in the installation of a Manufacturing Resource Planning (MRP) System division-wide, a computerized and vision-directed arc welding robotic system for the fabrication of the tank main frame, and a number of high risk technology development projects that were funded by manufacturing technology (MANTECH). The installation of these advanced systems and technology projects resulted in savings that have been passed on to the Army.

Three Phases Of IMIP

The efforts to improve productivity at these facilities entailed the use of the three phases of IMIP. Phase I determined the "as is" and "to be" conditions of the facility which formulated the strategic plan and the conceptual designs of the modernization requirements. Phase II detailed the design, development and validation of the modernization opportunities identified in Phase I. In this phase, implementation plans were identified, hardware and software requirements were determined, specific applications were validated through modeling or method demonstrations and cost benefit analysis performed. Phase III involved the contractor purchase and installation of the equipment needed to implement and complete the modernization project. Only upon completion did the Army begin to realize the savings and the contractor rewarded as negotiated. The Army fully funded all Phase I projects and some of the Phase II projects.

Manufacturing Technology Program

In implementing these projects, the MANTECH Program complemented and supported the IMIP efforts, e.g., robotic deburring at SAEP and implementation of high risk technologies at GDLS. Both MANTECH and IMIP, components of the Industrial Preparedness Program, aim to ensure readiness and responsiveness of the defense industrial base to the needs of the military establishment.

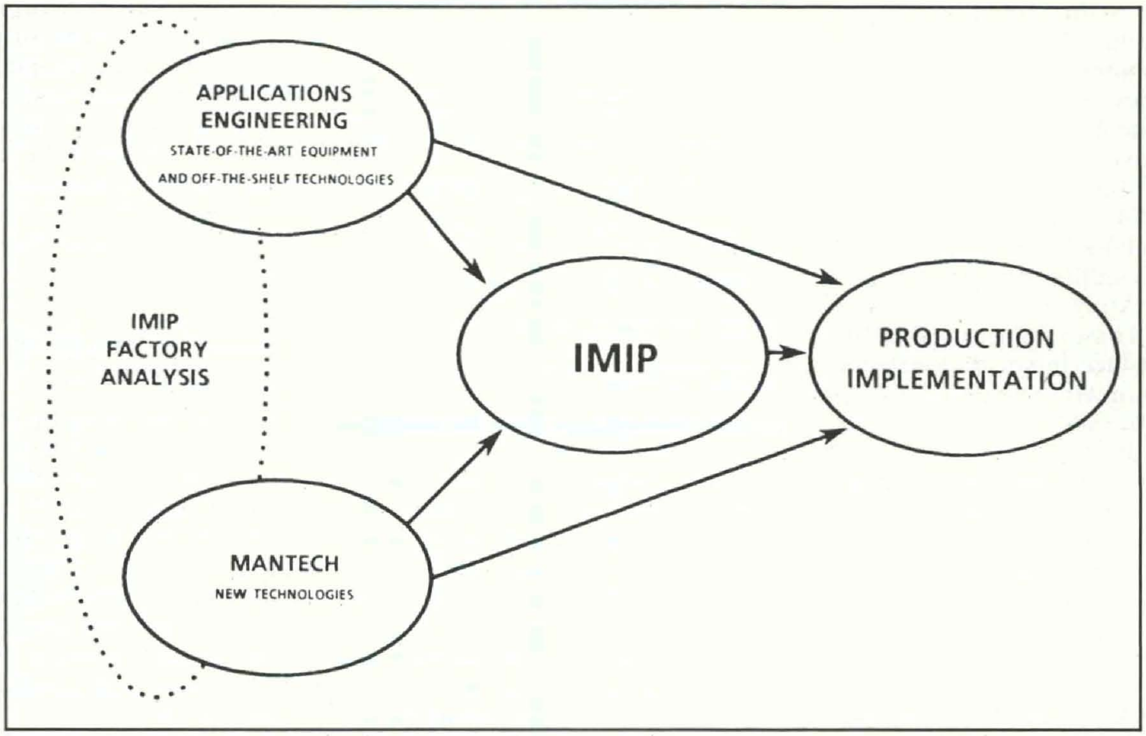
MANTECH, however, was employed in making first-case manufacturing processes and equipment improvements. IMIP, on the other hand, focused on further implementing successfully demonstrated MANTECH projects on the shop floor.

Key Incentives

The application of Army funded Phase I and II projects and the Productivity Savings Rewards (PSR) which were paid to the contractors after savings verification, were the incentives that made the contractors undertake the modernization of their facilities. The PSR, encompassing the savings sharing ratio, was negotiated between the Army and the contractors before they embarked on the productivity enhancing capital investments and related productivity improvement efforts. Incentives provided to the contractors were commensurate with the degree of contractor funding, risk of the investment, and other economic factors.

Business Agreement

The key document that was crafted by the Army and the contractors in the early phases of IMIP to guarantee its success was the "Business Agreement." Instead of the Army being simply a customer and the contractors simply a



IMIP/MANTECH Relationship.

source of supply, both parties entered into a partnership in which each shared the risks and the rewards of advancing production technology and modernizing industrial plants.

Current and Future Contractor Participation

Army IMIP funding has been limited over the past few years. Currently, the Army is assisting in the implementation of modernization projects that support systems being procured at the following contractor facilities:

- Saco Defense Incorporated, Saco, ME;
- Alliant Techsystems Incorporated, New Brighton, MN;
- Allison Gas Turbine Division of General Motors, Indianapolis, IN;
- Allison Transmission Division of General Motors, Indianapolis, IN;
- Garrett Engine Division of Allied-Signal Company, Phoenix, AZ;
- Litton Precision Gear Company, Chicago, IL;
- Bell Helicopter Textron Incorporated, Fort Worth, TX; and
- McDonnell Douglas Helicopter Company, Mesa, AZ.

Future plans call for the initiation of IMIP at the Boeing Helicopter facility at Ridley Park, PA; Sikorsky Aircraft facility at Stratford, CT, and various subcontractor facilities that support the development of the Comanche (Light Helicopter) Air Vehicle.

How To Participate

A contractor normally initiates participation in IMIP prior to the Full Scale Engineering Development (FSED) phase of a materiel acquisition. Army contractors, interested in formulating Business Agreements, should submit modernization proposals by way of the program executive office (PEO) to the Army major subordinate command (MSC) with whom they are under contract. The MSC, in turn, passes on contractor proposals to the Office of the Deputy Chief Of Staff for Concurrent Engineering at Headquarters, U.S. Army Materiel Command, for funding approval.

Project Evaluation Criteria

Criteria that are used in determining whether to fund a project proposal are the outyear materiel requirements, two years or less payback on the Army investment, a short duration of the project, PEO/PM support, and the estimated contractor or other government agency investment.

Conclusions

This is just a brief overview of the Army IMIP and its role in the enhancement of the defense industrial base. It is a low key effort, not robustly funded, but an essential Army program. Essential, if we expect Army contractors to continue to manufacture and assemble quality and reliable products that gain the full trust and confidence of the ultimate user—the soldier. The superb performance of the Ml tanks in Operation Desert Storm further demonstrated the value and benefits of IMIP as a force behind the modernization of the facilities that produced these tanks.

EDDIE JAPZON is the staff engineer for IMIP in the Office of the Deputy Chief of Staff for Concurrent Engineering, Headquarters U.S. Army Materiel Command. He has a B.S. degree in mechanical engineering from the University of San Carlos in the Philippines and an M.S. degree in management from Frostburg State University in Maryland.

INNOVATIVE OPERATIONAL TESTING

A Preview of the Future

By MAJ Laurence A. Womack

Introduction

With the shrinking defense budget and the push to get new and reliable systems into the field quickly, the test and evaluation community must rethink how to conduct quality testing to ensure quality products. This testing must be thorough, must stress the system under field conditions, and must be timely, cost effective, and designed to use minimum resources.

By definition, an operational test is the field test of the system under realistic combat conditions by representative military users. It uses personnel with the same military occupational specialty as those who will operate, maintain, and support the system when deployed.

Operational testing is expensive, which is why the need for innovation in operational testing is necessary. An example of an innovative approach was testing of the Lightweight Tactical Fire Direction System (LTACFIRE) and the Forward Entry Device (FED) conducted by the Test and Experimentation Command's Fire Support Test Directorate during 1990 at Fort Ord, CA.

Background and Purpose

In FY 88, Congress directed the Army to procure LTACFIRE for light infantry divisions. In the plan for procurement, a force development test and experimentation (FDTE) would be conducted after the first light infantry division was fielded with LTACFIRE. The 7th Infantry Division (Light) was fielded with LTACFIRE and LTACFIRE FDTE in late 1990.

The purpose of the LTACFIRE FDTE was to evaluate the effectiveness of automation and to refine future organization, maintenance, and training in the light infantry division.

In March and April 1990, the FED underwent an initial operational test and evaluation and did not meet its required operational capabilities in several areas. Because of the potential impact on the Army Tactical Command and Control System Common Hardware Software Program, a follow-on operational test and evaluation (FOTE) became necessary. The purpose of the FED FOTE, which was conducted in late 1990, was to evaluate the interoperability, system reliability, operational effectiveness, and training of the FED in the light infantry division fire support system and to verify that corrections identified in the initial operational test and evaluation were implemented.

System Description

The LTACFIRE is an interim system to replace the manual methods used by the light infantry division artillery. It is a lightweight, transportable, decentralized computer processing system for the control of artillery and mortar fires at division, brigade, and battalion level. It has user-friendly, menu-driven software, with a "touch screen" method of entry, which provides the light forces with responsive and continuous fire support (See Figure 1).

The FED hardware, with common software, is a nondevelopmental item which the Army will purchase under the Army Tactical Command and Control System Common Hardware Software Program to replace the currently fielded digital message device. It is a lightweight, hand-held, input/output device for foot mobile forward observers and fire support teams to use in conducting and planning fire support operations (See Figure 2).

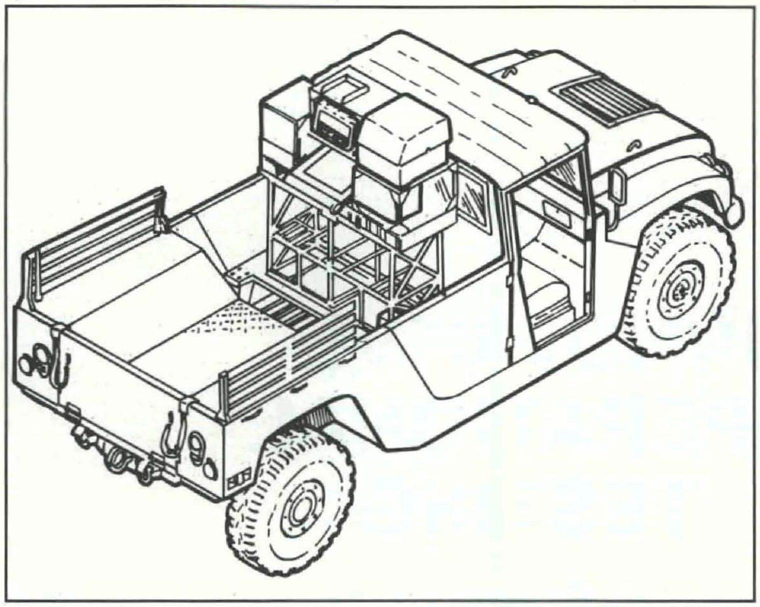


Figure 1.

Test Concerns

The initial concept was to conduct both the LTACFIRE FDTE and FED FOTE concurrently, but separately. This concept was pursued because the experimentation aspect of the LTACFIRE FDTE allowed maximum flexibility in correcting test related problems with doctrine, scenario inputs, and equipment. On the other hand, the FED FOTE was a pure evaluation which required strict control to determine if the FED met or failed to meet its required operational capabilities. This approach dictated two separate test directorates and the associated duplication of many functions, a large increase in funding for temporary duty and civilian local hire, and the need for additional instrumentation support.

An additional problem that was a potential "show stopper" was the beginning of "Operation Desert Shield," which put all FORSCOM support taskings on hold. The impending lack of support surfaced the need to develop an approach to testing that allowed for the reduction of personnel and cost to the minimum numbers required to accomplish both missions. At this point, the consolidation of personnel and resources was considered and the advantages and disadvantages evaluated. The Test and Evaluation Command's Fire Support Test Directorate formulated a plan and presented it to the U.S. Army Field Artillery School; TRADOC system manager, Fire Support Command Control, and Communications; program manager (PM), Field Artillery Tactical Data Systems (FATDS); and Operational Test and Evaluation Command. All endorsed the plan and work began on the test integration design.

Test Integration

A four-step approach was used to integrate both tests into one overall test plan. The first step was to finalize the list of essential personnel and resources needed by the test directorate to accomplish the combined test. Figure 3 illustrates the combined test directorate. This plan combined tasks and reduced the size of the test directorate from 123 personnel to 71—a 42 percent reduction.

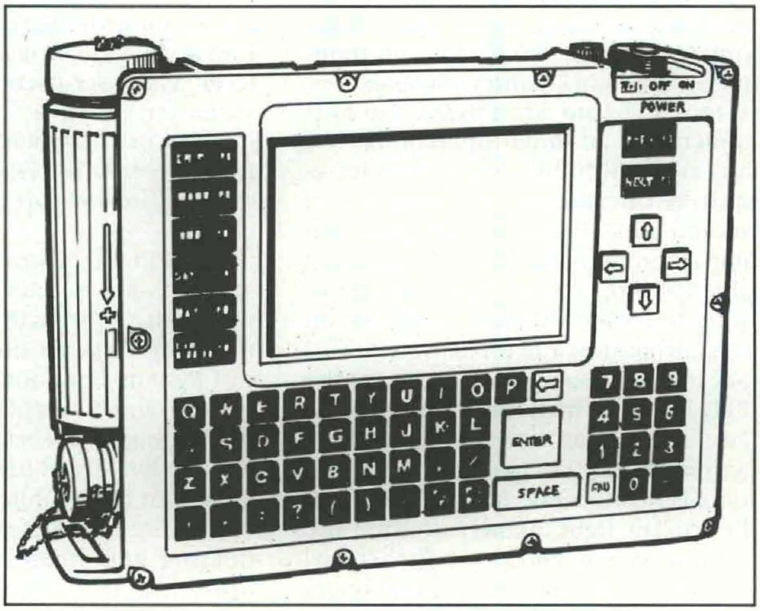
The second step was to take the plan and identify where the resources could be obtained. This was critical because the 7th Infantry Division Artillery was tasked to provide all test players, data collectors, and support personnel identified in the outline test plans. This could have been a possible "show stopper" if the division artillery had to provide all of the personnel. Our efforts to locate alternate sources for data collectors and support personnel were successful.

U.S. Army Communications-Electronics Command's New Equipment Training Team provided all the data collectors (13) for the LTACFIRE equipped nodes; U.S. Army Field Artillery School provided operations personnel (2); and U.S. Army Test and Experimentation Command's Test Experimentation Center provided all the FED data collectors (10).

The third step was to integrate the time-ordered events lists for both tests. This was accomplished by placing the FED FIST team on a separate radio net into the battalion fire support element and dedicating a battery fire direction center from the FDTE.

The fourth and final step was to brief all the key participants (U.S. Army Field Artillery School; U.S. Army Operational Test and Evaluation Command; PM FATDS; TRADOC system manager, Fire Support Command, Control and Communications; and 7th Light Infantry Division Artillery) concerning how to conduct the test integration and where to obtain the personnel.

Figure 2.



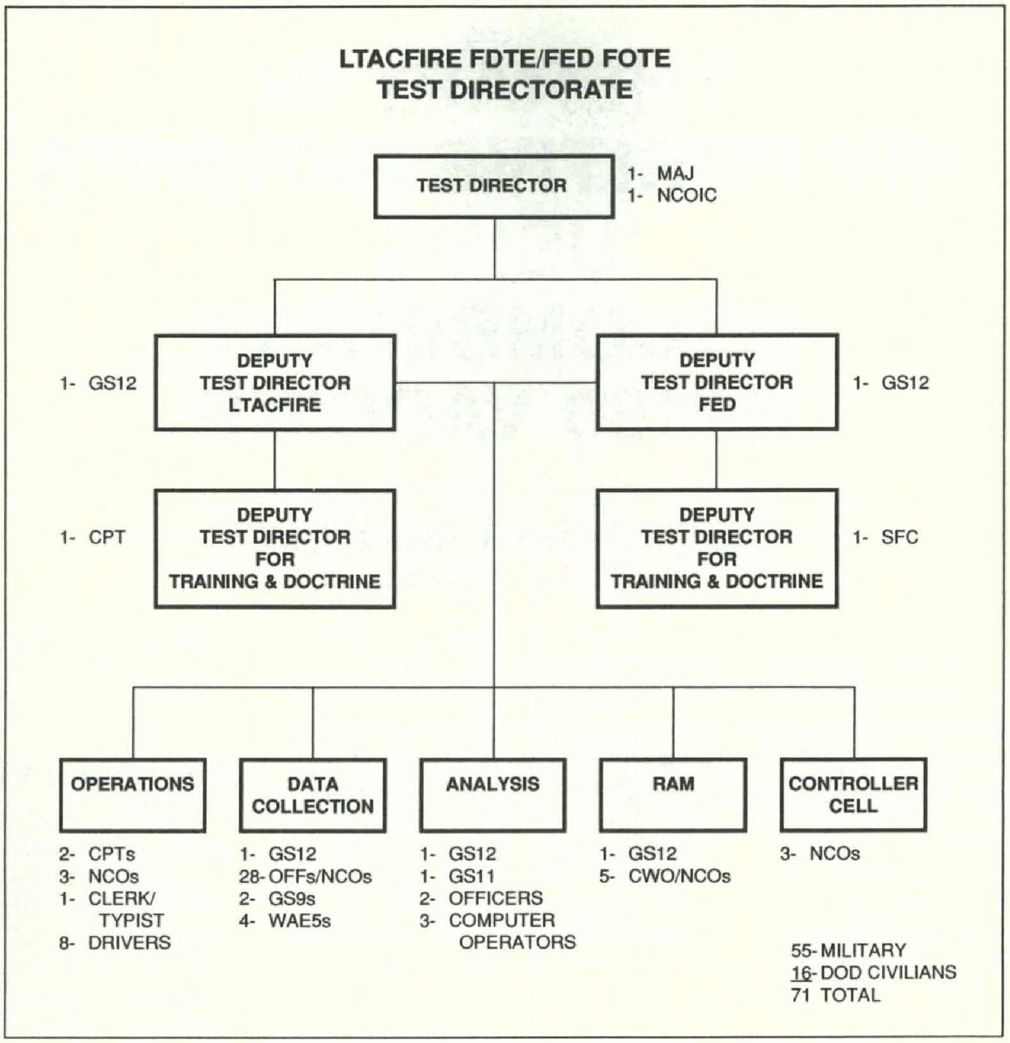


Figure 3.

Funding

In evaluating the funding requirements for combining these tests, the costs of conducting the tests separately was important to consider. The cost of each test was listed in the respective outline test plans. The LTACFIRE FDTE cost was $339K, and the FED FOTE would have cost approximately $274K (based on the cost of the FED initial operational test and evaluation). The combined test resulted in the FED FOTE costing $156.3K, or a 43 percent savings. This is intangible savings realized by comparing the actual cost to the projected cost of a separate FOTE. The actual FOTE cost savings were the result of combining and streamlining existing resources already computed into the LTACFIRE FDTE. All of the costs required in the combined test for site support, instrumentation, and transportation of equipment to the test site at Fort Ord, CA, were reflected in the LTACFIRE FDTE outline test plans. Additionally, the coordination for the data collectors and test players from Fort Ord considerably reduced the overall temporary duty costs. Through these and other cost saving measures, the LTACFIRE FDTE/FED FOTE was conducted at a 34 percent savings of allocated funds.

Conclusions

Constrained budgets require innovative concepts to create tests that are "cheap, fast, and good." Our efforts are a first step in demonstrating that combining operational testing is a viable method of reducing resources and costs.

The ultimate goal of all operational testing is to ensure the soldiers who use the equipment have an item which has proven it meets or exceeds the required operational capabilities. It is a challenge to all testers, whether operational or technical, to continue to develop and implement innovative testing techniques to accomplish this goal with minimum resources.

MAJ LAURENCE A. WOMACK is a field artillery officer serving as a test and evaluation officer in the U.S. Army Test and Experimentation Command's Fire Support Test Directorate at Fort Sill, OK. He has a B.S. degree from West Virginia State College and is a graduate of the Materiel Acquisition Management Course.

THERAPY IN HIV POSITIVE PATIENTS USING RECOMBINANT GP160 VACCINE

By LTC Robert R. Redfield, MC

Introduction

On June 13, 1991, *The New England Journal of Medicine* carried an article reporting on the trial use of a new vaccine. The report brought inquiries from television, newspapers, magazines—and just plain people. For the first time, the researchers reported, a vaccine had been used to modify the body's immune response to a chronic infection. The researchers were at the Walter Reed Army Institute of Research (WRAIR).

The vaccine was called gp 160. The chronic infection was HIV, the virus that causes AIDS. It is work that truly defies more than 100 years of medical theory and teaching. Soon after Louis Pasteur proposed the use of vaccines as intervention in viral infection, other researchers demonstrated that "it couldn't be done." It remained an obscure theoretical possibility until the development of genetic engineering and the proliferation of technology among many different laboratories allowed the breakthrough research presented in the NEJM paper.

The Walter Reed Staging Classificaton System for HIV Infection

Stage	HIV Antibody or Culture Status	Chronic Lymphadenopathy	CD4-Cells (µL)	Delayed Hypersensitivity Skin Test	Thrush	Opportunistic Infections
WR0	-	-	>400	NORMAL	-	-
WR1	+	-	>400	NORMAL	-	-
WR2	+	+	>400	NORMAL	-	-
WR3	+	±	<400	NORMAL	-	-
WR4	+	±	<400	PARTIAL ANERGY	-	-
WR5	+	±	<400	COMPLETE ANERGY	+	-
WR6	+	±	<400	PARTIAL OR COMPLETE ANERGY	±	+

Stage Definitions: WR0 defines members of high-risk groups; WR1-6 requires proof of infection by HIV. Patient must have CD4 count lower than 400 per µL persisting for 3 months or more to be classified WR Stage 3, 4, 5, or 6.

Chronic lymphadenopathy, CD4 cell count and defects in delayed skin test hypersensitivity must be persistent for 3 months or more for criteria to be fulfilled.

Anergy is defined as delayed reaction to an antigen, in this case introduced as a skin test for allergic reaction.

The Known World

Usually, the introduction of any antigen into the body stimulates the production of antibodies sufficient to control an infection. Immune responses to HIV antigens during natural infection are both humoral (neutralization antibody, viral receptor blocking antibody, antibody dependent cytotoxicity), and cellular (natural killer cell activity, HIV antigen-specific T-cell proliferative responses, cytotoxic T-cell responses). Yet, despite these host-directed immune responses, HIV infection results in a progressive, debilitating disease of the immune system. The virus persists despite production of anti-viral antibodies and some evidence of the production of cytotoxic T-cells (the cells responsible for killing the virus-producing factories).

Based on today's still-limited knowledge, it appears that certain antibodies, the T-helper response to the virus, and the T-cytotoxic responses, are blunted. Perhaps the virus "hides" some important immunogenic sites which would otherwise stimulate an effective viral immune response, or perhaps the primary infection of the T helper cell hinders the efficacy of the immune response.

The Walter Reed researchers hypothesized that the host-directed immune response to HIV gradually weakens, resulting in poor control of viral replication. Vaccine therapy explores the possibility of boosting and expanding the body's native immune responses to the virus that would help in controlling the infection. The hypothesis builds on the concept that, if critical viral proteins could be presented to the immune cells in a novel manner, a more effective anti-viral immune response could be generated. Just as vaccines lead to protection from disease in the unprotected host, vaccines during infection with a virus may be able to redirect the immune system in a more effective way. These concepts are all hypothetical and remain to be proven. There is still a critical need to understand which viral proteins would generate an effective immune response and improve viral control.

If the natural HIV specific immune response could be intentionally altered in a chronically affected host, understanding of HIV immunoregulation could be refined. Then the therapeutic potential of post-infection active immunization could be directed to produce specific control reponses. It might then be practical to modify the natural history of HIV infection. Under the direction of the Division of Retrovirology at WRAIR, the Military Medical Consortium for Applied Retroviral Research is conducting a long-term evaluation of vaccine therapy using a recombinant HIV envelope protein called gp 160 in volunteers who are HIV-positive.

The Vaccine

Gp160 is a protein on the outer surface of the HIV virus. Obtained through use of genetic engineering techniques unavailable even 10 years ago, the vaccine is provided to the Army under a Cooperative Research and Development Agreement (CRDA) with the manufacturer, MicroGeneSys, Inc., of Meriden, CT. Since the vaccine is made with only a part of the whole virus, there is no chance that this product will cause infection. The gp 160 vaccine has been administered to 30 volunteers who are in Walter Reed stage 1 or 2 (see attached chart) in a Phase I trial, and more than 200 non-infected people and has been found to be safe.

The results of the phase I trial were recently published in the *New England Journal of Medicine.* The trial was designed to explore dose and injection schedule, toxicity, and immunogenicity. Briefly, the results of the study include the following: 19 of 30 volunteers responded to the vaccine; that is, they increased both their humoral and cellular anti-HIV envelope immunity in response to vaccination with gp 160. Some volunteers were able to make new antibodies against the virus and new T-cell responses to gp 160 were observed. No one involved in the trial had an adverse systemic reaction, and local reaction at the site of injection was mild. The vaccine did not cause any diminution of immune system capabilities as observed both in volunteers, and in laboratory analyses of blood and other samples. After 10 months of follow-up there was no decline in the mean CD4 cell count for the 19 vaccine responders, while CD4 counts among the non- responders declined approximately seven percent.

The phase I trial showed that gp 160 is a safe and immunogenic vaccine in the patients with chronic infection. Presently, a tri-service Phase II study to determine clinical efficacy is ongoing. Additionally, 27 of the 30 original Phase I volunteers are involved in a roll-over study to examine long term effects of vaccination and duration of immune response. Other studies involving gp 160 are in the planning stages. It is hoped that these trials with gp 160 will increase our understanding of the host-initiated immune response in order to accentuate the body's ability to fight the deadly HIV virus, and will serve to guide the DOD program to develop a vaccine for prevention.

Having shown that the theory of intervention in chronic infection can work, researchers will hopefully find even wider application in the treatment of other viral diseases.

LTC ROBERT REDFIELD, MC, is chief, Retroviral Research, Division of Retrovirology, Walter Reed Army Institute of Research. He received his B.S. degree from Georgetown University in 1973 and his MD from the same institution in 1977. He is on the faculty of the Uniformed Services University of Health Sciences and has authored or coauthored more than 60 papers in leading scientific journals worldwide.

Research Team Cited

On July 31, 1991, Secretary of the Army Michael P.W. Stone recognized the nine members of the research team that published the *New England Journal of Medicine* article. In a ceremony at the Pentagon, Stone presented Meritorious Service Medals to COL Edmund Tramont, COL Donald Burke, LTC Robert Redfield, COL John Brundage, LTC Charles Davis, MAJ Deborah Birx-Raybuck, MAJ Steven Johnson, and CPT Victoria Polonis. COL Charles Oster, unable attend the ceremony, received his MSM at a later date.

In addition to The Surgeon General LTG Frank Ledford, distinguished guests at the ceremony included Sen. Ted Stevens and Rep. John Murtha, both of whom have been strong supporters of the Army's HIV research program.

APPLICATION OF LEVEL OF REPAIR ANALYSIS

By Nicholas R. Giordano

Introduction

Most of us are probably unfamiliar, and maybe even afraid, of the term "Level of Repair Analysis (LORA)," let alone why LORA is conducted or when it should be conducted. This article will alleviate some of these fears and explain why and when LORA is performed. The term LORA, as defined in AMC-R 700-27, 20 Feb 91, LORA Program, is "an analytical method used to determine the maintenance level at which an item should be replaced, repaired, or discarded." In simpler terms, LORA determines the most cost effective maintenance concept of a system based on economic and non-economic factors.

The term LORA is synonymous with Optimum Repair Level Analysis and Level of Repair as used in various other documents throughout the Department of the Army and Department of Defense. LORA has two key terms associated with it, LORA program and LORA process, which are also defined in AMC-R 700-27. The LORA program is associated with a specific hardware system or acquisition that establishes the procedures and actions necessary to ensure a cost effective program for determining the repair or discard of an item. The LORA process consists of seven steps, as depicted in Figure 1.

The LORA Process

The LORA process is shown as a continuous loop because it is iterative in nature and must constantly be updated and revised as the system matures and better data becomes available. The formal definition of the LORA process, as defined in AMC-R 700-27, is "iterative evaluations, which arrive at level of repair/discard alternative(s) based on economic and noneconomic considerations." Economic evaluations consider cost factors such as spare parts, transportation, inventories, labor, and training and performance factors such as mean time to repair (MTTR), operational availability, and mean time between failure (MTBF).

Non-economic evaluations consider pre-emptive factors such as safety, vulnerability, mobility, policy, and manpower that restrict or constrain the maintenance level where repair or discard can be performed.

Why LORA is Conducted

As explained in the previous paragraph, the objective of LORA is to establish the most cost effective maintenance concept of a system. LORAs are to be conducted on every system acquisition program, as defined by AR 750-1 and AR 700-127. These regulations state that analytical techniques and models will be used to develop and evaluate alternative support concepts. The LORA program is conducted as an integral part of the Logistic Support Analysis (LSA) program, as defined in MIL-STD-1388-1A task 303.2.7, Repair Level Analyses.

Results of the LORA are used for four main purposes: to influence design (i.e., discard versus repair); assist in assignment of the source, maintenance, and recoverability (SMR) codes; provide development and assignment of maintenance tasks for establishment of the Maintenance Allocation Chart (MAC); and assist in development of technical manuals.

Systems being developed for Army use, including joint service systems with the Army as lead, are regulated by AMC-R 700-27, which establishes the U.S. Army Materiel Command (AMC) objectives and policies and assigns responsibilities for a LORA program throughout all phases of a materiel system's life cycle.

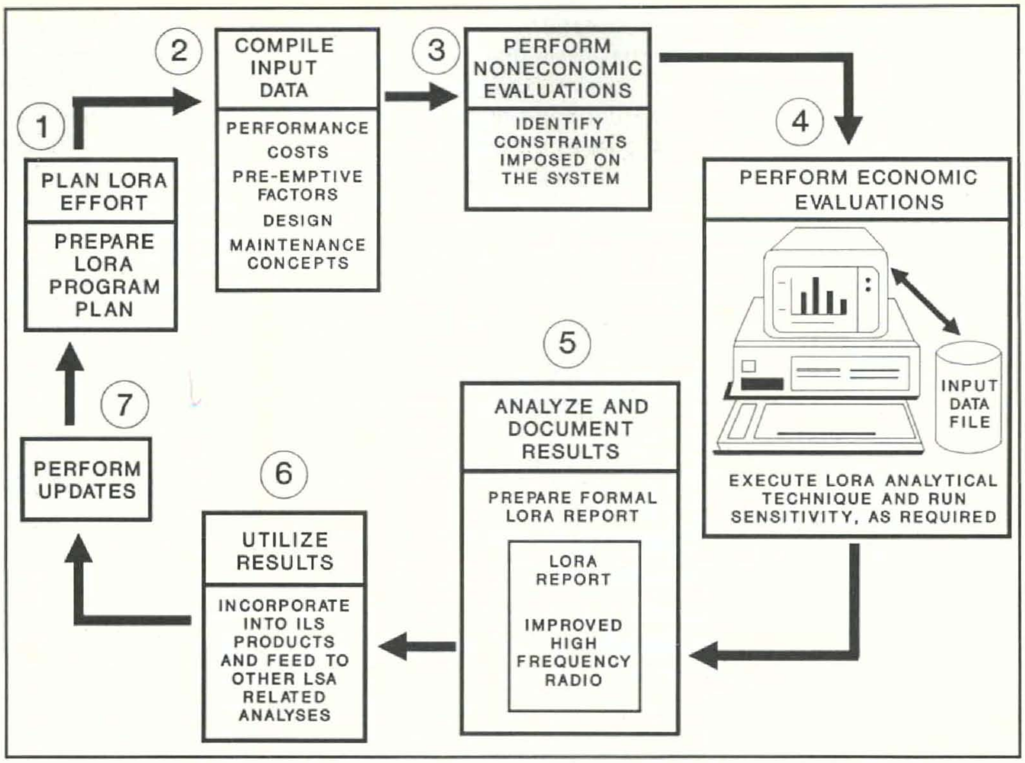


Figure 1.
Seven Steps of the LORA Process.

When to Perform a LORA

Although LORA is required by AR 750-1, AR 700-127, and AMC-R 700-27 and is applicable to all system acquisition programs, it should be tailored to fit the requirements of the individual system or equipment program. Therefore, "when" and to "what extent" LORA is performed is just as important as why LORA is performed.

As mentioned previously, LORA is iterative in nature and, therefore, is applicable to all phases of a system's life cycle. However, the system's life cycle phase will affect the extent of the analysis, or the scope of the LORA program and tailoring should be conducted to keep resource requirements at a minimum. A brief explanation of what LORA accomplishes and why it is performed in each phase of the life cycle is provided in Figure 2.

In the early phases (i.e., Concept/ Exploration and Demonstration/ Validation) the main purpose of a LORA is to direct the design of the system from a supportability standpoint. The design is usually still very flexible and allows the best opportunity for conducting tradeoffs, identifying alternatives, and directing design from a supportability standpoint. This includes determining items and parts that should be clearly designed for discard instead of being repaired. Also, the LORA may be used to evaluate early considerations of support equipment requirements (i.e., built-in-test versus automatic test equipment) and manpower and skill requirements.

The LORA also can be used in the early phases to establish early requirements of initial provisioning, including spare parts and test equipment, which can assist in development of budgets and funding levels for the latter stages.

The next two phases, Full Scale Development and Production/ Deployment, usually allow less design freedom. LORAs are usually conducted in these phases to establish the optimal support and maintenance structure of a system and assist in developing the SMR codes and MAC. A LORA is also applicable to fielded systems and is conducted to assess the current maintenance structure of the system. Fielded system LORAs should be conducted when there is a dramatic increase or decrease in the cost or failure rate of an item, when an engineering change proposal is submitted or implemented, when considering changing from total contractor support to organic support, or as part of a scheduled fielded system review.

Other factors that may affect the extent of the LORA program are: type of acquisition program or strategy (e.g., non-development, and product improvement program); amount of design freedom; resources; schedule, and availability of data. Since these factors also affect the extent of the LORA, the overall tailoring process should correspond to the size, complexity, and life cycle phase of the individual system or equipment program to reduce the resources required.

Sources and Reliability of Input Data

Since LORA is an analytical technique, input data is required to conduct the LORA evaluations (economic and non-economic) and collection of this data is usually a major task of the LORA process. Data is available from many sources and includes: LSA Record; MRSA's Logistics Parameter Library; other system engineering analyses and programs (i.e., transportation analysis, safety assessment, and reliability program); and historical data bases such as from existing and similar systems, and from LORAs previously conducted on similar and existing systems.

In the early phases of the life cycle, data may be based on engineering estimates, such as MTBF and MTTR, that could be unreliable. Therefore, sensitivity analysis will have to be conducted to assess how variations in these LORA input parameters affect the baseline maintenance concept and reduce associated risks. Initial input data values are used to establish an initial baseline maintenance concept.

After establishing the baseline concept, a sensitivity analysis is performed. The purpose is to: determine if variations in the selected input parameters would result in assignment of different repair levels; assess the effect on the total life cycle cost; and determine if any alternative maintenance concept would be more economical. Sensitivity analysis involves the following steps: identify and select the LORA input data elements to be analyzed; establish a numerical range(s) over which the selected data element(s) is expected to fall within; execute the LORA model/technique over the established numerical range(s); assess the impact on the baseline maintenance concept based on total cost and repair level designation; and, verify or change the recommended maintenance concept based on the results.

As mentioned previously, LORA is an iterative process and is continuously updated and revised as the system matures. Therefore, as more reliable data becomes available, the LORA will be updated and revised to reflect the most current values of the input parameters. This process results in the most cost effective maintenance concept based on the most current information and LORA input data.

Utilization of the LORA Results

Results of the LORA will be used to direct design and assist in development of the maintenance structure. Early results of the LORA indicate items that can be discarded at failure and separated from those that are to be repaired. This assists in establishing early SMR codes for provisioning. Results should also be analyzed and put into the form of recommended actions to be given to the equipment designer to affect the design. Later in the life cycle, the results are used to propose the maintenance concept for the system. This includes documenting the results in the Logistics Support Analysis Record (e.g., SMR codes, repair levels, test equipment requirements). The results are then used in formulating the MAC and in developing the technical manuals. The results also provide estimates of the life cycle costs of supporting the system, which can be used to establish funding requirements for spares, test equipment, and manpower.

Examples of LORAs

MRSA, as the Army LORA support office, has performed numerous LORAs on both developmental and fielded systems. Examples of developmental systems include: Pedestal Mounted Stinger; Air-to-Air Stinger; and M1 Laser Range Finder. Fielded system examples include: Improved High Frequency Radio (IHFR); and Aviator's Night Vision Imaging System.

The IHFR is a good example of how a fielded system LORA can assess the current maintenance structure of a system and recommend alternatives

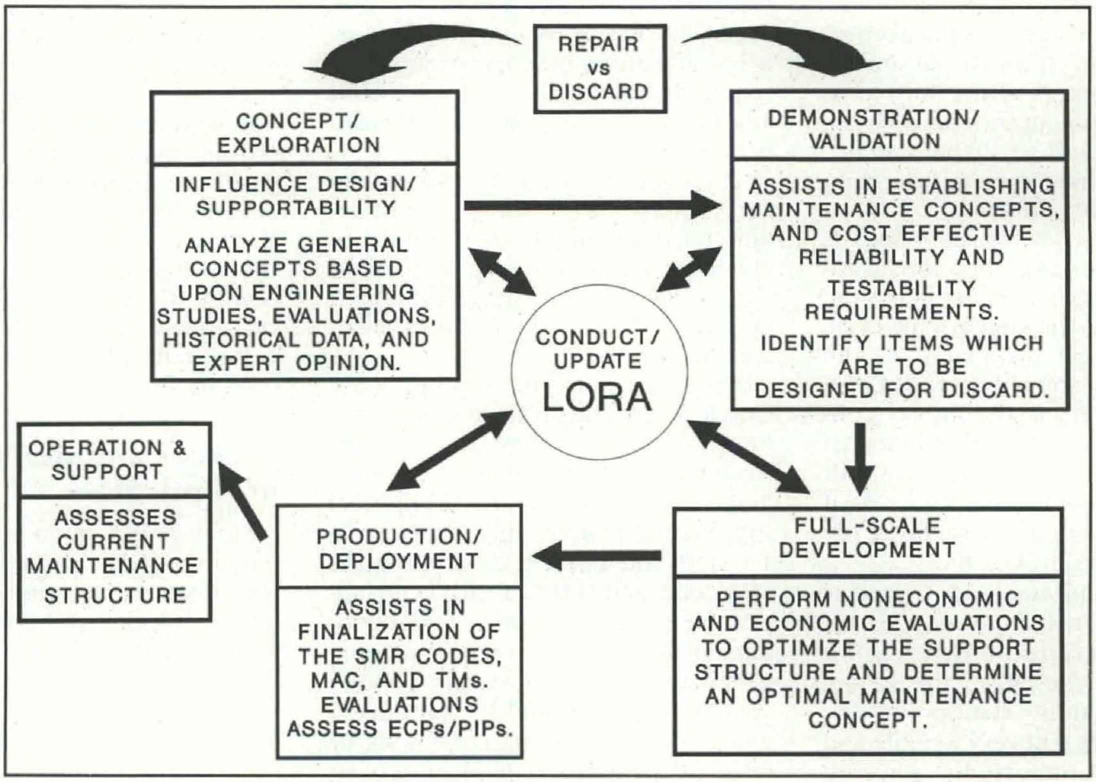


Figure 2.
The LORA Process During the Life Cycle.

Table 1-1.
Summary of the Repair Levels and O&S Cost.

SYSTEM CONFIGURATION	RECOMMENDED POLICY (LORA)	CURRENT POLICY (MAC)	TOTAL O&S COST	
			RECOMMENDED POLICY (LORA)	CURRENT POLICY (MAC)
AN/PRC-104A End Items Components Modules	 DS level DS level 6 at GS, 1 at DS, 1 at DEP, and 1 for discard	 ORG GS DEP	$22.77M	$30.45M
AN/GRC-213 End Items Components Modules	 DS level DS level 6 at GS, 6 at DS	 ORG GS 2 at GS, 10 at DEP	$32.57M	$43.09M
AN/GRC-193A End Items Components Modules	 DS level DS level 23 at DS, and 12 for Discard	 ORG GS DEP	$106.59M	$170.76M

NOTE: ORG - Organizational; DS - Direct Support; GS - General Support; DEP - Depot

that result in significant savings in operating and support (O&S) costs. The IHFR is a family of radios with three configurations (AN/PRC-104A, manpack; AN/GRC-213, vehicular pack with low power; and AN/GRC-193A, vehicular pack with high power). The LORA analyzed each configuration separately and resulted in significant savings over the current maintenance structure, as stated in the MAC. Table 1-1 shows the recommended repair levels as a result of the LORA versus the current repair levels stated in the MAC. The table also indicates the total O&S cost for the recommended policy versus the current policy (MAC).

As shown in Table 1-1, the potential savings over the life of the system (20 years), if the recommended policies are implemented, would be approximately: $7.8M for the AN/PRC-104A; $10.5M for the AN/GRC-213; and $64.1M for the AN/GRC-193A. The greatest savings were realized from a decrease in initial spares and inventory holding costs. The recommended policy for each configuration was to repair the end item utilizing a direct support (DS) contact team, which is indicated as DS in Table 1-1. It is more economical to move repair of most of the components and modules forward.

Currently, the components are being repaired at general support and depot. On the AN/GRC-193A configuration, 12 of the 23 modules were recommended for discard at failure, which also contributed to the overall cost savings. The results and recommendations in the IHFR's LORA report are currently being reviewed by the program manager (PM) Single Channel Ground and Airborne Radio System. The PM has also indicated that the results and recommendations of the LORA will be used to reevaluate the maintenance concept and update and revise the MAC and SMR codes.

Conclusion

The LORA and LORA program are important tools the Army can use to get the greatest value from its equipment. The two key points of this article are: LORA's purpose is to establish the most cost effective maintenance concept of a system; and the LORA process is iterative in nature and, therefore, is applicable to all phases of the life cycle. For more information on LORA and the LORA program, contact the USAMC Materiel Readiness Support Activity at DSN 745-3963 or commercial (606) 293-3963. Our mailing address is: Commander, USAMC Materiel Readiness Support Activity, ATTN: AMXMD-EL, Lexington, KY 40511-5101.

NICHOLAS R. GIORDANO is a senior engineer in the Logistics Engineering Branch of the USAMC Materiel Readiness Support Activity. He holds a bachelor's degree in mechanical engineering from Florida Atlantic University, a master's degree in business administration from East Texas State University, and is graduate of the USAMC Maintainability Engineering Program.

TACOM DEVELOPS M1 MINE CLEARING ROBOT

By John J. Schmitz and George Taylor

The U.S. Army Tank-Automotive Command's (TACOM) Research, Development and Engineering Center, Warren, MI, has developed and demonstrated a remote-controlled mine-clearing vehicle that may someday eliminate much of the danger soldiers face when encountering minefields. Such a vehicle would accompany assault forces and clear a path through minefields for other vehicles by using a V-shaped, track-width mine plow to push mines off to either side.

The Army currently does not have in its inventory a vehicle specifically designated for mine-clearing. Assault vehicle crews have had to rely mainly on combat engineers using hand-held metal detectors and bayonets to locate minefields, and manned M1-series tanks equipped with track-width mine plows to breach them.

A mine-clearing vehicle is now under development as part of the Army's Armored Systems Modernization Program, but it is not planned for introduction until the year 2004. So late last December, with the Persian Gulf War drawing near, the Army asked TACOM's RDE Center to design and build a remote control system capable of guiding an M1 equipped with a mine plow through minefields.

The request was a tough one to meet because the Army wanted the system in only eight weeks. Other requirements were that it be small, easy to install, and use transmitters and receivers already in the field. The center's Design and Manufacturing Technology Directorate not only met the requirements but completed the design, fabrication, installation and testing of a prototype system in five weeks. Fortunately, the war was over by then, but the system is available for use in future conflicts, and we believe it could be applied to other combat vehicles in addition to the M1.

The system is designed to be compatible with all current U.S. military radios now in use—the SINCGARS (Single-Channel Ground-to-Air Radio System) and the older style VRC-12 and PRC-77 series radios. It consists of two parts—the transmitter interface (TI) and the receiver interface (RI). The TI is a control box 8-inches by 6-inches by 5-inches which the operator uses to drive the robot vehicle from a safe distance in a control vehicle.

The receiver interface is a shoebox-size unit that is mounted in the robot vehicle. It executes the driver's commands by electronically actuating any of several electromechanical actuators and electric relays that control braking, acceleration, steering and other driving functions, as well as raising and lowering of the mine plow.

In operation, the operator enters a command into the transmitter interface to, say, stop the vehicle, and a circuit board feeds appropriate electronic signals into the control vehicle's radio. This radio in turn transmits the signals to the robot vehicle radio, which feeds them into a microprocessor inside the receiver interface. The microprocessor then analyzes the data and generates a signal to activate the actuator that controls the vehicle's brakes.

The power requirement for the transmitter interface is about 200 milliamperes at 12 volts. Currently, the unit is powered by a gelled-cell battery that can provide 20 hours of operation between recharges, but it could be wired to receive power from the vehicle's electrical system.

The transmitter interface contains six switches, but is capable of inputing up to 28 switches. The switches interface with the microprocessor in a matrix pattern, which is adaptable to various needs. The interface pads are already installed to accept new switches. The transmitter interface has a two-axis control stick, and can handle up to two control sticks. The control stick is connected to an analog-to-digital converter which is controlled by the microprocessor.

The microprocessor collects switch and control-stick inputs and transmits this information at 1299 Baud in both digital and tone outputs. The digital output is compatible with SINCGARS, hardwire, and computer ports. The tone output is compatible with analog media such as the VRC-12 and PRC-77 radios and land lines.

The receiver interface, which is also set up to handle both digital and tone signals, can be installed in an M1 in less than an hour by two people without special tools. Conversion from manual to remote operation of the M1 requires about two minutes and can be accomplished from the driver's compartment. The RI mounts in the hull just behind the driver's seat.

The main circuit board of the receiver interface contains 14 relays. The gear select in the M1 is controlled via five relays, (which are part of the 14 relays on the main board) and is connected to the transmission cable, located on the back of the T-bar. Master panel functions, such as engine start and stop, are also performed with relays and are connected through the master panel test jack.

There are currently seven unused relays, and they can be used for any user function as required, with no change to the main board. The receiver interface has four proportional outputs. These outputs drive actuator control cards which in turn control electromechanical actuators. The current system uses two such actuators, one to operate the service brakes and another to control the steering. The brake actuator is mounted on the left wall of the driver's compartment, just below the brake cable. It is connected to the brake lever at the end of the cable and allows full movement of the brake pedal at all times.

The steering actuator is mounted on the ceiling of the driver's compartment, just behind the T-bar. It is attached to the T-bar by a bracket mounted on the T-bar grip and is easily removed by a quick-release pin. Another output of the main board is a variable amplitude triangle wave, which controls the M1 throttle.

The system performed very well in tests conducted at TACOM. However, with Operational Desert Storm having reached a successful conclusion, it is not likely that the system will end up in the hands of troops any time soon. Despite this, however, we are continuing to improve the design, as well as looking for alternative uses—knowing that such a system has the potential of playing an important role in future military confrontations.

JOHN J. SCHMITZ is an electrical engineer in the Design and Manufacturing Technology Directorate, Army Tank-Automotive Command RDE Center.

GEORGE TAYLOR is a technical writer for the U.S. Army Tank-Automotive Command.

DOD to Create New Simulation Office

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In a long-awaited development, the U.S. Department of Defense is moving ahead with plans to establish a Defense Modeling and Simulation Office (DMSO) to coordinate the military services' disparate simulation efforts.

Approved June 21 by Donald Atwood, deputy defense secretary, the new office is intended to support the undersecretary of defense for acquisition "in strengthening the use of modeling and simulation in joint education and training, research and development, test and evaluation, and operations and cost analysis," Atwood states in a memorandum.

DMSO will serve as a coordinating office that will support an Executive Council for Models and Simulations (EXCIMS) also being established under the new management plan.

Composed of representatives from each military service, EXCIMS will advise the defense acquisition chief on modeling and simulation issues, such as instituting standards and developing funding strategies to improve simulation technologies, according to the Defense Modeling and Simulation Management Plan. EXCIMS also will submit a biennial report to Pentagon acquisition officials detailing the group's achievements and areas that require greater attention or funding.

Exactly who will take part in EXCIMS remains to be determined, Pentagon officials say. However, Army COL Ed Fitzsimmons, recently director of training policy in the Office of the Assistant Secretary of Defense for Force Management and Personnel, has been named to head DMSO.

Specifically, the DMSO will undertake the following activities:

- Develop policies to increase the attention focused on modeling and simulation in joint education and training, research and development, test and evaluation, and operations and cost analysis.
- Oversee the distribution of approved modeling and simulation guidelines to the individual services to assist them in developing their own simulation plans.
- Develop a liaison process to coordinate and assist in the development, acquisition and sharing of modeling and simulation technology and standards among the military services and the defense industry.
- Develop approved means to increase cooperation among the military services to maximize modeling and simulation interoperability while eliminating duplicative development of advanced modeling and simulation technologies.
- Advise the Pentagon acquisition chief on matters relating to improving the use of modeling and simulation that supports the Joint Requirements Oversight Council, Defense Planning and Resources Board and the Defense Acquisition Board.

Funded with $75 million that Congress provided in the Pentagon's 1991 budget, DMSO will move over the next month to establish working groups that will begin to address outstanding issues in the areas of standards, interoperability and technology.

Pentagon training officials emphasize, however, that the new office will refrain from telling the individual military services how to manage or operate their own training and simulation programs. Instead, DMSO will focus on ways to improve the acquisition of modeling and simulation systems and cut costs by eliminating redundant equipment and buying more commercially available products, officials say.

The formation of DMSO has generated widespread concern throughout the simulation and training industry as companies have feared the potential bureaucratic power the new organization could wield. However, since DMSO will not be an advocate for the acquisition of particular training systems, most industry concerns will be alleviated, Pentagon officials say.

In directing the establishment of such an office in the 1991 budget, Congress was particularly interested in establishing standards for modeling and simulation systems and increasing the interoperability of individual service systems.

While DMSO meets congressional aims, questions still exist about the technical expertise and support the new office will possess, a Senate source says. Noting that DMSO is envisioned as only a seven- person office, the source said "where do they go to get unbiased help to proceed with establishing new protocols?"

Water Purification Equipment Field Tested Under Fire

The war in the Persian Gulf forced the trial-by-fire in the early fielding of many equipment items. Water purifiers were among those pieces of equipment fielded early and tested under actual combat conditions.

Adequate potable water is important for survival in any environment, but it was critical in the harsh desert climate of Southwest Asia.

"The Army had adequate water purification support in Southwest Asia. Skid units with a 150,000 gallon-per-day purification capacity and barges with a capacity for 300,000 gallons-per-day were used for general support and 600 gallons-per-hour units provided division support. What was needed was a 3,000 gallon-per-hour machine for corps support to fill in the gap," said SGM Thomas Rosenthal of the Petroleum and Water Logistics Office, U.S. Army Troop Support Command.

The Troop Support Command (TROSCOM), commonly known as "The Soldier's Command," is in charge of the research, development, fielding and maintenance of a wide range of equipment items including operational rations, clothing, shelters, camouflage, mine detection and clearing equipment, watercraft, power generation, air delivery equipment and fuel handling and storage equipment.

The Army uses a three-step process to purify water. Regardless of whether the water began as brackish or salt water, all impurities and contaminants, including chemical and biological agents are removed. The end product is water that is much cleaner than the tap-water in most households.

First, the water is passed through a multi-media filter which removes the majority of the particles. Then it is forced through cartridge filters which remove the remaining particles. Finally, it goes through the reverse osmosis element which rejects the ions, allowing only pure water to pass.

TROSCOM's Project Office for Petroleum and Water Logistics had previously recognized the requirement for an intermediate capacity reverse osmosis water purification unit (ROWPU), and had been developing it for some time. Operation Desert Shield created an ideal situation to field test this new unit.

TROSCOM arranged to have three 3,000 GPH prototype ROWPUs air-lifted to Southwest Asia in October due to the need for a mobile intermediate range machine. Item managers also hoped to determine from this move if the length of the test cycle could be cut by field trials.

"Our results for purifying fresh well water were very promising. The units were easy to operate and made good water," said Rosenthal.

The 82d Quartermaster Detachment, Fort Irwin, CA., trained on the units and ran them during the war at King Khalid Military City (KKMC) and Log Base Charlie in Saudi Arabia. The units purified two and a half million gallons of water of KKMC from October to January and eight million gallons at Log Base Charlie from mid-January through mid-April.

"When the fighting stopped and the units were no longer needed in the northern part of the country we arranged for the 3K ROWPUs to be tested on sea water," said COL Robert Weimer, TROSCOM's project manager for petroleum and water logistics.

"The units worked well on sea water but the high salt content did cause problems," said SFC Ronald Allen of the 82d Quartermaster Detachment.

"When you operate on sea water, maintenance time more than doubles. The salt content in the Arabian Gulf is two and a half times that of normal sea water so we figured this would be the best place to test the units," said Allen.

The 82d ran the sea water test 24 hours a day, seven days a week for two weeks. The test data was then forwarded to the project manager to complement first article test data already collected.

"Overall we are very pleased with the operation of the 3K ROWPU. It is a very positive addition to our existing family of water purification equipment," Weimer said.

Development of The Maneuver Control System

Thanks to the foresight of a project manager who used an evolutionary approach in developing the Maneuver Control System, a number of Army commanders in Operation Desert Storm were provided with the most current battlefield information.

The Maneuver Control System is an integrated network of computers that helps commanders and their staffs at the corps, division, brigade and battalion levels manage information used in executing the commander's concept of operations.

"Our original purpose in using the 'evolutionary' approach—which means to field now and refine later—" said COL James T. Doyle, the project manager for Operations Tactical Data Systems, who managed the development and acquisition of the system, "was to get the system out to the field early so we could get user feedback to influence the system's design and features, plus to give the force expertise in using it." As it turns out, another benefit of that approach was that it gave some Desert Storm commanders a tool to analyze and disseminate crucial planning information on U.S. forces, Iraqi forces, and battlefield characteristics—a tool that otherwise wouldn't have been available for some years.

How does the system help a commander? It puts battlefield information at commanders' fingertips.

The Maneuver Control System, which employs software written in the DOD standard software language of ADA, is not a stand-alone system. Essentially, what it does is interface with command and control systems such as the Advanced Field Artillery Tactical Data System and the Combat Service Support Control System, and integrate information in its five databases. These databases are friendly forces; enemy forces; control measures; obstacle barriers; and nuclear, biological, and chemical data.

The system can display that information in the form of charts, reports, maps, or spreadsheets, which users can zoom in on, scroll, or print. Then, with one keystroke, users can transmit the data to up to 35 preprogrammed addresses, saving time on faxing or other means of distributing information. The transmit feature is particularly helpful in the case of map overlays, which can be transmitted and then viewed on screens by recipients.

Before the Maneuver Control System, maps would most often be prepared as mapboards—which are about 4-feet by 8-feet, or about the size of a sheet of plywood or sheetrock—which would have to be painstakingly duplicated, and then loaded on vehicles to be distributed by messengers to various sites—a labor-intensive proposition.

Another important Maneuver Control System feature is the automatic replication of database information. That feature insures that if a node at one level goes down, or if a node has to shut down to be moved to another location, its database information is not lost—it has automatically been replicated onto selected other nodes and can be accessed from them—thus achieving continuity of operations, or CONOPS in military terminology.

Evolutionary Approach

The evolutionary approach used to develop the Maneuver Control System placed an initial version of the system in the field at the front end, with refinements evolving as the system is used in the field. This differs from the typical five to 20 year development cycle for Army materiel where first concepts are proven, prototypes are developed and tested, and then production models are manufactured and fielded. The system is being developed in four blocks, representing a further evolution.

Block one called for the development, to military specifications, of a tactical computer terminal; some software; 16 preformatted messages; the capability to transmit and receive standing requests for information; process queries from remote nodes; and transmit data to up to 35 preprogrammed addresses. This block was completed in late 1988.

Block two, which is currently being completed, will add commercial off-the-shelf items such as an Analyst's Console and a Tactical Computer Processor. Also included, will be the ability to transmit data via Mobile Subscriber Equipment and the Single Channel Ground and Airborne Radio Systems, as well as over commercial telephone lines.

Block three, by late 1992, will add the ability to interface with other systems of the Army Tactical Command and Control System and will include new hardware and software from the Army's Common Hardware and Software Project. In addition, enhanced Maneuver Control System software, which is more user friendly, will be added. Also, the "mil spec" Tactical Computer Terminal and the Analyst's Console and Tactical Computer Processor hardware will be replaced.

Block four will provide software enhancements and more capabilities and will add additional common hardware devices such as the Lightweight Computer Unit and the Handheld Transportable Unit.

'You Get What You Pay For'

After speaking at the 25th annual DOD Cost Analysis Symposium, Stephen K. Conver, the Army Acquisition Executive, was approached by a British gentleman who gave him a quote he had handwritten on a scrap of paper. Mr. Conver agreed that his message could not have been stated more eloquently, and he asked the Bulletin to share the quote with you:

"It's unwise to pay too much,
but it's worse to pay too little.
When you pay too much,
you lose a little money—that is all.
When you pay too little,
you sometimes lose everything
because the thing you bought
was incapable of doing the thing
it was bought to do.

The common law of business balance
prohibits paying a little and
getting a lot—it can't be done.
If you deal with the lowest bidder,
it's well to add something for the
risk you run, and if you do that,
you will have enough to pay for
something better."

John Ruskin
1819-1900

LETTERS

Dear Sir:

I have been a reader of the Bulletin and its predecessor ever since I was Deputy for Laboratories to the CGs of AMC from 1968 to 1976. The publication has been a useful tie to the continuing R&D developments in the Army, and has allowed me to follow developments which I helped initiate.

However, in my opinion you have missed the mark in your stated attempt in the July/August edition to review 50 years of Army R&D. You failed to identify the significant contributions of early Army scientists such as Harry Diamond and the proximity fuze, Henry Kalmus the second greatest patent holder in U.S. Government history and inventor of the Kalmus filter, Ray Bowles and fluiditics plus the founder of the Ballistics Research Lab to name just a few. You have overlooked the fact that the Army R&D accomplishments are anchored in individual commitment and genius, not a faceless organization.

This failure to recognize that talent and continuity are key factors leading to R&D success is exemplified in your two articles in the July/August issue depicting the Missile Command. In developing the article around MG Chen, the current CG, and a selection of recently fielded weapons, you have totally ignored the work of the laboratory and its key role in proving the feasibility and in developing these weapons systems carried out over the last two decades. I do not mean to take away from General Chen, who has a proven technical background based on his successful education at the University of Michigan. I received similar degrees there 47 years ago. However, the developments of the systems cited were due to the vision and talents of the Missile lab during the time Dr. John McDaniel was technical director. As a matter of fact "Big" John and I decided to initiate the MLRS proof of feasibility while flying to Huntsville in a U-21 in 1973. The system was to be as a low cost, accurate, proliferation answer to the Russian Organ Pipe. We started with money which became available when the OSD forced us to stop work on directed energy weapon research due to the Navy out politicking the Army. Although very successful, the MLRS, as often happens, grew in complexity and cost from our initial concept.

In another interesting bit of the history of technology, in the early '70s, I brought together Dr. McDaniel and Optelcom, a new fledgling company doing research in fiber optics, to explore the use of fiber optics for data transmission and vehicle control of RPVs and missiles. This work was a key ingredient to the development of the FOGM feasibility which was proven and a workable missile system developed under the leadership of Dr. McCorkle, the present Laboratory Technical Director. Optelcom is still working with the missile laboratory. The command leadership you cite had nothing to do with these key developments of enhanced Army fighting capability because they weren't on the scene at the time.

Similarly, you omitted a large amount of key pertinent laboratory technical recognition in the article describing the new Air Defense PEO and his program responsibilities, which should be included in an R&D bulletin. All the systems cited are based on past laboratory developments.

I would have thought that you might have mentioned some of the outstanding helicopter research carried out by the Army Aviation Labs which are collocated with NASA. The research on large lift blade technology carried out by the Ames lab in the full scale wind tunnel led to the XV-15 and the current V-22 program. The concept was the brainchild of the lab director in the early 70's.

Also, from the historical and scientific contribution perspective, I was surprised you omitted mention of Dr. John Weiss, Director of the Human Engineering Lab for the last 34 years and Dr. Ben Harris who spent his career from WW II to his retirement, as Technical Director of the Chemical Lab in the early 1980's working to enhance the Army position in all aspects of Chemical Warfare.

I would like to see the bulletin try and concentrate more fully on spreading the work concerning the R&D activities and accomplishments of interest to the R&D community. With help from the numerous retired former leaders of Army R&D still available, you should be able to develop an outstanding issue on the great technical contributions of the Army technical community over its past lifetime.

Sincerely yours,
Dr. R. B. Dillaway

Army RD&A Bulletin Responds:

Thank you for your insightful letter regarding these three articles in our July-August issue. We are sorry you feel we "missed the mark" with these articles but would like to offer a few words of explanation which may clarify our intent in publishing them: The article on 50 years of Army R&D achievement is a *condensation* of a new book distributed by the Office of the Deputy Assistant Secretary of the Army for Research and Technology. The intent, as stated by the author, was to provide an overview of some key technological achievements based on their relevance to military needs, and their contributions to society as a whole. These achievements, unquestionably, would not have been possible without the dedicated efforts of people—the backbone of any successful endeavor. In this case, the people are Army scientists and engineers. Failure to pay tribute to them should in no way be construed as an attempt to downgrade their importance.

The intent of the articles on the Army Missile Command and the PEO for Air Defense was to familiarize our readers with key RD&A organizations and leaders. Unfortunately, space limitations of this continuing series preclude detailed discussions of past laboratory developments and leaders. Again, this should not be interpreted as an attempt to denigrate their importance.

What Suggestions Do You Have for Improving Cooperative R&D Efforts Between the U.S. and Its Allies?

BG Joseph Raffiani Jr.
Deputy for Program Assessment for International Cooperation
Office of the Assistant Secretary of the Army (Research, Development and Acquisition)

Cooperative R&D efforts, by their very nature, are difficult to initiate, formulate, and execute. The key is obtaining long term support from Army, OSD, and Congress. The kind of support required transcends budget fluctuations and personnel turnover. This means that an international project must address fundamental military requirements in each nation, that planning begins prior to selecting final concepts or contractors, and that the project has the priority to be funded in the POM and compete favorably for future funding. Additionally, the project has to be given the same management emphasis, within the accepted PEO/PM structure, as domestic programs. Managing international programs "off-line" simply does not work.

The above formula does not guarantee success because these factors, plus others, will be debated in all participating nations, for different reasons and at different milestones. To reduce the impact of these debates on the project leads one to recognize the need to limit the number of participating nations and, accordingly, the number of contractors.

LTC David W. Andrews
British Liaison Officer
Headquarters, Army Materiel Command

Allies must have clear visibility of each other's military needs and how our RD&A programs will meet these needs. Windows of opportunity will appear when two or more nations need to replace or upgrade systems within the same timescale. If timescales don't exactly match, that will not matter, these can be harmonized. Whenever possible, we need to throw across a bridge between similar projects. It would help if we could agree on a standard RD&A pattern. We must commit full and proper funding up front in order to prevent downstream fiscal "glitches." We must also build flexibility into our programs to let other nations "buy-in" as our programs develop and expand. Finally, let us aim for production sharing in successful RD&A areas because it makes military expenditure more acceptable when it generates jobs at home.

Michael F. Fissette
Assistant Deputy for International Cooperative Programs
Headquarters, Army Materiel Command

First, we must have recognition and reinforcement by senior DOD and Army leadership regarding the essential nature of cooperative R&D. Coalition warfare is obviously crucial, but this takes interoperability of equipment, especially C3, consumables and spares. Reduced budgets and increasing global competitiveness in dual use technologies also need to be recognized as factors demanding cooperation. R&D cooperation supports strong alliances and results in the best equipment for our soldier with financial burdensharing reducing our costs.

To improve cooperation, however, we must recognize existing technology transfer issues and must deal with them early. Additionally, I believe four considerations are essential to a cooperative strategy. First, we must apply total quality management concepts to streamline existing procedures. For example, current mechanisms for staffing loans or Memoranda of Agreement, are too stifling. Second, we must start cooperation early by harmonizing requirements and developing cooperative ventures in the technology base. Third, we must encourage industry-to-industry cooperation. Many of our systems are developed by prime-subcontractor teams. We need an industry constituency and they need to think globally and work with government in a synergistic manner. Finally, we need to understand the positive results of success stories rather than dwelling on a few visible troubled programs. Successes include programs like the NBC reconnaissance vehicle acquired from Germany and excellent cooperation in chemical detectors and alarms with the UK and Canada and also with France. There are hundreds of positive exchanges at various levels with our allies and we must continually recognize the net value of the various international programs.

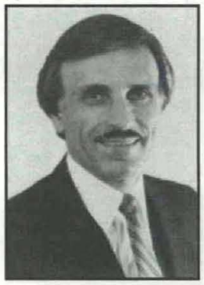
SPEAKING OUT

LTC Hans Melcher
German Liaison Officer
Headquarters, Army Materiel Command

You can hear it everywhere: "With defense budgets shrinking, allied and friendly nations should work together and cooperate more closely!" But past years have shown the difficulties in conducting international projects in practice. What is it that stands in the way of international cooperation, and who are the cooperation killers? Well, here are a few examples: a misguided strive for national technological and economic independence; outdated restrictions in technology transfer; politicians and decision-makers identifying with their pork-barrel interests; prejudices rooted in yesteryear's concerns; and a fear that one partner might profit more from cooperation than the other.

So how can international cooperative R&D efforts be improved? Fight the cooperation killers! This is a never-ending task for generations of Armaments Attaches and Liaison Officers. But it also involves the tedious process of educational efforts. We invite and encourage the U.S. Army to participate more actively in the U.S.-German Scientist and Engineer Exchange Program, because this program has a long-range potential for improving international cooperative efforts.

In the current German-U.S. armaments relationship, we try to place more emphasis on cooperation in the arena of technologies, and the harmonization of military requirements, as a basis for mutually beneficial R&D cooperation.



Bryant R. Dunetz
President, Center for Industry Cooperation and Trade
and former Assistant Deputy for International Cooperation
Headquarters, Army Materiel Command

The basic principles for R&D cooperation among the allies have not really changed in spite of drastic and unpredictable world changes and events in the last two years. Standardization, interoperability and conservation of scarce budgets will continue to be the main drivers. Desert Storm produced a compelling list of high priority requirements for cooperation.

Unquestionably, while the U.S. technology in many areas ranks among the best in the world, it by no means is the only good technology. Technology cooperation can stimulate beneficial competition and challenge our technologists to develop better solutions. For example, the Europeans have developed many technologically advanced solutions in the field of chemical defense and CW verification technologies. The U.S. has and should continue to benefit from these efforts.

Improvements will be realized by: maintaining an aggressive and active program of scientific and technical exchanges; monitoring developments in the foreign civil sector, particularly technology advances in the European community and Japan; and keeping the Army leadership apprised of these developments and how they can contribute to force requirements of the future. In my opinion, there are many opportunities for R&D cooperation. Selecting the ones that have a good chance of succeeding, however, is a difficult endeavor.

CAREER DEVELOPMENT UPDATE

Defense Acquisition Workforce Improvement Act (P.L. 101-510)

This is the second installment of extracts from the new legislation:

"Subchapter I—General Authorities and Responsibilities Section 1705. DIRECTORS OF ACQUISITION CAREER MANAGEMENT IN THE MILITARY DEPARTMENTS There shall be a Director of Acquisition Career Management for each military department within the office of the service acquisition executive to assist the executive in the performance of his duties under this chapter. The Secretary of the Navy, acting through the service acquisition executive, may appoint separate directors for the Navy and the Marine Corps. Section 1706. ACQUISITION CAREER PROGRAM BOARDS

(a) ESTABLISHMENT.—The Secretary of each military department, acting through the service acquisition executive, shall establish an acquisition career program board to advise the service acquisition executive in managing the accession, training, education, and career development of military and civilian personnel in the acquisition workforce and in selecting individuals for an Acquisition Corps under section 1731 of this title.

(b) COMPOSITION OF BOARD.—Each acquisition career program board shall include the Director of Acquisition Career Management (or his representative), the Assistant

Secretary with responsibility for manpower (or his representative), and the military and civilian senior officials with responsibility for personnel development in the various acquisition career fields. The service acquisition executive (or his representative) shall be the head of the board.

(c) SUBORDINATE BOARDS.—The Secretary of a military department may establish a subordinate board structure in the department to which functions of the acquisition career program board may be delegated.

Subchapter III—Acquisition Corps Section 1732. SELECTION CRITERIA AND PROCEDURES.

(a) SELECTION CRITERIA AND PROCEDURES.—Selection for membership in an Acquisition Corps shall be made in accordance with criteria and procedures established by the Secretary of Defense. Such criteria and procedures shall be in effect on and after October 1, 1993.

(b) ELIGIBILITY CRITERIA.—Except as provided in subsections (c) and (d), only persons who meet all of the following requirements may be considered for service in the Corps:

(1)(A) In the case of an employee, the person must be currently serving in a position within grade GS-13 or above of the General Schedule (including any employee covered by chapter 54 of title 5).

(B) In the case of a member of the armed forces, the person must be currently serving in the grade of major or, in the case of the Navy, lieutenant commander, or a higher grade.

(C) In the case of an applicant for employment, the person must have experience in government or industry equivalent to the experience of a person in a position described in subparagraph (A) or (B), as validated by the appropriate career program management board.

(2) The person must meet the educational requirements prescribed by the Secretary of Defense. Such requirements, at a minimum, shall include both of the following:

(A) A requirement that the person—

(i) has received a baccalaureate degree at an accredited educational institution authorized to grant baccalaureate degrees, or

(ii) has been certified by the acquisition career program board of the employing military department as possessing significant potential for advancement to levels of greater responsibility and authority, based on demonstrated analytical and decisionmaking capabilities, job performance, and qualifying experience.

(B) A requirement that the person has completed—

(i) at least 24 semester credit hours (or the equivalent) of study from an accredited institution of higher education from among the following disciplines: accounting, business finance, law, contracts, purchasing, economics, industrial management, marketing, quantitative methods, and organization and management, or

(ii) at least 24 semester credit hours (or the equivalent) from an accredited institution of higher education in the person's career field and 12 semester credit hours (or the equivalent) from such an institution from among the disciplines listed in clause (i).

(3) The person must meet experience requirements prescribed by the Secretary of Defense. Such requirements shall, at a minimum, include a requirement for at least four years of experience in an acquisition position in the Department of Defense or in a comparable position in industry or government.

(4) The person must meet such other requirements as the Secretary of Defense or the Secretary of the military department concerned prescribes by regulation.

(c) EXCEPTIONS.—(1) The requirements of subsections (b) (2) (A) and (b) (2) (B) shall not apply to any employee who, on October 1, 1991, has at least 10 years of experience in acquisition positions or in comparable positions in other government agencies or the private sector.

(2) The requirements of subsections (b) (2) (A) and (b) (2) (B) shall not apply to any employee who is serving in an acquisition position on October 1, 1991, and who does not have the 10 years experience as described in paragraph (1) if the employee passes an examination considered by the Secretary of Defense to demonstrate skills, knowledge, or abilities comparable to that of an individual who has completed at least 24 semester credit hours (or the equivalent) of study from an accredited institution of higher education from among the following disciplines: accounting, business finance, law, contracts, purchasing, economics, industrial management, marketing, quantitative methods, and organization and management. The Secretary of Defense shall submit examinations to be given to civilian employees under this paragraph to the Director of the Office of Personnel Management for approval. If the Director does not disapprove an examination within 30 days after the date on which the Director receives the examination, the examination is deemed to be approved by the Director.

(d) WAIVER.—(1) Except as provided in paragraph (2), the acquisition career program board of a military department may waive any or all of the requirements of subsection (b) with respect to an employee of that military department if the board certifies that the employee possesses significant potential for advancement to levels of greater responsibility and authority, based on demonstrated analytical and decisionmaking capabilities, job performance, and qualifying experience. With respect to each waiver granted under this subsection, the board shall set forth in a written document the rationale for its decision to waive such requirements. The document shall be submitted to and retained by the Director of Acquisition Education, Training and Career Development.

(2) The acquisition career program board of a military department may not waive the requirements of subsection (b) (2) (A) (ii).

(e) MOBILITY STATEMENTS.—(1) The Secretary of Defense is authorized to require civilians in an Acquisition Corps to sign mobility statements.

(2) The Secretary of Defense shall identify which categories of civilians in an Acquisition Corps, as a condition of serving in the Corps, shall be required to sign mobility statements. The Secretary shall make available published information on such identification of categories."

CAREER DEVELOPMENT UPDATE

Training with Congress

The 1991-92 Training with Congress Fellowship Program (sponsored by the American Defense Preparedness Association) is underway. Officers selected to participate in this year's program are: LTC Colleen F. Prasil, FA 51; LTC Charles L. Mudd, FA 53; and LTC Duwayne W. Jones, FA 97.

Army Acquisition Corps officers who are graduates of the Program Management Course and are interested in participating in next year's program should contact their assignment officers at PERSCOM.

Civilian Graduate Study Program

We are pleased to announce the panel results for the selection of civilians for the Army Acquisition Corps graduate study program. John L. Skrletts and Richard J. Snyder, both of the Program Executive Office, Communications Systems, have been selected to attend the Executive Master of Science in Engineering Program at the University of Pennsylvania.

Command Eligibility for AAC Officers

On Oct. 11, 1991, the chief of staff, Army made the decision that now allows Army Acquisition Corps FA 51 and 97 officers to compete for functional area Table of Distribution and Allowances commands when those positions are determined to be acquisition related and added to the AAC critical position list.

A listing of AAC command positions associated with this decision will be published in the next issue of *Army RD&A Bulletin*.

BOOK REVIEWS

The Impact of R&D Investment on Productivity— *New Evidence Using Linked R&D-LRD Data*

By Frank R. Lichtenberg and Donald Siegel
An Article Published in *Economic Inquiry*, Volume XXIX, No. 2, April 1991, pages 203-229

Reviewed by CPT Tom Gilbert, an Army Acquisition Corps officer currently attending Oregon State University.

This research article illustrates the impact of technological change, or more precisely, the effects of research and development (R&D) on the U.S. national economy. This factor is important as it relates to the investment business sectors are willing to place in future production capability. This has been an indicator of competitive behavior and improved performance and output.

The article asserts that investment in R&D has a strong impact on the overall productivity growth of business. The authors used various modeling series to examine the available data and the implications of R&D to productivity growth. They cited the diversification of business as the most difficult obstacle to quantify the analysis of available data since business does not always operate in one specific commercial segment.

The writers explained the Longitudinal Research Database (LRD) that consolidates the measures of productivity at the business level. This time series file contains a large volume of data on various business segments. Through the LRD, a measurement of business productivity has been demonstrated with a correlation between increased R&D investment and increased productivity. The authors cited a lack of good quality productivity measurement as a leading factor in previous models. They emphasized the need to use micro-level studies versus the aggregate macro studies used on industry-wide comparisons. They were, however, cognizant of the limitations of the micro study and outlined some of the predominant factors.

One area of interest was the revelation that federally-funded R&D programs, and these include the military R&D activities, have limited measurable impact except with the productivity of the small industry sector. Measurement of the impact of federal funds may be difficult due to the nature of the investment (non-industrial related research and defense) and the problem of measuring the related industry benefits to that research. It was noted that federally-funded research programs appeared to have little effect on productivity growth (perhaps through inadequate measurement criteria).

The researchers did point out that it is apparent that R&D returns on investment are increasing over time. The size of the firm engaging in R&D was a factor in the rate of return. It appeared that the smaller the firm, the less it received in return on R&D investment. The rate of return on basic research by industry was noted as a strong determinant in productivity increases.

In conclusion, the researchers reaffirmed that there was a distinct relationship of R&D to positive productivity growth. Yet it remains uncertain to what degree the model underestimates economic growth from the contribution of federal and military efforts and expense on research and development.

BOOK REVIEWS

Assignment: Pentagon— The Insider's Guide to the Potomac Puzzle Palace

By MG Perry M. Smith, USAF (retired)
Pergamon-Brassey's: 1989

Reviewed by John Brand, LABCOM Survivability Management Office

This little book is not just an engaging and entertaining essay in mere survival for Pentagon-bound military. It is a delightful mixture of coping strategies for staff people, a window into anecdotal history, and a discourse on ethics and philosophy. Although the advice on coping professionally with a Pentagon staff environment and its stresses is intensely practical and situation oriented, it is applicable to any staff assignment in any headquarters—I suspect it would do for Xerox or IBM as well as DOD. The advice is also applicable for workers in research and development or test and evaluation. This book should be read by military and civilian defense professionals—and by others.

There is a wealth of advice on mundane matters such as car pooling (not least to limit the work day), finding things in "The Building," house hunting, and so on. These alone would justify getting and reading the book. But more important, especially to anyone who works with other human beings, is the advice on being a good staff officer. That advice is useful to all military and civil professionals.

The advice is simple and concrete, as a few of the chapter headings suggest: The Pentagon: Realities and Myths (Chapter 2); Rules of Thumb: Helpful Hints on How to Get Ready to Work, Survive and Thrive (Chapter 3); Where Were You When the Page Was Blank? . . . the Agony and the Ecstasy of the Action Officer (Chapter 6); Difficult Bosses (Chapter 9); Working with Defense Contractors (Chapter 15); Some of the Fudge Factory's Deficiencies (Chapter 16); Interviewing (Chapter 18); How to Give and Receive Briefings in the Pentagon (Chapter 19); People Who Can Help You (Chapter 22); Military Ethics in the Pentagon (Chapter 25); and Future Shock: Pentagon Changes Through the 1990s (Chapter 26).

These bits of advice never mince words. For example, in "Rules of Thumb" we are told:

> *"Learn from the Bad Folks. The good people are plentiful . . . However, you can learn more of what not to do from the bad people: the slick operators, the sycophants, the manipulators, those who play fast and loose with the facts . . .*
>
> *"Learn whom to trust and whom not to trust . . .*
>
> *"Maintain your integrity. In the jungle of the Washington scene, it is quite easy to sell your soul incrementally without even realizing what you are doing.*
>
> *There are certainly lots of temptations to cook the numbers . . .*
>
> *"Beware of those who operate outside the system . . .*
>
> *"Watch out for 'loose cannons on the deck' . . .*
>
> *"Be prepared to be fired . . ."*

The essence of a Service staff, and perhaps even more of a Joint Staff, is teamwork. Underlying the team work, however, is the advocacy process that is used to determine the common point of view. This dynamic ebb and flow of ideas, with defense of often competing points of view, is often misinterpreted as useless pandemonium. What is overlooked is the essential noisiness of any free market, especially one of ideas. A static appearance may be mistaken for perfection, but such an environment cannot adapt to a changing world. Of course, unless the market place of ideas eventually converges to a common policy, the process is ineffectual, and cannot adapt to any world. Good staff work is one of the essences of the general staff—the other is leadership, and this book has a lot of advice about both. But without ethics neither action officer nor leader can function, and ethics is a theme that recurs over and over throughout this book.

Perhaps the most fascinating aspect of this book, one which commends it to the attention of anti-militarists in academia or citizens interested in all aspects of the social environment in which they live, is the window into the philosophy of an intensely ethical and honest man. Ill wind notwithstanding, and contrary to some sensationalist novelists and reporters, the people who end up in The Building are drawn from society rather than some foreign planet—they are just usually brighter and harder working than the average. The advice that is given is based on how to function according to a code of conduct based on honor, and there is a large segment of the population that needs to be exposed to advice to working people based on common and tacit acceptance of honor, honesty and intelligent public service. The philosophy in this book is not a sermon to the believing or propaganda to the disbelieving; it is a discourse from one public servant to another based on and with shared acceptance of a philosophy as a working tool. This is more enlightening to the cynical or the misled than all the press releases in the world.

Perhaps the best advice on ethics is summed up in the chapter on "Military Ethics in the Pentagon:"

> *"Military services must, of course, understand the bureaucratic and political rules of the game, but they can still live within the framework of high institutional and personal integrity. If standing up for a principle costs you a promotion, a great new job, or forced retirement, so be it." (p. 230)*

It is worth remembering that this was written by a man who earned the rank of Major General—and that in spite of having once been fired in mid-career, as he says, from a job in the Pentagon.

☆U.S.

BOOK REVIEWS

The Political Economy of Military Expenditure: An Introduction

By Peter Dunne

An Article Published in *The Cambridge Journal of Economics*, Volume 14, No. 4, December 1990, pages 395-404

Reviewed by CPT Tom Gilbert, an Army Acquisition Corps officer attending Oregon State University

This article illustrates a contemporary view of the importance and impact of military expenditure on the economies of modern industrialized countries, specifically the U.S. and Britain. The paper outlines divergent thoughts on the effect of the "peace dividend" on a nation's economy.

This research is of particular relevance since the U.S. military is entering the first stage of a sizable contraction in force levels, weapons procurement and total gross expenditures. Since the U.S. military will enter the new century at its smallest size (in both manpower and percent of GNP) since before the Korean War, this article provides a unique perspective on the anticipated impact on the economy.

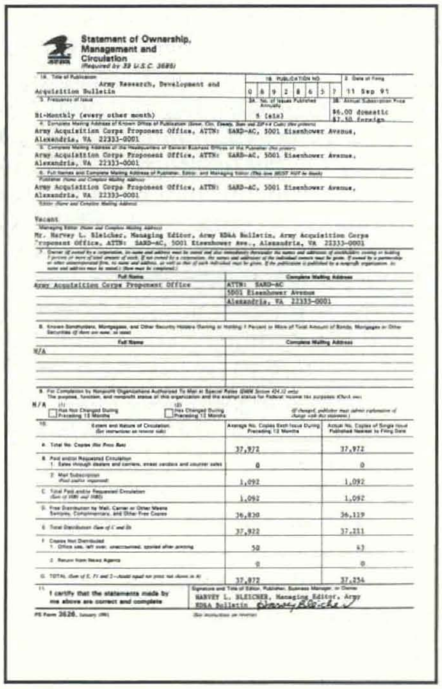
The article acknowledges that military expenditure has significant impact on the economy for the employment it provides through direct or indirect means and the trade it permits. The largest problem in adequately measuring the cost effectiveness of that expenditure has been the inability to measure the force capability of the military as a quantifiable and finite figure.

Three approaches to examining the military's role in the economy were discussed. They were the neoclassical, liberal, and Marxist economic approaches. A corollary effect of military expenditure, called underconsumption, is that using the military as an outlet permits the "absorption of surplus" without the increase in payroll to maintain contribution levels.

Macro-economic effects of military spending appear to adversely impact the ability of the nation in the area of consumption expenditure. The cost of the military reduces capital that could have been used by the public and private sectors of the economy. A side effect of military action, according to the author, is that so long as the conflict does not directly impact the nation, war is basically good for the stock markets.

The industrial effects of the military, specifically with procurement, illustrates the potential to use this sector as a means of achieving artificial employment levels. An example of this in the U.S. is that as the military draws down, we are seeing the parochial side of the elected officials as they scramble to save their own district's military complex.

Overall, the economic effects of military reductions are difficult to quantify. It is the considered opinion of the author and his colleagues that the downsizing of the military is anticipated to be good for the economy. This will permit the economy as a whole to seize new economic opportunities.



Statement of Ownership, Management and Circulation
(Required by 39 U.S.C. 3685)

1A. Title of Publication: Army Research, Development and Acquisition Bulletin
1B. Publication No.: 0 6 9 2 8 6 5 7
2. Date of Filing: 11 Sep 91
3. Frequency of Issue: Bi-Monthly (every other month)
3A. No. of Issues Published Annually: 6 (six)
3B. Annual Subscription Price: $6.00 domestic, $7.50 foreign
4. Army Acquisition Corps Proponent Office, ATTN: SARD-AC, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001
5. Army Acquisition Corps Proponent Office, ATTN: SARD-AC, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001
6. Publisher: Army Acquisition Corps Proponent Office, ATTN: SARD-AC, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001
Editor: Vacant
Managing Editor: Mr. Harvey L. Bleicher, Managing Editor, Army RD&A Bulletin, Army Acquisition Corps Proponent Office, ATTN: SARD-AC, 5001 Eisenhower Ave., Alexandria, VA 22333-0001

7.

Full Name	Complete Mailing Address
Army Acquisition Corps Proponent Office	ATTN: SARD-AC, 5001 Eisenhower Avenue, Alexandria, VA 22333-0001

8.

Full Name	Complete Mailing Address
N/A	

9. N/A

10. Extent and Nature of Circulation	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies	37,972	37,972
B. 1. Sales through dealers and carriers, street vendors and counter sales	0	0
2. Mail Subscription	1,092	1,092
C. Total Paid and/or Requested Circulation	1,092	1,092
D. Free Distribution by Mail, Carrier or Other Means, Samples, Complimentary, and Other Free Copies	36,830	36,119
E. Total Distribution	37,922	37,211
F. 1. Office use, left over, unaccounted, spoiled after printing	50	43
2. Return from News Agents	0	0
G. TOTAL	37,972	37,254

11. I certify that the statements made by me above are correct and complete: HARVEY L. BLEICHER, Managing Editor, Army RD&A Bulletin

PS Form 3526

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Phone: (703)274-8977/8
DSN: 284-8977
Fax: (703)274-8038

☆U.S. GOVERNMENT PRINTING OFFICE: 1990—261-854/40002

FROM THE ARMY ACQUISITION EXECUTIVE. . .

Today the Army acquisition community faces a major challenge: to develop, produce, and field superior equipment for our soldiers with the smallest budgets in a decade. The Army must deal with this reality as we modernize. Success in future conflicts depends on accomplishing more with less and reinforces the arguments for more effective contracting.

The essential steps in system contracting are: (1) requirement statement; (2) source selection; (3) development contracting; (4) contract management; and, (5) production award. We must plan for and carefully manage each of these steps. I suggest the following be considered as we move into this era of budget constrained modernization:

1. Balanced requirements. We are often accused of "goldplating" weapon systems. With decreasing budgets, streamlined, realistic requirements are more critical than ever. We need to be sure that we do not ask for more than the technology can deliver, for earlier delivery than can be achieved with moderate risk, or for capabilities that are more than we can afford. Our requests for data need to be tailored to specific programs. Although considerations for follow-on competition often require that we obtain technical data packages, we should examine the program's future and realistically determine the benefits versus the costs of these data.

2. Best value source selections. The source selection process reduces the field of competitors to that offeror who can best deliver the required product within the proposed cost and contract schedule. To assure the selection of that offeror, our solicitations must emphasize:

(a) **Realistic proposals.** Award to a contractor with unrealistic costs will lead to either cost and schedule overruns or unsatisfactory performance or both, possibly concluding with a major restructuring or contract termination. Our aim is "best value," including equitable distribution of risks—not to secure the lowest estimated award price. It is essential that each contractor's proposal be measured against a government cost estimate (GCE) tailored to his proposed approach. I encourage Source Selection Authorities to instruct their Source Selection Evaluation Board Chairmen to assess the realism of each cost/price proposal using a GCE based on that contractor's technical and management approach.

(b) **Program affordability.** We must employ the technique of Design to Cost (DTC) to balance the importance of development, production, and operating and support costs. DTC serves as a yardstick and works to encourage that systems are developed within the original cost, performance and time frameworks.

(c) **Past performance.** A contractor's applicable track record of technical, cost and management performance should be considered during evaluation. Evaluators should thoroughly examine a contractor's performance on similar efforts. We must be tough but fair in the evaluation of past performance. Data must be timely and accurate. We should fully investigate negative reports to confirm their applicability to the current selection. All negative data should be discussed with offerors so they have an opportunity to respond.

(d) **Management structure.** The organizational structure cited in the management proposal should indicate how the contractor will implement his technical proposal. Evaluators should carefully review the organizational structure, relationships and arrangements (such as joint ventures, teaming proposals, and even significant subcontract agreements) to assure accountability and clear responsibility for contract performance by a defined prime contractor organizational entity and specific individuals. In evaluating these arrangements, take into account government risk associated with lack of accountability. As a general proposition, we should use joint ventures only as a last resort because of the divided responsibilities inherent in those relationships.

3. Development contracting. In Engineering and Manufacturing Development (EMD) contracts we must evaluate the entire cost proposal and insist on fee structures that represent a true picture of the contractor's share of risk. We should aggressively seek a contract type that incentivizes contractors to hold costs within their proposed estimate while adhering to the contract's technical requirements. Incentive fee contracts should have share ratios which provide meaningful rewards for cost underruns and significant loss of fee for cost overruns. My June 27, 1991 memo, "Contracting for Research and Development," covers this subject in more detail.

4. Contract management. Contract management is a team effort involving the Administrative Contracting Officer, the Procuring Contracting Officer, as well as the PEO and PM. The contractor's performance must be carefully monitored to provide early detection of problems.

Even with proper safeguards in place, major problems can still arise. When a contract is hampered with serious cost overruns/cost growth and/or unacceptable schedule delays, the Army must consider contract termination. Contracts should clearly indicate those conditions which would prompt the Army to initiate a review to determine if the effort should be terminated.

5. Affordable production. Past acquisition strategies have been characterized by fixed price or not-to-exceed (NTE) production options in competitively awarded, cost type EMD contracts. These option requirements often fail to consider a contractor's inability to realistically price ill-defined options early in the development program. While there may be an argument for locking-in production prices while still in a competitive phase, we should not place unwarranted financial risk on the contractor—precisely what we are avoiding with the cost reimbursable EMD contract.

Instead of insisting on fixed or NTE option prices prior to award, we should give the contractor time to learn more about the system and its production costs by delaying negotiation of production options until after Critical Design Review. To encourage reasonable prices in production, development contracts should be structured to provide significant award fees to contractors who meet the original DTC.

We must develop the most appropriate approach for each acquisition. Our ability to accomplish Army modernization objectives will be enhanced with streamlined realistic requirements, selection of the best value contractor, by effectively monitoring his efforts and ensuring affordable production systems for our troops. I am confident that the general approaches described above will help us meet this challenge.

Stephen K. Conver

ARMY RD&A BULLETIN
ISSN 0892-8657

Army RD&A Bulletin
5001 Eisenhower Avenue
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