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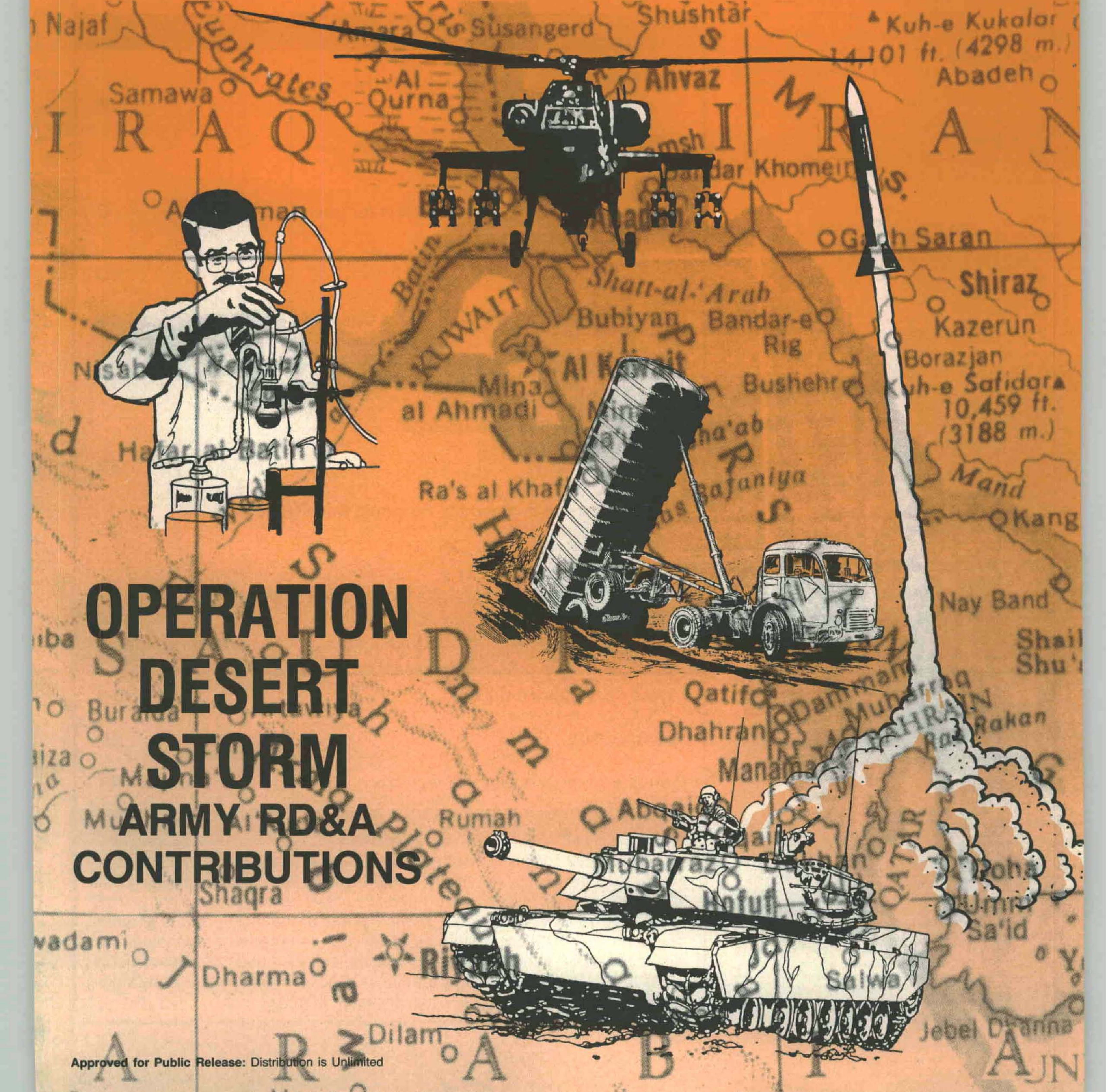

OPERATION DESERT STORM

ARMY RD&A CONTRIBUTIONS

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MAY-JUNE 1991
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ARMY RD&A BULLETIN

Research Development Acquisition

Professional Bulletin of the RD&A Community

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COVER

Although the conflict in Southwest Asia is now over, the factors resulting in the huge military success of the United States and its coalition partners in that effort will undoubtedly be a much studied subject for sometime to come. This issue of *Army RD&A Bulletin* is devoted to one of the most obvious of those factors — the RD&A contributions which provided the most technologically advanced equipment ever seen on a battlefield. Included are achievements of the Army Materiel Command, the Army Corps of Engineers, the Army Medical R&D Command, and the Army Research Institute.

AMC RD&A SUPPORT FOR OPERATION DESERT STORM

"The quality of American technology, thanks to the American worker, has enabled us to deal successfully with difficult military conditions and help minimize precious loss of life. We have given our men and women the very best. And they deserve it."

President George Bush
State of the Union Address
January 29, 1991

By Kathleen Christ

Introduction

In the months just prior to the Iraqi invasion of Kuwait, the Army Materiel Command's (AMC) Technology Planning and Management Office conducted two Tech Base Seminar War Games. Technologies and systems anticipated to be available by the year 2015 were evaluated in various scenarios. Almost prophetically, one mid-to-high intensity scenario was set in the Southwest Asian desert against a large and well equipped enemy force. The results highlighted the problems with delivering a highly lethal force, over very long distances, to a host nation with minimal infrastructure. Using the AirLand Battle-Future concept, the capabilities shown to provide the greatest impact were information related: low cost, launch-on-demand satellites; multispectral sensors; and real-time battle management. Operation Desert Shield and subsequently Operation Desert Storm validated these concerns and the value of the multiple capabilities of these complex systems.

The Army has traditionally prepared and trained for the European/Soviet threat scenario. Operation Desert Shield forces faced similar equipment and tactics, but in the severe environment of Southwest Asia (SWA). The Arabian Peninsula is characterized by high temperatures during the day and sharp drops in temperatures at night. Desert winds can reach almost hurricane force. Few roads and a limited infrastructure were in place. Sand effects on equipment required increased maintenance. The environment, threat of chemical and biological warfare and the use of tactical ballistic missiles — such as the SCUD, provided severe challenges for our Army, soldiers and equipment.

The AMC research, development and acquisition team was equal to the challenges, providing our soldiers the technology and materiel to win. Today's equipment, the result of years of dedicated effort by the AMC community, performed well. AMC teams were mobilized to make available their expertise to Desert Shield. Hundreds of innovations and technological solutions to unexpected and projected problems were provided by AMC's seven laboratories, eight research, development and engineering centers (RDECs), and their university and industry partners.

A call for "good ideas" from the private sector appeared in the Commerce Business Daily. Approximately 2,000 proposals were received. Patriotic individuals submitted their "good ideas" hand-drawn on notepaper. Ideas ranged from devices for digging trenches safely under fire to an individual soldier cooling suit.

AMC set in motion an impressive production surge and R&D acceleration review process to manage the vast number of "good ideas." A general officer steering committee met weekly to review the ideas, ferret out the high payoff, near term opportunities then advocate them to the Army staff.

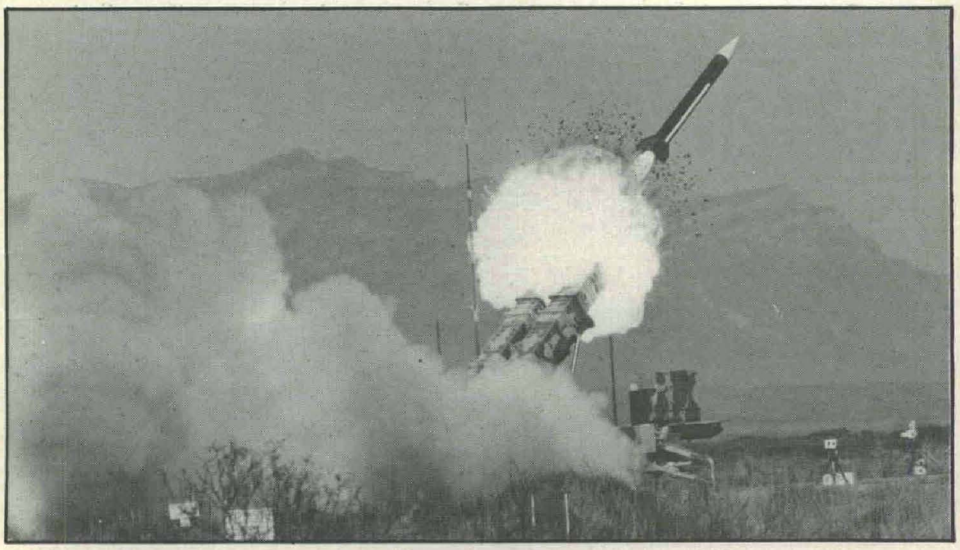
Increased Production and New, Good Ideas

Most fielded systems in the Persian Gulf war were the result of years of work by AMC's laboratories, RDECs and their partners in the private and academic sector. Research and development conducted a decade or more ago provided the base for these systems. Examples such as the M1/M1A1 and the Apache helicopter more than proved their value in battle. The RDA community responded quickly to unexpected problems. Items currently in the technology development phase were accelerated and placed directly in the field, developmental items were fielded in limited numbers and numerous occasions of production "surge" resulted from AMC-Industry teamwork.

No item more dramatically emphasized the contributions of the AMC community than did the Patriot missile system. Accelerated development of modifications to the warhead, M818E2 fuze and software designs added an anti-tactical ballistic missile capability. Now known as "SCUD-Busters," the Patriot system provided catastrophic warhead kill of Iraq's ballistic missiles. The Patriot also produced an unforeseen but enormous political tool which not only saved countless lives and hurt Iraq's strategic plan, but provided strength to the allied coalition.

Fire support played an important suppression role. Low-rate production of the Army's Tactical Missile System (ATACMS) was accelerated. An all-weather, long range effective ground-to-ground missile capability added substantially to the air force pummeling of Iraq's ground forces.

The environment created unforeseen problems. Aviation maintenance demanded a clean environment free of sand and dust to service our helicopter fleet. A shelter 75 by 29 by 190 feet was requested. No shelter that large existed in development or production. A small firm was found that could produce rapidly erectable "clam shelters," named for the type of door at each end of the structure.



Patriot Missile System.

During the early deployment, several helicopter accidents occurred during night exercises. Although wearing night vision goggles, the pilots were flying into visible sand dunes due to the lack of terrain contrast and distance cues. A quick, low-cost solution was fielded.

The environment provided positive opportunities as well. Power is always in short supply. Lightweight solar panels were provided as portable power sources capable of recharging batteries used in communications equipment. The panels are silent, generate no heat and result in low detectability when powering communications and electronic equipment, making them ideal for deep reconnaissance missions.

The landmine, always a major concern in wartime, once again reared it's unglamourous albeit ugly head. Two systems developed by AMC were deployed to assist in the disposal of mines in the desert and along the Kuwait beaches. An enhancement kit for Security-Explosive Ordnance Disposal (S-EOD) Robots was provided to enhance remote operating capability. First used in Panama during Operation Just Cause, the enhancement kits for the S-EODs substantially reduce the risk to soldiers neutralizing unexploded mines and munitions.

Artificial Intelligence Module Test Bed (AIMTB)

The AIMTB is a Congressional Balanced Technology Initiative program sponsored and managed by the U.S. Army Intelligence Center and School with support from the U.S. Army Laboratory Command's Harry Diamond Laboratories (HDL). A spinoff of research ongoing in the HDL, the system provides the tactical commander and staff at division and corps level the ability to process intelligence information on the battlefield. As such, it improves the timeliness and accuracy of intelligence support to the battlefield commander through the use of artificial intelligence and advanced hardware and software technology.

The AIMTB is a complex system containing state-of-the-art processing technology requiring innovative packaging, system power and environmental control designs. An open architecture approach is taken for the hardware and software designs, enabling it to be flexible enough to grow with advancements in hardware and software technology while still being operated and molded by interactions with field units.

An interim testbed was delivered to the U.S. Army 307th Military Intelligence (MI) battalion in December 1988. The unit served as a fielded platform to determine user requirements and test the software. The unit is still in operation today.

Following further modifications and developments, the final four AIMTB systems were delivered and installed in July and September 1990 to units stationed in Germany. Two units were deployed with the U.S. Army 307th MI battalion with the remaining two units sent to the U.S. Army 7th Corps for fielding at different sites. The systems performed exceptionally throughout various field training exercises.

In December 1990, the U.S. Army 7th Corps deployed to Southwest Asia. Based on the continuous successful performance of the AIMTB during field training exercises in Germany, the U.S. Army 7th Corps commander requested the testbeds be immediately fielded to the theater. Once in SWA, hardware updates correcting known deficiencies as well as providing additional capabilities were completed by the end of January 1991.

The AIMTB was utilized extensively during Operation Desert Storm. Integrating data from a variety of sources, the system accurately portrayed threat targets and the battlefield situation. Initial reports from the field commanders have been positive. As the commander, 307th MI Battallion, said "It is the best system of its type. No other capability, fielded or in design, can meet the needs . . . as can this system." The AIMTB is an excellent example of technology transfer at its best.

Combat Engineer Vehicle Mine Rake.

Developed and delivered within four months, the Combat Engineer Vehicle (CEV) Mine Rake was forwarded to augment the existing blade on the front of the CEV. The rake can rapidly clear a mine-free path substantially wider than our tanks. The rakes provided an essential capability to the rapid movement of our ground forces. Designed and produced in-house, more than 40 systems were deployed.

Advice and Counsel

Within weeks of the Iraqi invasion, a research and development sustainment analysis group was formed to anticipate sustainment demands. Potential operational, materiel and infrastructure issues and problems were identified. A booklet, *Sustaining Desert Operations*, providing insight and solutions was prepared and sent to logisticians and commanders in the field.

AMC advisors provided direct, in-theater advice on equipment operating in the unique desert environment and resulting hostile enemy actions. Expertise ranged from assessing lithium battery performance, to atmospheric effects on chemical hazards and smart munitions, material wear and corrosion, night vision devices, secure communications and electronic countermeasures.

The AMC Field Assistance in Science and Technology (FAST) Office continued it's success as a conduit for field assistance. Beginning in October 1990, monthly FAST "Shuttles" delivered urgently needed equipment and identified new requirements to the AMC labs and centers for solutions. Some of the items provided the troops through the "shuttle" were dust/sand covers for M-16 rifles, adapters to link drinking straws in chemical protective masks to five-gallon water jugs, and special tape to protect the edges of helicopter rotor-blades from erosion caused by the sand. A sleep restraint system for M1 and M60 tanks had previously been developed and was fielded in substantial numbers, allowing armored vehicle crewmen to sleep safely inside their vehicles during extended or continuous field operations. Seemingly small and insignificant in the fast paced, high technology world, these simple fixes often provide a capability that enhances performance and raises morale.

Chemical warfare experts applied state-of-the-art modeling and analysis capabilities to provide field commanders advice on use of chemical protection equipment. MOPP reduction advice and training on the tricky operation of unmasking after contamination was provided. A data base created to predict agent persistency was also made available. The ability to predict "Persistency Footprints" was provided for decontamination of equipment. Subsequently, a booklet entitled *Chemical Warfare Countermeasures for the Middle East* was prepared and forwarded to SWA. The booklet highlights key

Center for Combat Identification Technologies

The Army has had a long standing concern about fratricide. Friendly fire incidents have occurred in virtually every conflict. Operation Desert Storm was no different. However, sometimes it takes such conflict to remind us of the importance of such concerns.

As a result of the accidental destruction of a U.S. Marine Corps Light Armored Vehicle by a U.S. A-10 airplane, the U.S. Army established the Center for Combat Identification Technologies on Feb. 8, 1991. The center is a multidisciplinary team of experts from the appropriate AMC laboratories and research, development and engineering centers, Army Training and Doctrine Command centers and program managers for the various weapon systems employed on the battlefield. They were tasked to find or generate immediate solutions to the fratricide problems encountered in Operation Desert Storm.

Within one week, a series of field experiments were conducted at Fort A.P. Hill, VA, Langley Air Force Base, VA, and Aberdeen Proving Ground, MD. Over 30 devices were evaluated using fixed and rotary wing aircraft and ground vehicles. A second series of experiments, involving all services and DARPA, were subsequently conducted at Yuma Proving Ground, AZ, the following week.

Simple, reliable and easily installed "fixes" were deployed.

Although Operation Desert Storm is successfully completed, the center's work is just beginning. The center is working with the other Services, allies and private industry to exploit all technological approaches to mitigate fratricide. Near term focus will be the adaptation of existing techniques for use and test in operational environments such as the National Training Center. For the long term, technologies will be developed which will enable weapon systems to continue to be utilized at their maximum capability while preventing fratricide and maintaining low enemy detectability and identification. Moving forward on a lesson relearned!

NEW CONTRIBUTIONS
OF THE AMC LABORATORIES AND CENTERS

Initiatives Submitted: RDE Centers 69
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Initiatives Deployed:

- 50 caliber Countermine Rifle
- Infrared Blinking Lights
- Binoculars & Long-Range Scopes
- Remote Tank Breaching System
- Mortar Fuze Testing
- Mine Clearing Rake
- Biological Agent Collection/ Detection System
- Mine Probes
- S-EOD Disposal Kits
- Lens Abrasion Protection
- Load Expert System
- Water Purification Tablets
- External Discharge Device for Lithium Batteries
- Thermal Tape
- Terrain Avoidance System
- Fire Fighting Agent Evaluation
- Patriot II System Upgrade
- Technical Assessments
- M1 Decoys
- Ultra-lightweight Camouflage
- Micro-Climate Cooling System
- M1 & M60 Sleep Restraint System
- Thermal Tarps
- AC/DC Converter
- Lithium Battery Status Indicator
- Vulnerability Do's/Don'ts Books

actions to assist individual soldiers, first-line leaders, and chemical staff officers in surviving and continuing their fighting mission on a chemical warfare battlefield.

Assessment teams were sent to SWA by AMC to provide on-site support and collection of valuable information for use in future improvement and design of U.S. weapon systems. A team deployed just before the start of the ground war, assigned to the U.S. VII Corps, conducted battle damage assessments (BDA) of our armored vehicles.

After the Army's early deployment of the BDA team, the Department of Defense tasked the services to collect weapon systems performance data. Led by the Army Materiel Systems Analysis Agency (AMSAA), the advance group of this team arrived in SWA in early March with the remainder of the team following shortly thereafter.

Lessons Learned

Out of every conflict come the inevitable lessons learned — what worked, what didn't and what could have been used. The Gulf War will be no different. We will capture the lessons learned and apply them to future materiel development.

To capitalize on these lessons, a Desert Storm Technology Base Task Force has been established. The task force is comprised of personnel from across AMC activities and the Office of the Surgeon General, Corps of Engineers and the Army Research Institute. Appropriate adjustments will be made to the next revision of the Army Technology Base Master Plan to address the shortfalls. The Master Plan is the basis for the tech base community's input into the Training and Doctrine Command's Army Modernization Memorandum and the Long Range Army Materiel Requirements Plan.

The lessons learned and performance data collected will be incorporated into research and development planning for next generation and future systems. In addition, a follow-on seminar war game will be conducted so that the tech base community can again "war game the future."

Conclusion

GEN William G.T. Tuttle, AMC commander, has identified a number of key missions for AMC. These include developing and acquiring non-major systems and equipment; providing development and acquisition support to program executive officers; and defining, developing and acquiring superior technologies. These have been accomplished to the fullest as witnessed by AMC's RDA support to Operation Desert Storm.

Superior technology and the ability to respond in real time have proven essential in Operation Desert Storm. GEN Tuttle has reemphasized the importance of each of these and is pushing for an enhancement to our ability to further improve the technology available to deter future conflict and aggression. As GEN Norman Schwarzkopf stated in his daily news briefing on Feb. 27, 1991: ". . . one of the things that has prevailed, particularly in this battle out here, is our technology."

AMC is proud of its contributions to Operations Desert Shield and Storm and is dedicated to keeping our technological edge!

KATHLEEN CHRIST is the assistant to the LABCOM director of corporate laboratories at LABCOM Headquarters, Adelphi, MD. She holds a Bachelor of Engineering degree in industrial engineering from Youngstown State University.

HEL AND THE PATRIOT AIR DEFENSE SYSTEM

By John R. Erickson and Gary L. Kurtz

Introduction

During Operation Desert Storm, concerned observers on both the east and west borders of Iraq watched anxiously for the successful performance of the Allied forces and their materiel. No other weapon system created more hope, anxiety, and pride than the Patriot Air Defense Artillery System. But it took more than American technology to achieve the applauded results — it required people and materiel working together synchronously to get the desired system performance.

Here is the story of how human performance and equipment performance, such as that advocated by the Manpower and Personnel Integration (MANPRINT) Program, were integrated by the U.S. Army Human Engineering Laboratory.

History

In the late 1950s and early 1960s, the Human Engineering Laboratory (HEL) was funded by several project offices at Redstone Arsenal, AL, to provide human factors engineering (HFE) support during development of their systems, e.g., Hawk, Jupiter, Pershing, Saturn, Nike Zeus, Surface To-Air Missile Defense (SAM-D), Safeguard, Patriot, etc. While working on these programs, the HEL soon learned that the Army's Human Engineering program had little leverage either within the Army or industry.

Through the good graces of the U.S. Army Missile Command (MICOM) Standards Office and the hard work of HEL's resident HFE specialist, several HFE Military Specifications, Standards and Data Item Descriptors were developed, coordinated with interested agencies through the Department of Defense (DOD) and industry, and approved as tri-service Military Specification, Standards and Data Item Descriptors. This documentation package provided program offices, contracting officers, and industry contractual tools for implementing HFE requirements into contracts and provided the means for measuring contractor performance in addressing these requirements.

In the process of developing these specifications and standards, voids in HEL's knowledge of human performance and environmental effects on human performance became embarrassingly evident.

One area, for example, was the effects of acoustical energy on operator health and operator performance. After considerable collaboration with industry, medical agencies in the three services, and the DOD human engineering community, the HEL, through the MICOM Standardization Office, published a coordinated MIL-STD on acoustics which is applicable to the full spectrum of military hardware and system development.

Another area where there was a significant data void was in symbolic representation of information on displays. In the 1950s, the techniques of painting alphanumeric data and symbology over a target on an air defense Plan Position Indicator Display was developed. With computer control of positioning the data and symbology on the display, it was feasible to have the data/symbology track the target as it moved across the display. These two capabilities created two problems; i.e., proliferation of symbols, frequently with conflicting meanings, and display clutter, each having adverse effects on operator performance.

In the late 1950s, the HEL conducted a number of experiments to evaluate radar symbols in terms of discriminability and as an aid in target identification. However, because of lack of funding support and cumbersome simulation equipment, limited progress was made beyond summarizing the state-of-the-art at that time of radar symbology and identifying the many human factor problems that needed addressing.

Simulation of Patriot Engagement Control Console

Progress on solving man-machine interface problems occured when the HEL was tasked by MICOM to participate in the 1965-1966 Source Selection Evaluation Board convened to select a contractor for advanced development of a new air defense system known as SAM-D.

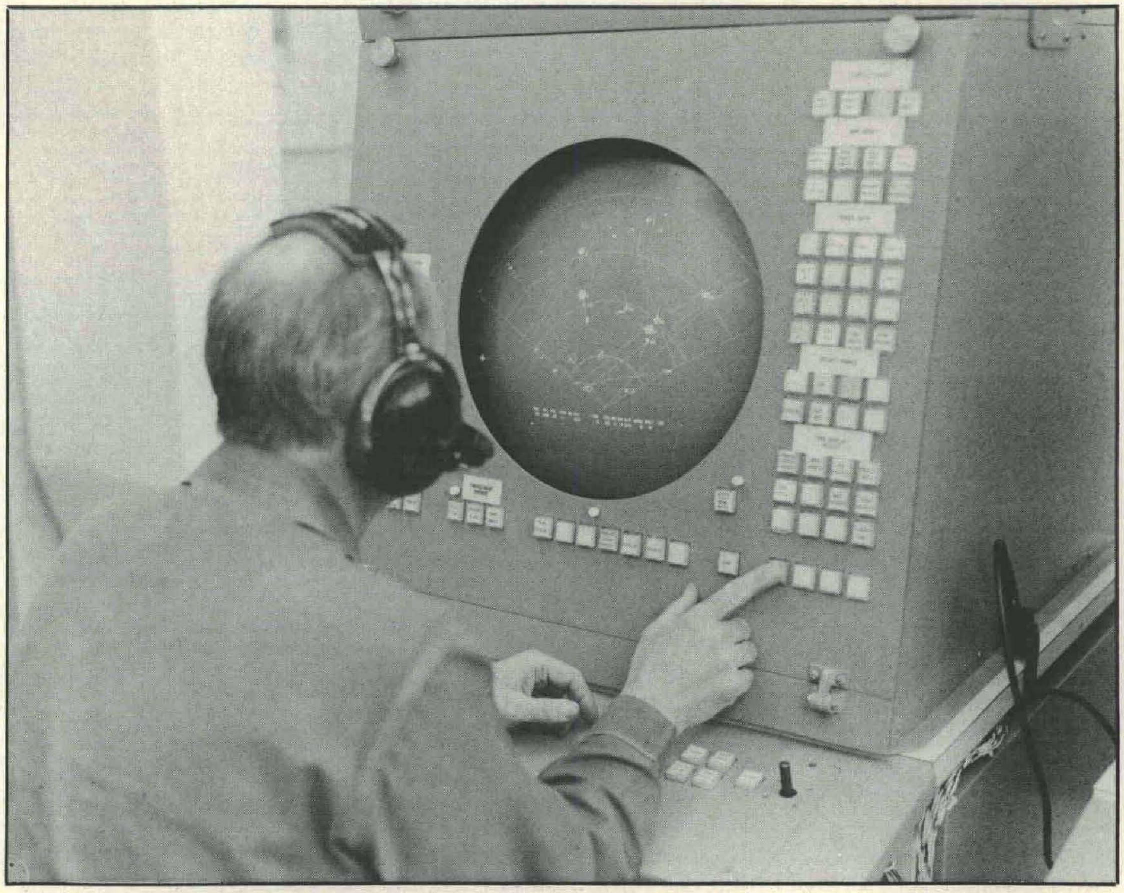
In addition to fulfilling its role in the Source Selection Board, the laboratory outlined those areas which would require in-depth research in order to define the role of the system operators and the methods and techniques by which the operators would control and direct the system during engagement. These areas included: symbolic representation of the threat, color versus monochromatic displays, horizon mapping, countering electronic countermeasures threats, inter- and intra-site coordinations and communication, and training.

As a result of participating in the Source Selection Board and the realization of the research required to address the areas noted above, laboratory experiments were initiated by the Applied Research Team of the Human Engineering Applications Directorate, HEL, to fill these design data voids. In 1969, this team developed and installed its Command/Control Simulator consisting of a calligraphic display system, a Varian 620f-100 computer and associated CDS 114 disk drive.

Using the contractor's specifications, two of the CRT consoles were reconfigured to simulate the Patriot engagement control console (see accompanying photo). Software to emulate the operator console activities was developed which had the following characteristics:

- Modular structure for easy software changes;
- Real-time execution;
- Faithful simulation of Patriot display and control processes;

HEL's Simulated Patriot Engagement Control Console.



• Operator interaction via function keys and stiff stick control;

• Collection and storage of soldier/system performance measures; and

• Ability to present unlimited number of tactical air defense scenarios.

During the succeeding years, a series of experiments closely phased with the system development milestones were conducted. Each experiment had been designed to be responsive to the developmental issue in question at that point in the development cycle. These laboratory experiments were closely coordinated with the project management office, the contractor, and the air defense community. The facilities and capabilities of the HEL were deliberately being used to complement the contractor's human factors capabilities and provide a means of investigating alternative approaches without a major investment in duplicative facilities.

The HEL facilities and their mission funding posture provided a bridge over fluctuations in project funding caused by normal technological perturbations in the program. This led to major contributions to the air defense community, which included the development of the first simulation of the operating consoles for Patriot and the application of HFE to the total Patriot system.

Simulation of the Operating Consoles

The simulation portrayed a technically accurate dynamic display of a series of tactical air defense scenarios. The flexibility of the simulator permitted restructuring of the display and controls to permit measuring the relative effectiveness of the operator in performing his target detection, acquisition and recognition tasks.

The simulation also provided a significant tool to train air defense console operators for their role in testing the Patriot system at Fort Bliss and White Sands Missile Range. These training efforts also provided a mechanism by which the air defense board personnel could provide their assessment of the ability of an operator to perform his tasks at a time in the development cycle when it was still cost effective to modify the design.

The simulation provided a means for the project office to demonstrate this facet of the system to the Army Materiel Systems Analysis Agency, the Training and Doctrine Command, the Operational Test and Evaluation Agency (OTEA), and other DOD and Army Materiel Command agencies. The knowledge and experience gained by laboratory personnel in this research program resulted in improved definition of the requirements for the Patriot Operational Tactical Trainer delivered to the Air Defense School and in a well-developed operational test program conducted by OTEA.

The specific contributions for improving the display and control (D&C) soldier-machine interface (SMI) for the Patriot were:

• Automatic designation (hooking) of priority threats — This significantly reduced operator reaction time.

• No more than two D&C consoles — This provided an efficient division of operator tasks/work load; e.g., enemy target engagement operations and friendly protection operations.

• Improved tabular display engagement queue — This provided more meaningful and useable information on the engageability of each threat; e.g., a launch window time.

• Enhanced layout of the graphical and tabular displays and workstations — This provided efficient and logical presentation of key enemy target information.

• Improved control coding and labeling — This reduced operator errors and time to engage enemy targets.

• Elimination of undesirable and unmeaningful control functions, significantly improving operator performance.

The in-house expertise developed in support of Patriot was and still is being applied to computer modeling and simulation of a variety of research and experimental programs to include:

• Tank fire-control studies.

• Predictions of antitank guided missiles gunner performance.

• Avionic instrumentation and pilot work load assessment.

• Ammunition supply point queuing.

• Helicopter canopy glint/glare configuration modeling studies.

• Class IX requisitioning and receiving processing procedures at the retail level.

• Forward Area Air Defense Command and Control Intelligence (FAAD C^2I) display and control studies.

• FAAD integrated weapon display and control system.

• Soldier-Portable Air Defense Display System (SPADDS).

HFE Application Activities

While the Applied Research Team at HEL was concentrating on the D&C SMI experiments to optimize the Patriot Engagement Control Station, other personnel did additional work. The U.S. Army Tank-Automotive Command, Armament R&D Center, the Mobility Engineering Research and Development Center, and HEL field representatives at the U.S. Army Air Defense Artillery School, MICOM, and PM TRADE, were applying HFE requirements of design standards MIL-H-46855, MIL-STD-1472 and MIL-STD-1474 to the design of system elements for which their commands were responsible. These personnel also conducted numerous evaluations of specific elements of the Patriot system.

Conclusion

HEL's participation in the Patriot system development program came at a time of significant growth of the total laboratory. The Patriot was one of several major system developments that provided an opportunity to enhance the professional stature of human factors technicians, contribute to HFE technology, lay some groundwork for the MANPRINT program, and apply this technology to system development programs.

Observing the success of the Patriot during Desert Storm makes all of the HEL personnel proud to have had the opportunity to contribute to its successful development.

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TACOM SOLVED HOT EXHAUST PROBLEM FOR DESERT TROOPS

Responding quickly in support of Operation Desert Shield (ODS), the U.S. Army Tank-Automotive Command's (TACOM) RD&E Center developed an exhaust-heat shield kit that solved a critical problem troops in Saudi Arabia had encountered when towing disabled M1-series tanks with other M1s.

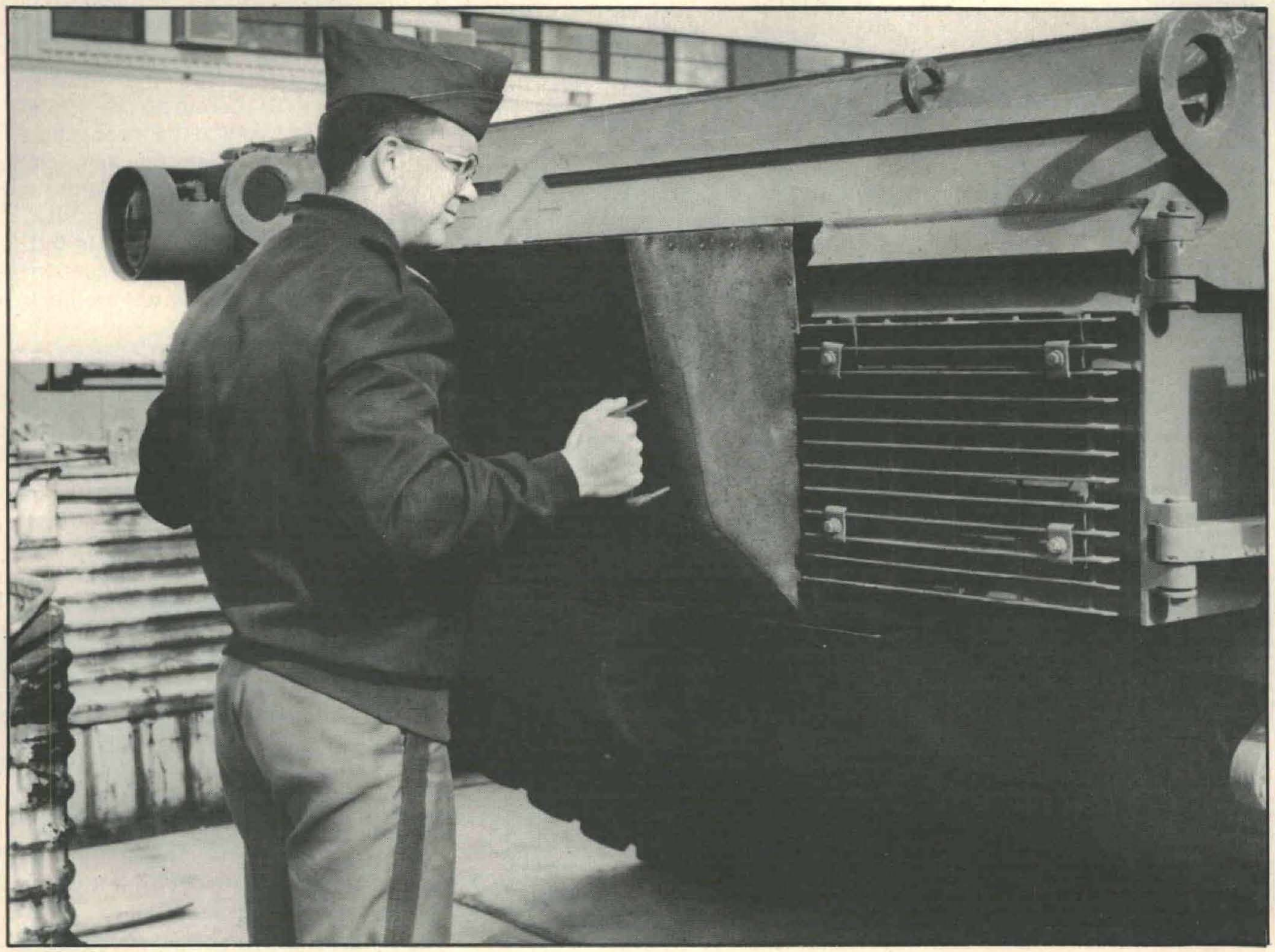
The engine that powers the M1 is a 1,500-horsepower gas turbine. The turbine engine runs with air exhaust temperatures ranging from 500 to 750 degrees Fahrenheit — enough heat to damage the paint, headlight lenses, turret vision blocks, hatch seals, and electronic components of a towed tank.

To protect troops from sustaining burns while removing the shields after towing, the exhaust shield uses a thermal blanket that keeps the intense exhaust heat from radiating through the metal.

Though the M1 has sufficient pulling power to tow a vehicle equal to its own weight, it was never intended for towing disabled tanks on a regular basis. The vehicle designated for this task is the diesel-powered M88 recovery vehicle. But the M88 is currently in short supply, and an improved recovery vehicle soon to undergo design and user testing will not be ready for fielding before 1995. So troops were forced to use M1s in a towing role.

"We have known about the heat problem for a long time," said Randal Gaereminck, who headed the heat-shield project in the RD&E Center's Improved Recovery Vehicle (IRV) Office. "However, nothing was done about it, because the M1 was never supposed to be used for towing except in emergency cases." However, the problem did become much worse during Operation Desert Shield so TACOM came up with a quick fix that allowed troops to tow M1 to M1 until the new recovery vehicle is ready.

The heat-shield project began last October when TACOM Commander



CPT Elwood J.C. Kureth attaches the exhaust deflector to the exhaust grille of an M1 tank.

MG Leo J. Pigaty asked the IRV Office to develop a suitable heat-shield design as quickly as possible. Within two weeks following that request, a joint effort involving the IRV Office, the Abrams System Engineering Support Office and the Design and Manufacturing Technology Directorate, resulted in the design and fabrication of two prototypes of a kit consisting of two heat shields.

One of the prototypes was a large metal deflector which, when secured with four J hooks to the engine-exhaust grill access door at the rear of the vehicle, directs the exhaust upward. This allows it to pass harmlessly over the top of a towed tank. The other was a smaller shield that protects the towbar pintle from exposure to exhaust heat by covering a slot in the bottom of the access door that accommodates a hook used to secure the door. Some of the exhaust normally passes through this slot during vehicle operation and comes in contact with the pintle, raising its temperature to over 300 degrees. As a result, troops are forced to wait for it to cool down after towing before disconnecting the towbar.

To protect troops from sustaining burns while removing the shields after towing, the exhaust shield uses a thermal blanket that keeps the intense exhaust heat from radiating through the metal. The blanket consists of a one-inch-thick layer of fiberglass insulation which is covered with a layer of a high-temperature rubber composite material.

Gaereminck said the prototype kits performed well in durability tests at the Army's Aberdeen and Yuma proving grounds, and the Design and Manufacturing Technology Directorate was tasked to produce 100 kits for Operation Desert Shield. He said these were shipped to Saudi Arabia by year's end.

"Because of the short time we had to work with," said Gaereminck, "our only choice was to do the job in-house. If we had gone to an outside contractor, it would have taken three months just to start a contractual effort. If we had asked one of the depots to do it, we would have lost a couple of months drafting up a technical data package and holding meetings to make sure they understood what we wanted. But because the job involved a small number of items, we were able to build them and field them faster than we could go on the outside for them."

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

Desert Storm

MEDICAL R&D COMMAND CONTRIBUTIONS TO OPERATION DESERT STORM

By Chuck Dasey

Introduction

The combat soldier is the focal point and the beneficiary of Army medical research and medical materiel development. The U.S. Army Medical Research and Development Command (USAMRDC), its nine laboratories and institutes, and its two contracting and acquisition management activities contributed in numerous vital ways to successful medical support and medical readiness in Operations Desert Shield and Desert Storm. While not as dramatic as smart bombs, Patriot missiles, or combined air and armor assaults, the command's efforts were equally important.

History shows that infectious disease invariably takes a greater toll on armies than enemy weapons. A Middle East military history lesson helps to illustrate the problems addressed by the command.

Middle East Military History

In one World War I campaign, an allied force with 50 per cent of its members infected with malaria was able to defeat an opposing German-Turkish force, perhaps because 85 per cent of the Germans and Turks had malaria. Rommel's World War II Africa Corps lost three men to disease for every one lost to combat injury. Rommel left Africa twice during the war to recover from hepatitis. A division from New Zealand joining the battle of el Alamein lost 14 per cent of its soldiers to hepatitis A in its first 30 days of fighting.

American forces assigned to the Middle East in World War II represented only 0.6 percent of the total U.S. Army average strength, but they contributed 3.6 percent to total Army cases of dysentery and diarrhea. U.S. forces reported 2,968 cases of sandfly fever in 1943, or 56 cases per 1,000 men. Twenty-nine cases of malaria per thousand men were reported for the same year.

A deployment of 12,000 U.S. soldiers and Marines to Lebanon in 1958 resulted in 50 percent of the force experiencing diarrhea, with five percent (600) admitted to hospitals. In 1961, a British brigade sent to Kuwait to discourage an attack from Iraq suffered such extensive heat injuries that five percent of the force required medical evacuation.

Disease and non-battle injuries always take a high toll on deploying armies. Historical experience in the Middle East reinforces this fact of war. The USAMRDC organized to address these and other threats in several ways.

Infectious Disease and Environmental Threats

Researchers at the Walter Reed Army Institute of Research (WRAIR) were called upon very early in Operation Desert Shield to provide information about the infectious disease threats in the region. They responded with a detailed pamphlet describing 19 types of infectious diseases found in Southwest Asia. They supported the Office of the Surgeon General in determining the appropriate vaccinations to give deploying soldiers to protect them from indigenous infectious disease threats. They also made recommendations for special procurement of therapeutic drugs to treat various diseases. The WRAIR pamphlet was subsequently issued as a pocket-size booklet.

Climatic and other hazards were addressed by the U.S. Army Research Institute of Environmental Medicine (USARIEM). *A Pocket Guide To Environ-*

Researchers at the Walter Reed Army Institute of Research (WRAIR) were called upon very early in Operation Desert Shield to provide information about the infectious disease threats in the region.

The M291 Skin Decontamination Kit uses a non-toxic mixture of ion exchange and charcoal-based resins to decontaminate nerve or blister agents on exposed skin.

mental Medicine for Operations in Southwest Asia, published in a 5- by 7-inch format to fit in BDU pockets, addresses medical problems caused by heat, cold, dust, sand, wind, stress, snakes and scorpions, and other hazards. It offers concise advice on first aid and buddy aid, and a summary of key points and reminders for surviving and functioning effectively in the desert.

Some extremely valuable advice was provided, including recommended water intake of up to four gallons per soldier per day, and the "weak link" rule, which says that the first heat casualty indicates the unit is near its limit, and more casualties will follow unless there's an immediate break for rest and rehydration. Defense Department guidelines for water consumption and work-rest schedules during acclimatization in the desert are based on research by USARIEM.

Prepared at the request of the deputy chief of staff, personnel, HQDA, the guide was shipped directly to Army units deployed in Southwest Asia. Copies were also provided to the U.S. Marine Corps for distribution to deployed Marine units, and to the British Embassy for distribution to British Army units.

Chemical and Biological Defense

The USAMRDC is responsible for medical protection of service members from the threats of chemical and biological attack, as well as naturally-occurring infectious disease and other non-battle injuries. The Defense Department and the mass media acknowledged the threat of both chemical and biological weapons from the very beginning of Operation Desert Shield.

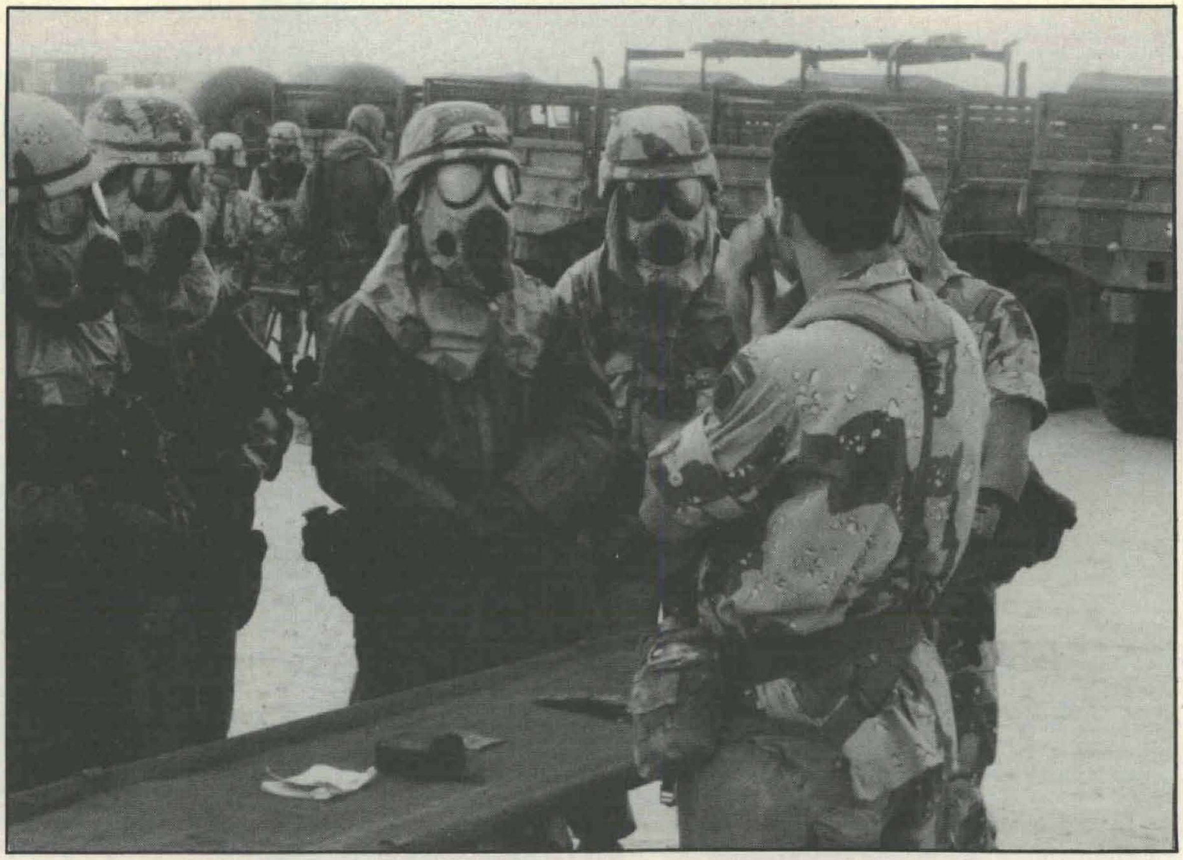
In the chemical arena, each soldier deployed to the region was issued four types of medical protection against chemical warfare agents. All four are products of the Medical Chemical Defense Research Program, with significant basic research conducted at the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) at Aberdeen Proving Ground, MD, and with product development and fielding supported by the U.S. Army Medical Materiel Development Activity (USAMMDA) at Fort Detrick, MD.

Pyridostigmine, a drug used safely and effectively for years to treat nerve disorders, such as Myasthenia Gravis, was identified in the mid-1980s as an effective pretreatment for nerve agency exposure. When taken in advance, the pretreatment enhances the effect of the antidote drugs in the event of exposure.

The Mark I nerve agent antidote kit consists of two autoinjectors, one containing atropine, a drug that interrupts the activity of chemical nerve agents, and a second that contains pralidoxime chloride, a drug that restores normal nerve function. The USAMRICD and USAMMDA played key roles in the early 1980s in the selection of drugs, the packaging of the kit, development of doctrine for its use, and technological improvements to it, which are in development.

A third drug, diazepam, more commonly known by its trade name, Valium, has been identified as an effective antidote for convulsions resulting from nerve agent poisoning. Although it was already available in medical channels, diazepam has now been issued in autoinjectors to individual soldiers, with training on how and when to use it, and strict accountability to prevent inappropriate use.

A fourth chemical defense product is the skin decontamination kit. Army scientists took the skin decon kit that was in the field and came up with a better, user-friendly item that is easier to carry and quicker and easier to use. Its composition, a non-toxic mixture of ion exchange and charcoal-based resins, is another important improvement.



Soldiers of the 82nd Airborne Division receive training in the use of the M291 Skin Decontamination Kit during Operation Desert Shield.

Vaccines act as pretreatments, stimulating the body's defenses against possible future exposure to infectious diseases. The average length of time for development of a safe, effective and approved vaccine is 15 years. The U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) has developed and established the safety and effectiveness of several vaccines for biological defense, and the USAMRDC has managed compliance with all civilian regulatory agencies involved.

The command also maintains contacts in the pharmaceutical industry, so that accelerated production, which is no easy task, is nonetheless possible in a contingency situation. The USAMRDC, as the lead agency for the accelerated production of vaccines for biological defense in Operations Desert Shield and Desert Storm, resolved several challenging contractual issues as part of the effort. Production, delivery and administration of these vaccines proceeded on schedule.

Post-exposure treatment with therapeutic drugs is another line of defense. The command contracted for the purchase of antibiotics and other drugs to protect soldiers from both naturally occurring and potential biological warfare threat agents. Ribavirin, an antiviral, was tested in clinical trials in Korea and the Peoples Republic of China by investigators at USAMRIID. It was purchased in both liquid and tablet forms to prevent and treat a life-threatening viral hemorrhagic fever illness that occurs naturally in Southwest Asia.

Another drug, Centoxin, a human monoclonal antibody, protects against severe bacterial infections and shock. Investigators at WRAIR participated in an extensive clinical trail in multiple medical centers which showed this treatment can be life-saving. This drug was distributed to medical facilities in the theater of operations for the treatment of bacterial infections following combat wounds or burns. Fortunately, the extremely low incidence of combat wounds in Operation Desert Storm resulted in little requirement for the use of Centoxin, but future combat zones may indicate considerably more use.

An essential element of casualty management and disease control is accurate and speedy diagnosis. The USAMRIID has developed highly specific, easy-to-perform, laboratory tests for several infectious diseases found in the Middle East. These tests were used in Army and Navy laboratories in Saudi Arabia, Egypt and Europe to define the disease risks and provide valuable information to allow clinicians to use the most appropriate medical treatments. Six laboratory teams received training and diagnostic supplies and equipment at USAMRIID before deploying to provide medical laboratory support.

Many regulatory issues surfaced in the effort to field vaccines and drugs for biological and chemical defense. The USAMRDC's Human Use Review and Regulatory Affairs Office maintained constant communication with the U.S. Food and Drug Administration during Operation Desert Shield to insure compliance with all drug regulatory standards.

The U.S. Army Medical Research Acquisition Activity (USAMRAA) absorbed a surge of purchasing and contracting workload in direct support of Operations Desert Shield and Storm. The vast majority of the purchasing and contracting actions for medical materiel shipped to the overseas theater, amounting to approximately 65 percent of a normal annual workload, were above and beyond the normal mission of the unit. Items purchased included antibiotics and vaccines for biologic defense skin decontamination kits, chemical agent antidotes, hospital equipment, medical supplies, laser protective aviation spectacles and Ballistic Laser Protective Spectacles for soldiers.

Field Medical Equipment

Three pieces of field medical equipment developed at the U.S. Army Biomedical Research and Development Laboratory (USABRDL) were used in Southwest Asia.

The far-forward surgical table with accessories is designed for use by the special forces and forward surgical teams. The table uses a standard field litter as the operating platform, and is packaged with accessories including surgical lighting, I-V poles, armboard and instrument tray. It can be assembled by one person in five minutes, without tools, and weighs 85 pounds.

A portable surgical scrub sink was also used. This too was designed to be lightweight and portable. A collapsible, anodized aluminum frame supports a waterproof fabric basin, and a foot pedal operated switch and valve assembly controls water flow from pressurized and non-pressurized sources, and temperature, through an electric heater. The sink is half the weight and volume of the existing field surgical scrub sink.

In a high-tech age, we sometimes overlook the simple things. The USABRDL has also developed a new field litter. Instead of wooden poles and canvas fabric, the new one is made entirely of polypropylene, and is easier to decontaminate than the wood and canvas model. A similar item, a wheeled litter carrier, for transporting patients and heavy pieces of equipment, was also used in Southwest Asia. It is lightweight, rugged, stable and foldable to reduce storage volume.

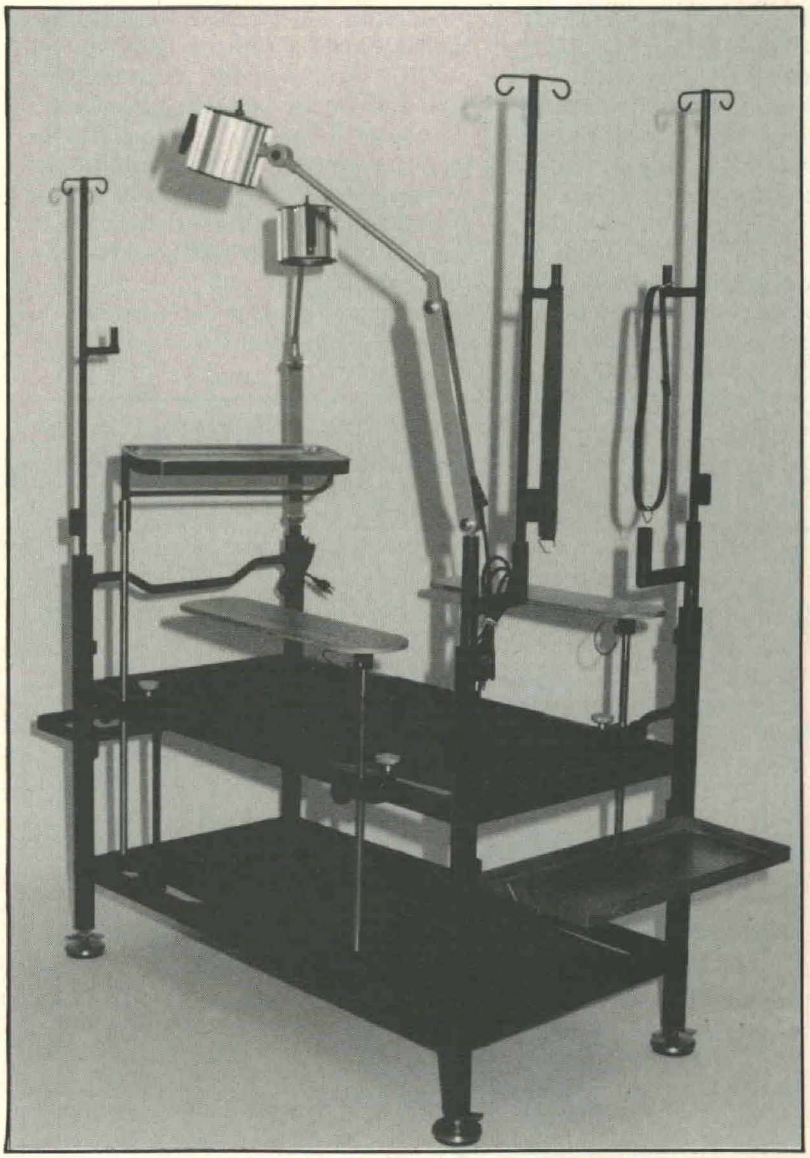
Dental researchers at the U.S. Army Institute of Dental Research (USAIDR) developed a miniature X-ray system which was used in Operation Desert Storm. With a total weight of 25 pounds, the suitcase-size system can be used for dental X-rays or to view limb fractures. It is battery powered, and can be recharged from alternating current or from vehicle batteries. A filmless imaging subsystem produces a Polaroid-type self-developing picture.

In Saudi Arabia, ticks and sandflies are capable of spreading disease. An improved, extended duration version of the Army's standard bug repellant, Deet, developed by the USAMRDC, was used by soldiers in the desert. The new repellant smells better, feels more comfortable on the skin, and works for 12 hours per application. Insect repellant can also be processed into the battle dress uniform fabric with a kit issued to individual soldiers. The basic laboratory research for the arthropod repellent was conducted at another of the command's laboratories, the Letterman Army Institute of Research (LAIR), and the product development process was coordinated by USAMMDA.

A similar involvement by these two units, as well as many other Army organizations, occurred in the development and fielding of the ballistic laser protective spectacles, which protect soldiers' eyes from low intensity laser beams used as target designators and range finders. The USAMRDC contributed laser bioeffects research and optical correction inserts. These spectacles were valuable in the desert for their protection of the eyes from wind-blown sand and dust.

Deployable Teams

Another major contribution to Operation Desert Storm were the teams who went or were ready to go to the theater of operations to provide specialized assistance. Expertise possessed by the command was readily available to the CENTCOM surgeon. Teams for environmental medicine, aviation medicine,



A surgical table for far forward use. The table can be assembled in five minutes.

dental casualty assessment, and various infectious disease research teams were ready for rapid deployment.

Special immunization teams accompanied shipments of biological defense vaccines to the theater of operations. They were responsible for insuring proper handling of the vaccines in the medical logistics system, and for advising and assisting medical personnel who helped administer the vaccines to up to 10,000 soldiers per day.

Teams were dispatched to Southwest Asia to assess morale and other aspects of the psychological well-being of deployed soldiers in September and December. The Division of Neuropsychiatry, WRAIR, has long studied the psychological and psychiatric effects of deployment, the anticipation of combat, the combat experience, and the return to peacetime duty or civilian life. These teams visited deployed units to survey soldiers individually and in small groups to identify causes of stress and possible ways to minimize stress.

They reported that morale was, in general, high in September and higher in December. Combat unit members were perceived to care for, trust and respect each other. Combat service support units were observed to be very proud of their enormous output of labor. Access to telephones and mail from home were seen as the biggest morale boosters. However, problems of family separation caused by the deployment had the most negative impact. The "maturation" of the theater led to improved unit living areas, increased amenities such as showers, and the sense of the unit area as "home."

A work/sleep cycle evaluation team accompanied combat aviation units into Iraq to measure sleep quantity and quality and to advise commanders on avoiding performance decrements due to sleep loss.

The short-term result of these efforts is to make recommendations to the leadership to minimize stress-related performance deterioration. In the longer term, the researchers analyze available data about the deployment, publish these insights, and integrate new knowledge into Army doctrine.

Casualty Data Assessment Teams interviewed almost two-thirds of all wounded-in-action soldiers after their evacuation to military hospitals in Germany. For many of these patients, the bedside interview with the team member was the first opportunity to talk at length about the events surrounding the injury. Casualty data assessment leads to analysis of the entire casualty picture of the conflict. Many soldiers wounded in combat vehicles provided the vehicle identification number. After other agencies locate and evaluate the damaged vehicles, attempts will be made to associate the type of wound with the damage sustained by the vehicle. This information can lead to improved safety features in combat vehicles.

Three burn care teams deployed to Saudi Arabia from the U.S. Army Institute of Surgical Research (the "Army Burn Unit"). One team deployed to King Khalid Military City where it treated coalition forces, civilians, and enemy prisoners of war. A second team set up in Riyadh to treat U.S. headquarters forces. The third team deployed later to Dhahran, just in time to treat victims of the barracks SCUD attack.

The USAMRICD teaches the Medical Management of Chemical Casualties Course, which trains active duty and reserve doctors, nurses and corpsmen in techniques for dealing with chemical casualties. The instructors were on the road beginning in August, training active and reserve units preparing to deploy. A team was in Saudi Arabia for most of the operation, working with medical units on the ground and at sea. An important accomplishment was the building of soldier confidence in the ability to manage a chemical attack. The education removed some of the mystery surrounding the chemical threat and emphasized survivability through proper use of protective equipment, doctrine and medical countermeasures.

After returning soldiers are heartily thanked for a job well done, one of the most important jobs of the research and development community is just beginning — the application of lessons learned. The Army Medical Department will take new steps forward in its ability to protect and sustain the force. That progress will be fully supported by "Research for the Soldier."

A portable surgical scrub sink was developed for use by Special Operations Forces and far forward surgical teams.

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CORPS OF ENGINEERS R&D SUPPORT FOR OPERATION DESERT STORM

Introduction

Many factors contributed to the lightning-like success of the U.S. and coalition forces in their operations against Iraq. Superior military leadership, the determination of the coalition forces, and the training and ability of the individual soldiers, sailors, and airmen were all key parts in the overall operation. Another major factor was the technological superiority of the allies' weapons, equipment, engineering, logistics, and intelligence systems.

Almost nightly, Americans were shown the effectiveness of such systems as the Patriot, but there are countless other behind-the-scenes instances where research and development support and expertise provided significant input to Desert Shield/Desert Storm operations. The U.S. Army Corps of Engineers' research organizations provided invaluable expertise in areas such as combat engineering, mobility, sustainment engineering, survivability, camouflage, logistics, and environmental concerns.

The Corps' R&D community is comprised of four separate laboratory complexes: the Waterways Experiment Station (WES), Vicksburg, MS; the Construction Engineering Research Laboratory (CERL), Champaign, IL; the Cold Regions Research and Engineering Laboratory (CRREL), Hanover, NJ; and the Engineer Topographic Laboratories (ETL), Fort Belvoir, VA. The individual work of the ETL is highlighted elsewhere in this issue of *Army RD&A Bulletin*.

These R&D laboratories responded to a wide variety of Desert Shield/Desert Storm needs with R&D initiatives that were structured to produce the required technology in a restricted time frame.

Theater Construction Management System

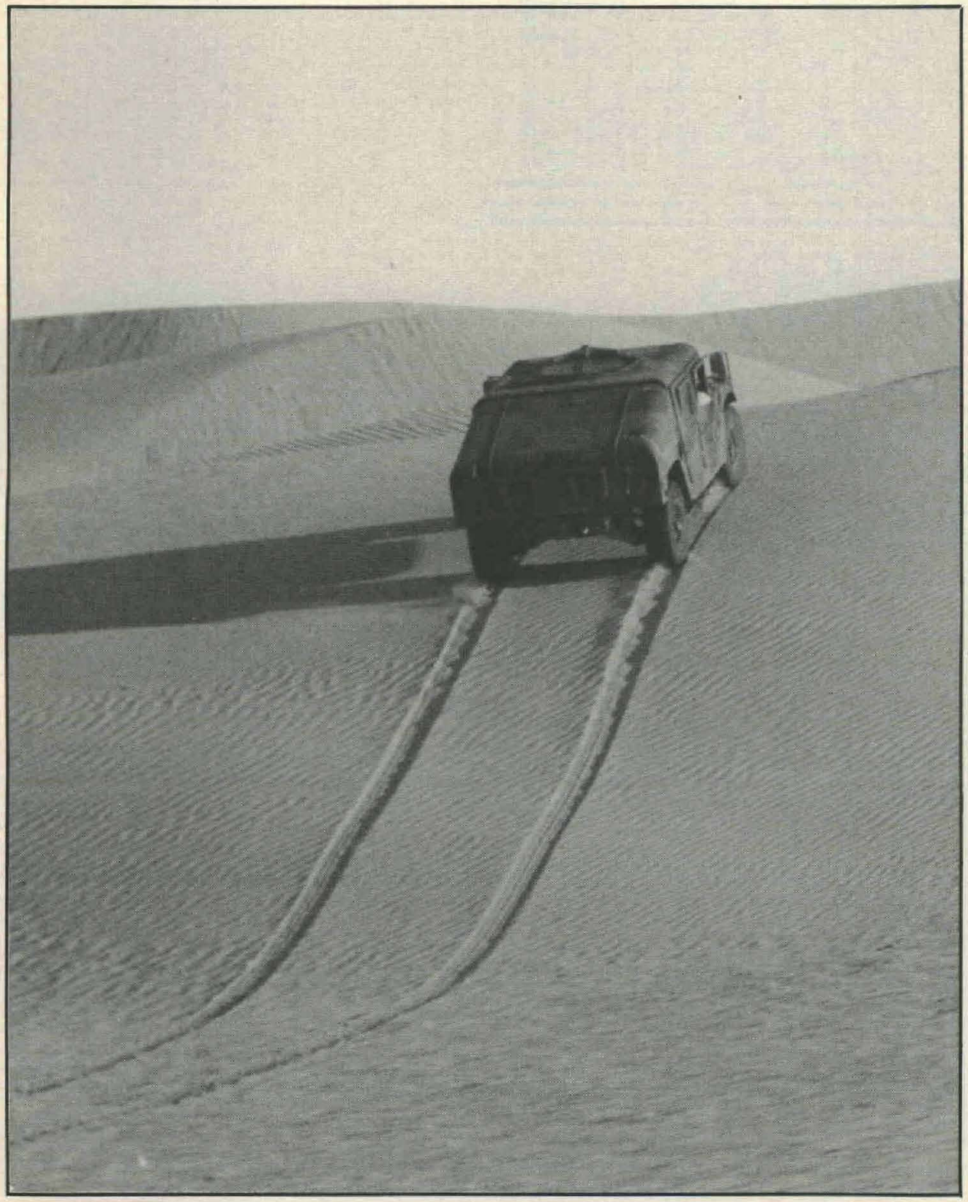
One such example was the Theater Construction Management System (TCMS), under development by CERL. The initial prototype version of TCMS received its first operational tests with 416th Engineer Command units in the Gulf war.

TCMS is a fully integrated construction management system. It allows engineer command units down to the company level to automate facility planning, design, drafting, network analysis and project scheduling functions of the theater construction mission. A key component of the experimental system is the Program Support Environment, a CERL-developed data base that links otherwise disparate software programs together.

The initial version of TCMS was demonstrated in late summer 1990 to combat engineer unit staff officers. When Iraq invaded Kuwait, the 416th Engineer Command requested that CERL expedite the procurement and fielding of the TCMS prototype. By mid-September, CERL had installed 10 TCMS work stations in combat engineer units heading to the Gulf. The units' soldiers were given crash courses on how to use TCMS and its commercial software programs.

A special software program was developed to convert more than 450 Army Facilities Components System standard military facility drawings to a TCMS compatible format. Special data bases to relate planning requirements and design information on the drawings were also developed.

In the Gulf, TCMS allowed combat engineer units to accomplish construction missions faster and more economically. We are awaiting detailed feedback from the 416th Engineer Command on their use of the system in actual field conditions; this feedback should be invaluable in the further development and refining of TCMS.



WES ran a series of tire and mobility tests on a variety of vehicles, including the HMMWV, at Yuma Proving Ground.

Pipeline Crosslines

One of the major problems facing coalition forces in the initial stages of the ground operations in Kuwait was crossing defensive barriers built in conjunction with large oil pipelines (up to 5 feet in diameter). Due to its extensive experience with the Trans-Alaska pipeline, CRREL was tasked with the problem of evaluating various alternatives for pipeline crossings.

The pipelines were usually surrounded by minefields, barrier berms and other types of obstacles. Plus, the pipelines carried pressurized sour crude oil, which could flow from a rupture and mix with the desert sand to form a soft asphalt-like mixture that could compromise vehicle mobility.

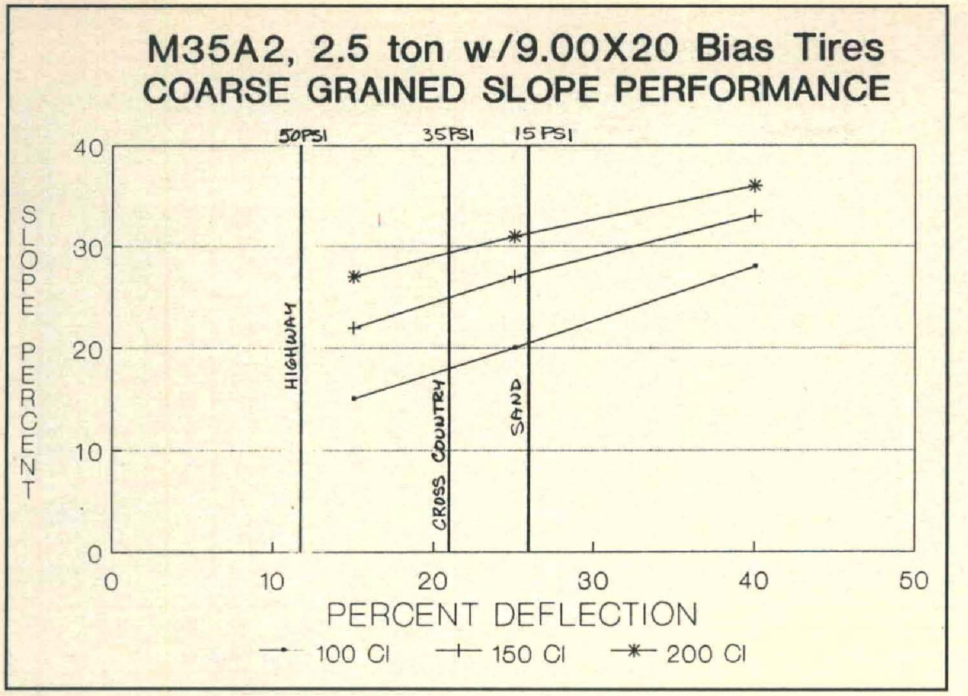
CRREL studied 12 alternatives for pipeline crossings. The most expedient solution involved curtailing the oil flow from pumping stations and control valves, cutting the pipe with explosives, pushing the pipe aside, and using bulldozers to fill ditches and remove berms. However, to preserve the integrity of the pipe and to prevent further damage, an earthen roadway over the pipe was recommended. Initial feedback from the theater indicated that this method was successfully used.

WES CONTRIBUTIONS

The Waterways Experiment Station (WES) is the Corps' largest R&D complex with six separate laboratories. WES was involved in a wide variety of Desert Shield/Desert Storm projects ranging from mobility to structures to offshore beach profiles.

Camouflage, Concealment and Deception

The WES camouflage, concealment and deception (CCD) team provided assistance to the V Corps, the 24th Mechanized Infantry Division, and the 3rd Armored Division in camouflage material acquisition and training in the use of CCD materials. A series of tests were conducted at WES to evaluate special camouflage decals and identification, friend or foe, markers for use among the coalition forces. Results from these tests allowed for more



WES was tasked by Headquarters, USACE to develop a prototype mine plow attachment kit. The request came from the U.S. Army Engineer School. The kit was designed and fabricated in a seven day period. However, because of time constraints this kit was not fielded into the Kuwaiti theater of operations (KTO). The Engineer School is conducting further evaluations of this kit for possible future use.

In early March, WES became involved in the design of special purpose equipment that will be used to clean the Kuwaiti desert of mines after hostilities. WES worked with the U.S. Army Tank-Automotive Command and Caterpillar, Inc., to design a mine rake assembly that will be mounted on an armored D7 bulldozer. While initially designed for Kuwaiti cleanup operations, this mine rake is also being considered for permanent inventory.

effective use of camouflage decals and IFF markers during Operation Desert Storm.

In November, a WES CCD team member traveled to Saudi Arabia to provide support for training, evaluation, and deployment of CCD operations for all Air Force and some Army facilities in theater.

Vehicle Mobility

During the early stages of Operation Desert Shield, recurring wheeled vehicle mobility and tire problems were reported to WES, the Army's center for vehicle mobility. These problems concerned poor cross-country mobility, insufficient traction, improper tire pressure, and poor tire performance. A WES researcher accompanied a four-man team from the U.S. Army Tank-Automotive Command to Saudi Arabia in November to observe these problems firsthand.

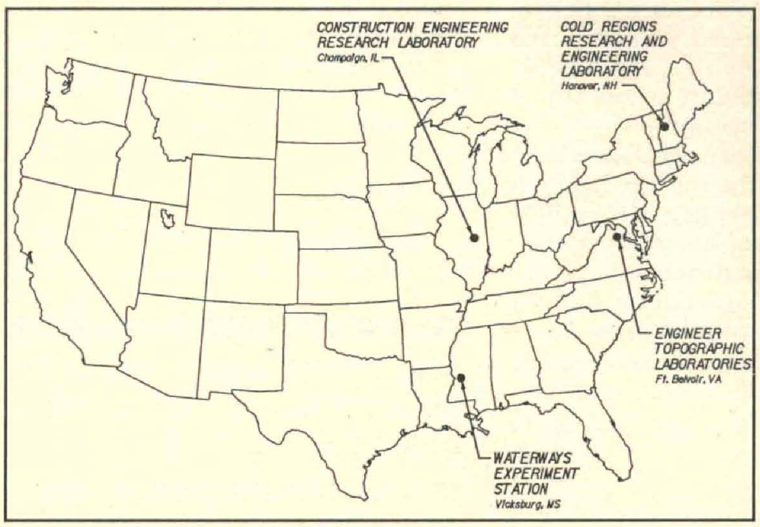
WES subsequently began tire and vehicle testing at Yuma Proving Ground, AZ, with a variety of vehicles, including the High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) and the Marine Light Armored Vehicle. Each vehicle was tested with a variety of commercial radial and bias-ply tires to select off-the-shelf replacements and optimum tire pressures for desert operations. Tests included drawbar pull, motion resistance, and slope climbing.

WES also used the Army Mobility Model to determine the effects of tire pressure and vehicle configuration on desert mobility. Results indicated that the ability for a driver to rapidly change tire pressure from controls within the vehicle, such as with the Central Tire Inflation System, can provide significant mobility advantages.

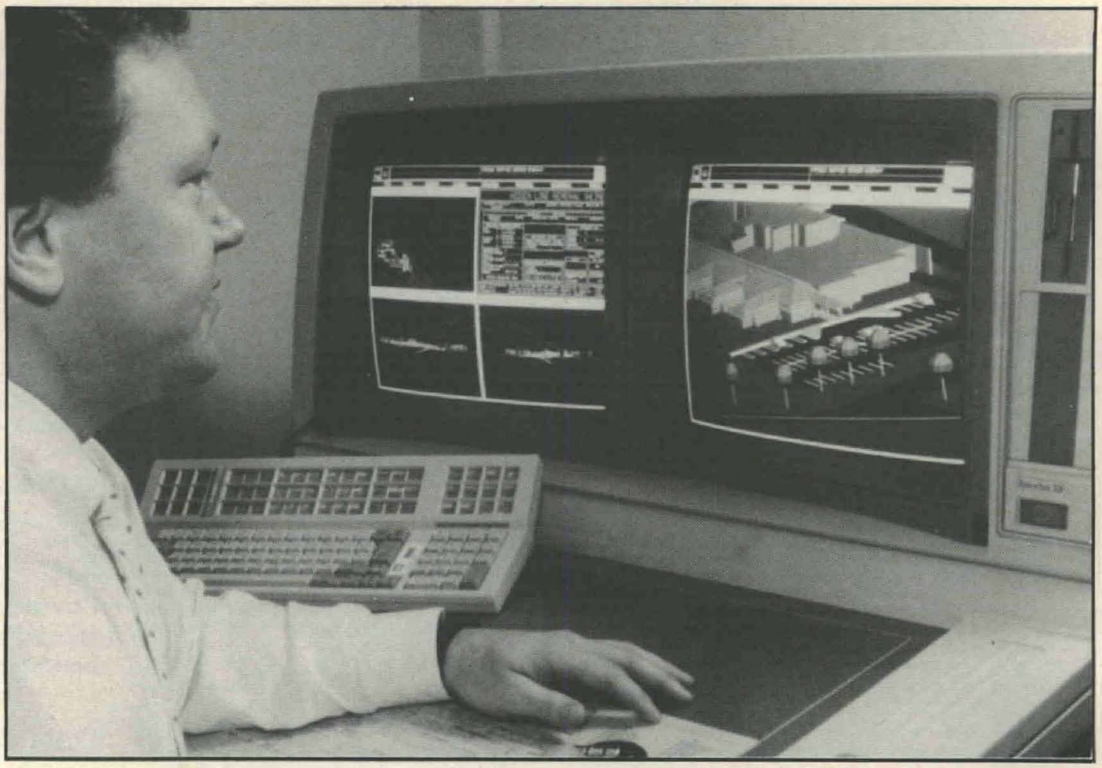
As a result of the field tests and mobility model predictions, WES provided guidance on recommended tire inflation pressures and suggested retrofit/replacement tires for vehicles. These recommendations improved the overall ground mobility of coalition forces.

Dust Control

The extremely harsh dust environment of the desert is a major problem for soldiers and equipment, particularly helicopter operations. WES developed in three days a guidance manual entitled, *Dust Control in Desert Environments.* FORSCOM distributed this manual to in-theater personnel. The manual provides information on present day methods for controlling desert dust and guidance for selecting the proper materials and methods for use in locations such as helipads, roads, and other high use areas. The use of locally available materials, such as



The U.S. Army Corps of Engineers has four major research and development laboratories.



The Corps' Computer-Aided Design and Drafting (CADD) Center, assisted in generating CADD files for Kuwait City.

asphalts or aggregates, or prefabricated landing mats, membranes and sand grids for dust control was also addressed in the manual. As a result of this manual, crushed aggregate treated with asphalt emulsion was selected to control dust in many load bearing and non-load bearing locations.

Oceanographic Conditions

Military operations in coastal areas, such as amphibious operations or Logistics Over the Shore, depend on knowledge of average and extreme wave conditions. Oceanographers at WES have developed computerized numerical models that predict the oceanographic conditions based upon reported weather conditions.

In 1989, WES began developing a Sea State Data Base for the Persian Gulf using weather data collected from 1973 to 1986. This data was subsequently used to provide predicted water levels, currents, and wave conditions for CENTCOM for use by coalition forces at selected nearshore locations along the Kuwait and Saudi Arabia shoreline. This information was also available to help track the course of the Persian Gulf oil spill.

The Kuwaiti reconstruction effort will be one of the most challenging missions the Corps of Engineers has ever undertaken. In 1983, Kuwait City contracted with a foreign consortium for the country's first digital topographic and utility data base using a Computer Aided Design and Drafting (CADD) platform. The Corps tasked the WES CADD Center with developing utility and topographic drawings of 600 square kilometers of Kuwait City from the existing multi-source data base.

Based on the Corps' requirements, the WES CADD Center generated over 7,200 data files to produce 2,753 drawing files. To reduce the estimated plotting time of 200 hours, WES received support from the Vicksburg, Nashville, Savannah, New Orleans, Louisville, and Jacksonville Corps Districts. All CADD work was completed by the end of February.

Summary

These highlighted R&D efforts of the Corps laboratories are just a few of the research projects conducted in support of Operation Desert Shield/Desert Storm. They all have one common link — when the problem was identified, the full R&D capabilities of the Corps were applied to rapidly develop a solution.

Many of these research efforts were significantly accelerated to quickly answer critical questions. The Corps responded with timely R&D products that played a major role in the successful operations of the coalition forces. Researchers are continuing to evaluate the effectiveness of the supplied R&D items and incorporating feedback from users in the field to refine and enhance current and future R&D efforts.

The Corps R&D laboratories will support allied clean-up and reconstruction operations with the same vigor demonstrated with the military operations phase. In their overall support to the past and continuing operations in the theater, the Corps R&D laboratories embody the spirit of the Corps' motto, "Essayons — Let Us Try."

> The Corps responded with timely R&D products that played a major role in the successful operations of the coalition forces.

A number of U.S. Army Corps of Engineers employees contributed to this article.

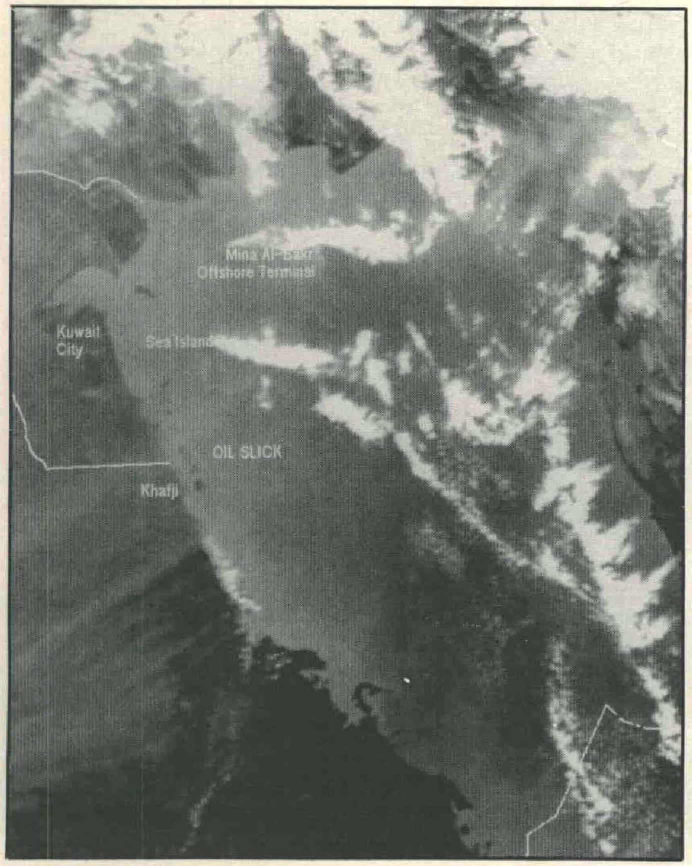


Figure 1. NOAA depiction of Persian Gulf oil spill from AVHRR satellite data.

REMOTE SENSING OF THE PERSIAN GULF OIL SPILL

By Dr. Lewis E. Link, Jr.,
Dr. Harlan McKim,
and Andrew Bruzewicz

Introduction

Oil spills represent a major environmental hazard with potential long-term consequences. The Valdez, AK, spill in the spring of 1989 heightened our awareness of the seriousness of such events and the great difficulties in coping with them, especially in remote and extreme environments. The January 1991 deliberate spill of oil into the Persian Gulf by the Iraqis added to the complications of a military engagement.

When a spill occurs, containment and cleanup operations must be initiated as rapidly as possible. In both the Alaska and Persian Gulf spills, containment and cleanup were not immediately feasible because of the lack of equipment and the respective (different) hostile environments. In both cases, planning actions to counter the oil required the ability to periodically determine its location and distribution and to project its trajectory or movement for the future. For a large spill, remote sensing provides perhaps the only practical monitoring and mapping approach because of the need to repeatedly cover large areas and provide a geographical product for planning purposes. While attractive, remote sensing techniques specifically for oil spills are not routinely available. This considerably hindered the monitoring of the Valdez spill. The Persian Gulf was more complicated because of the difficulty in conducting even visual observations.

Commercially available satellite remote sensing techniques were adapted to track the Persian Gulf spill and provide input to forecast models that projected movement of the spill as a function of forecasted weather conditions. Corps of Engineers efforts were accomplished as part of a multiagency team. The team consisted of the Oceanographic and Atmospheric Administration (NOAA), which provided low resolution, high frequency image data from the NIMBUS satellite to provide the Coast Guard with quick assessments (daily if cloud cover allowed) of the location of major concentrations of oil, and the Corps of Engineers, which processed higher resolution Landsat image data to provide more detailed distribution maps of the oil on a periodic basis (weekly if cloud cover allowed). Landsat is a commercial satellite that does multi-spectral imagery. These data were provided to NOAA and subsequently to the Coast Guard for planning control and mitigation efforts for the spill.

Remote Sensing Technologies

Oil seldom remains a uniform layer on the water surface because of wave action and currents. It undergoes chemical and physical changes with loss of

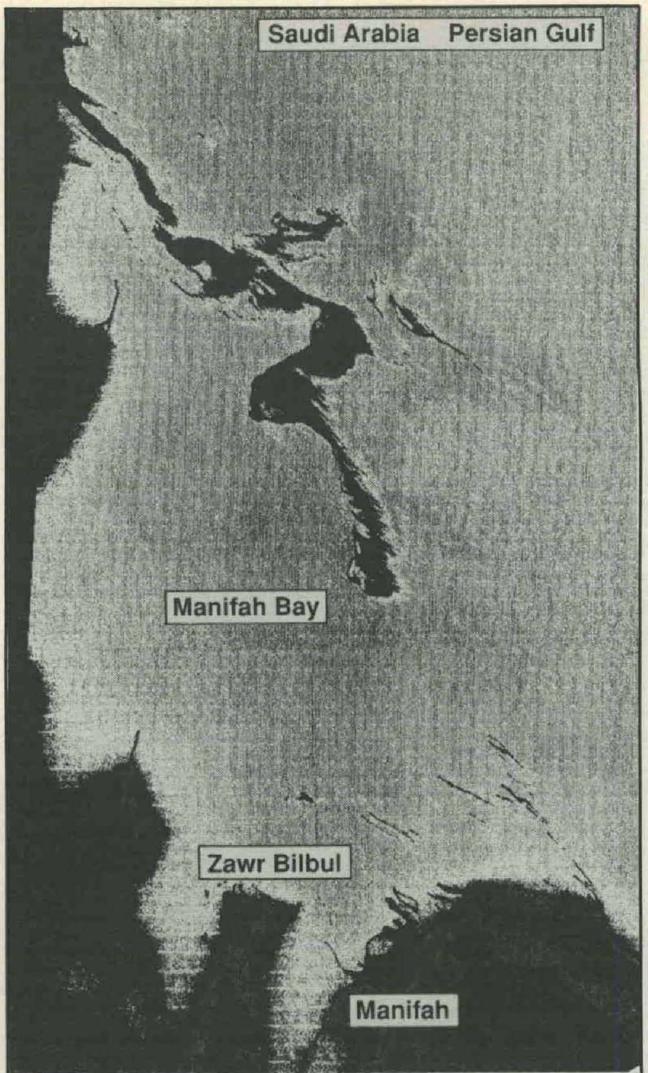


Figure 2. Processed data for Feb. 8, 1991 Landsat TM band 5 showing oil slick in Manifah Bay, Saudi Arabia.

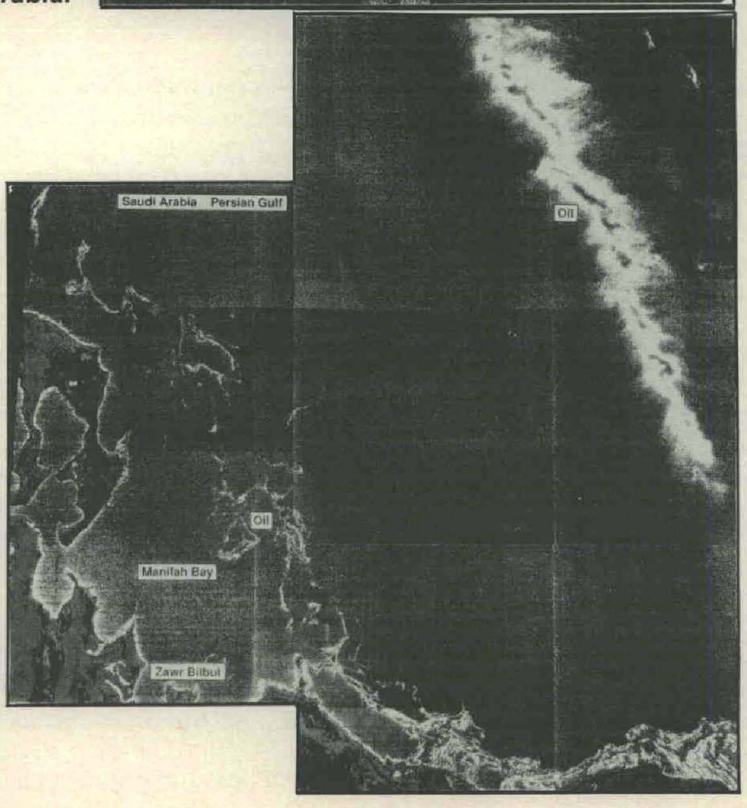


Figure 3. Processed data for Feb. 16, 1991 Landsat TM band 5 showing oil slick in Manifah Bay, Saudi Arabia.

volatiles and other weathering. All of these processes complicate the remote detection of oil spills and especially the ability to characterize the spill (type and thickness of oil). Historically, aerial photography was successfully used to track spills, with most success using film/filter combinations with sensitivities in the ultraviolet (UV) and blue regions of the spectrum. A decade ago success in using satellite imagery for oil mapping was very limited.

Thermal infrared (IR) sensing was recognized early as a potential tool for discriminating oil on water because of the difference in emissivity between oil (0.97) and water (0.99), making the oil covered areas appear cooler to the sensor than open water areas. Radar, especially side looking radar (SLAR), has been demonstrated to be a viable oil mapper. The oil dampens the capillary wavelets created by wind, causing less radar return for oil-covered areas. UV laser systems, through laser-induced fluorescence, have demonstrated some capability to characterize oil on water.

There are no satellite systems specifically designed to sense oil. Current systems, however, have much improved capabilities over those applied a decade ago. The NIMBUS Advanced Very High Resolution Radiometer (AVHRR) system is designed to give daily global cloud cover data through five spectral bands. The two bands in the thermal IR can provide oil spill information; however, it is limited by the 1.1 km resolution of the system. The 2700 km swath width gives an excellent capability to examine large areas quickly and the high frequency of coverage provides rapid repeat coverage to track the general motion of a spill.

The U.S. Landsat satellite, with its Thematic Mapper (TM) system, provides digital image data of much higher resolution (30 m for all bands except the thermal IR band which has 120 m); however, the system provides repeat coverage of a specific point only every 16 days (in reality, coverage is available roughly every eight days since there are two Landsat satellites in orbit at the present time). Each orbit covers a swath of approximately 185 km.

The TM has seven sensing bands, three of which are particularly suited for oil sensing: the blue band, the intermediate IR band and the thermal IR band. A major deficiency in the use of TM data for oil spill mapping is that the overall satellite and information distribution system is not configured to rapidly provide data to a user for analysis. Both the AVHRR and the TM systems are impacted by cloud cover and require clear skies for use in mapping oil.

Only two aircraft-based sensor systems have been developed with at least the partial objective of mapping oil. The Coast Guard Air-Eye system comprises a SLAR and a UV/thermal IR imager on a small Falcon jet aircraft. The Air-Eye generates film products that are manually interpreted. The Canadian Innotech, Inc. system is an eight-band multispectral scanner that provides digital data for the visible and near-IR portion of the spectrum. It does not have thermal IR capability and the raw sensor data recorded on high density tape must be deconvolved by a special computer system before analysis is possible. Deconvolution is a mathematical process that attempts to resolve pieces of overlapped information and look at them as separate entities.

Since the computer is located in a fixed site, rapid processing of data at a remote location is not feasible. Other multispectral systems available in the U.S. share the same problem. Only the Geoscan, Ltd., system from Australia, a 24-channel system that records on magnetic tape or read-write optical disk, provides in-the-field processing for rapid access and analysis.

Remote Sensing of the Persian Gulf Spill

The AVHRR data for the two thermal IR bands were analyzed through NOAA to delineate the general location and distribution of the Persian Gulf Spill. Figure 1 shows a typical product from those efforts, with the oil delineated along the Saudi coastline as a series of oval-shaped anomalies just to the south of the Kuwait border. The emissivity difference causes the larger concentrations of oil to appear cooler (displayed as darker on the image) than the surrounding water. Note the very large area coverage and the interference of clouds in the lower portions of the image. This type of image product was produced routinely to provide input to NOAA oil spill forecast models as well as to monitor the potential for environmental damage and impact on critical facilities such as desalinization plants.

The Landsat TM image data were processed by two research organizations of the Corps of Engineers, the Engineer Topographic Laboratories (ETL) and Cold Regions Research and Engineering Laboratory (CRREL). ETL used conventional multispectral processing approaches, which allowed a full range of band integration and display. CRREL used a portable Macintosh-based system, which allowed very rapid interactive processing of the image data and integrated the data products into a GIS.

Studies by the Corps labs both in the laboratory and in Alaska indicated that the thermal IR (TM band 6) and intermediate IR (TM band 5) had the most potential to map oil. In addition, TM band 1 had some potential because of its excellent water penetration capability. In clear, shallow waters such as in the Persian Gulf, much of the energy received by the band 1 sensor is reflected from the bottom on the seafloor. Oil on the surface will reduce the energy reaching the bottom and likewise the energy returning to the sensor.

Figure 2 shows the TM band 5 image from February 8 processed by the CRREL Macintosh system. The oil is clearly delineated on the image as well as the relation of the oil to the land. One small concentration of oil can be seen contacting the shoreline just to the right (east) of Zawr Bilbul (immediately above the designation for Manifah on the image). The scale of the image is approximately 1:100,000.

Figure 3 shows the band 5 processed image for the area shown in Figure 2, but for the February 16 TM image coverage. Again the oil is reasonably obvious, as is the relative movement of the oil from February 8. Some distributed stringers remain in the area of Manifah Bay, where the dominant oil slick was located in Figure 2. Note that winds and associated currents have carried the oil significantly to the east. The value of this information for planning spill control measures is obvious. These data were provided to NOAA and the Coast Guard for the Persian Gulf oil spill response team. Since only limited verification data were available for these images, primarily visual observations, the accuracy of the oil distributions displayed on the process TM images is undetermined. Feedback from on-site personnel, however, does verify the general validity of the TM data products and the processing methods used for oil spill mapping.

Of paramount importance in this effort was the cooperation of EOSAT Corp. in providing TM data as rapidly as possible within the constraints of the existing system. What typically takes four weeks was at first reduced to two or three days. This time frame was then further reduced significantly by moving the CRREL image processing system to EOSAT Corp. to demonstrate an even more streamlined processing capability. The TM data were provided directly to the Corps team at EOSAT for processing and the products supplied directly to NOAA for use in the Persian Gulf.

During the demonstration, products were typically produced and provided to NOAA within 24 hours of the acquisition of the image by the Landsat satellite. The TM data were demonstrated to be very useful for providing detailed updates of the more frequent and larger area coverage of the AVHRR. The optimum sensing package for oil spill sensing from satellites would be a system with the resolution of the TM, the daily coverage of the AVHRR and the all-weather mapping capability of a SLAR. This system is not available at this time, but the next generation of commercial satellite systems will move in that direction. Aircraft systems have the most immediate potential for providing tailored and responsive coverage of a spill, given that the data can be quickly processed at the spill location. This should be a major developmental priority for the U.S. oil spill response community.

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TOPOGRAPHIC ENGINEER TECHNOLOGY... VITAL IN DESERT STORM

By COL David F. Maune

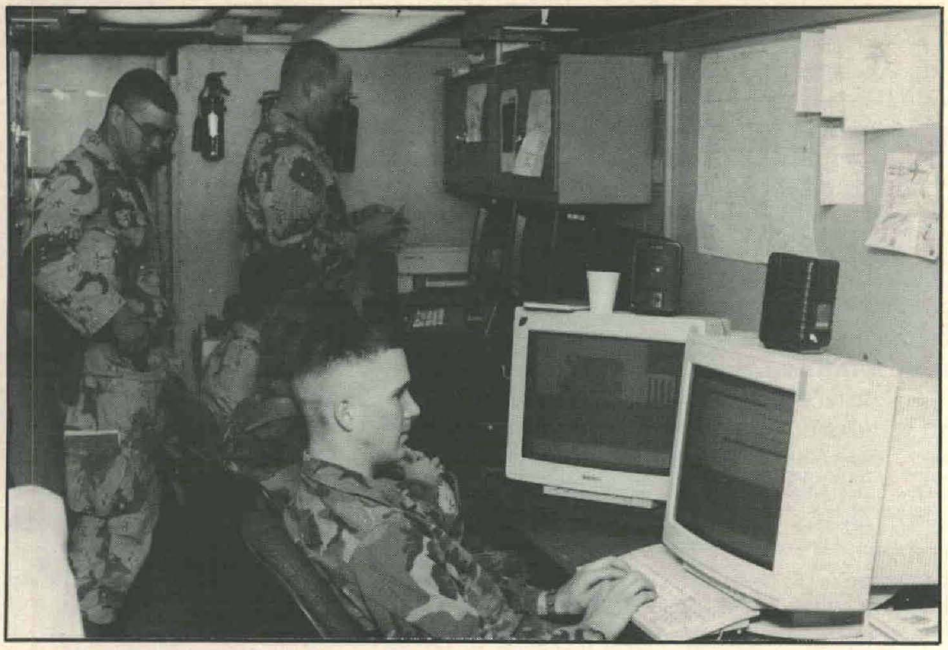
Introduction

In General Schwarzkopf's famous briefing on Feb. 27, 1991, he emphasized the fact that technology had enabled him to "see" the entire battlefield while Saddam Hussein could not. Much of that superior knowledge of the battlefield was provided by the U.S. Army Engineer Topographic Laboratories (USAETL), an element of the U.S. Army Corps of Engineers (USACE). USAETL has a dual mission to conduct both R&D as well as operational support. As such, it is funded about equally with both R&D and operations and maintenance (O&M) appropriations.

Background

USAETL has been an Army leader in the exploitation of space technology since the 1960s when the Corps of Engineers was responsible for worldwide topographic mapping. The Engineer Topographic Laboratories pioneered technologies in digital photogrammetry, radargrammetry, automated terrain analysis, and topographic applications of multispectral imagery. USAETL has also supported development of image exploitation systems for the Army's highly successful Tactical Exploitation of National Capabilities (TENCAP) Program.

Since the formation of the Defense Mapping Agency (DMA) in 1972, the



Two of the automated mapping terrain analysis systems supporting Desert Storm — the FORSCOM Automated Intelligence Support System (FAISS) and the Earth Resources Data Analysis system (ERDAS) on a Sun workstation.

USAETL has been an Army leader in the exploitation of space technology since the 1960s when the Corps of Engineers was responsible for worldwide topographic mapping.

chief of engineers has remained the "topographer of the Army," responsible for "bridging the gap" between the total topographic needs of battlefield commanders and the digital and hard-copy mapping products provided by the DMA. USAETL executes those responsibilities by providing soldiers and their commanders with superior knowledge of the battlefield. This knowledge takes the form of expedient mapping, terrain analysis, surveying and navigation, systems support, point positioning, image intelligence, and battlefield environment exploitation.

Mapping, Charting and Geodesy

Mapping, charting and geodesy (MC&G) are among the most fundamental items required in combat. DMA is responsible for the provision of MC&G products, while Army topographic engineers in a field environment provide specialized MC&G products as well as other topographic support.

When Desert Shield began, to meet the immediate demands of the vast number of deploying troops, DMA began shipping quantities of standard MC&G products from its depots, recognizing that some items would be out-of-date and coverage would not exist in all areas. Topographic engineer units in Saudi Arabia therefore had the dual mission to help overcome deficiencies in standard MC&G products while producing specialized items demanded by hundreds of customers "hungry" for accurate terrain information.

Topographic Technologies

As leader of the Army's "Digital Topographic Revolution," USAETL undertook many technological initiatives to help deployed "topo field units" (six division terrain teams, two corps topographic companies, and the topographic engineer battalion supporting the U.S. Central Command) complete their mission responsibilities. Major achievements included:

- Transforming digital topographic data onto approximately 16,000 copies of seven different media types by the end of the war. Systems deployed in Desert Storm that were able to exploit digital topographic data or Landsat imagery, for example, could not use it on the media (nine-track tape) furnished. Instead, they utilized removable hard disks, floppy disks, tape cassettes, etc. Landsat is a commercial satellite that does multispectral imagery. USAETL took the initiative of performing the required transformations in order to bridge this data gap and resolve numerous other issues involving data incompatibility.

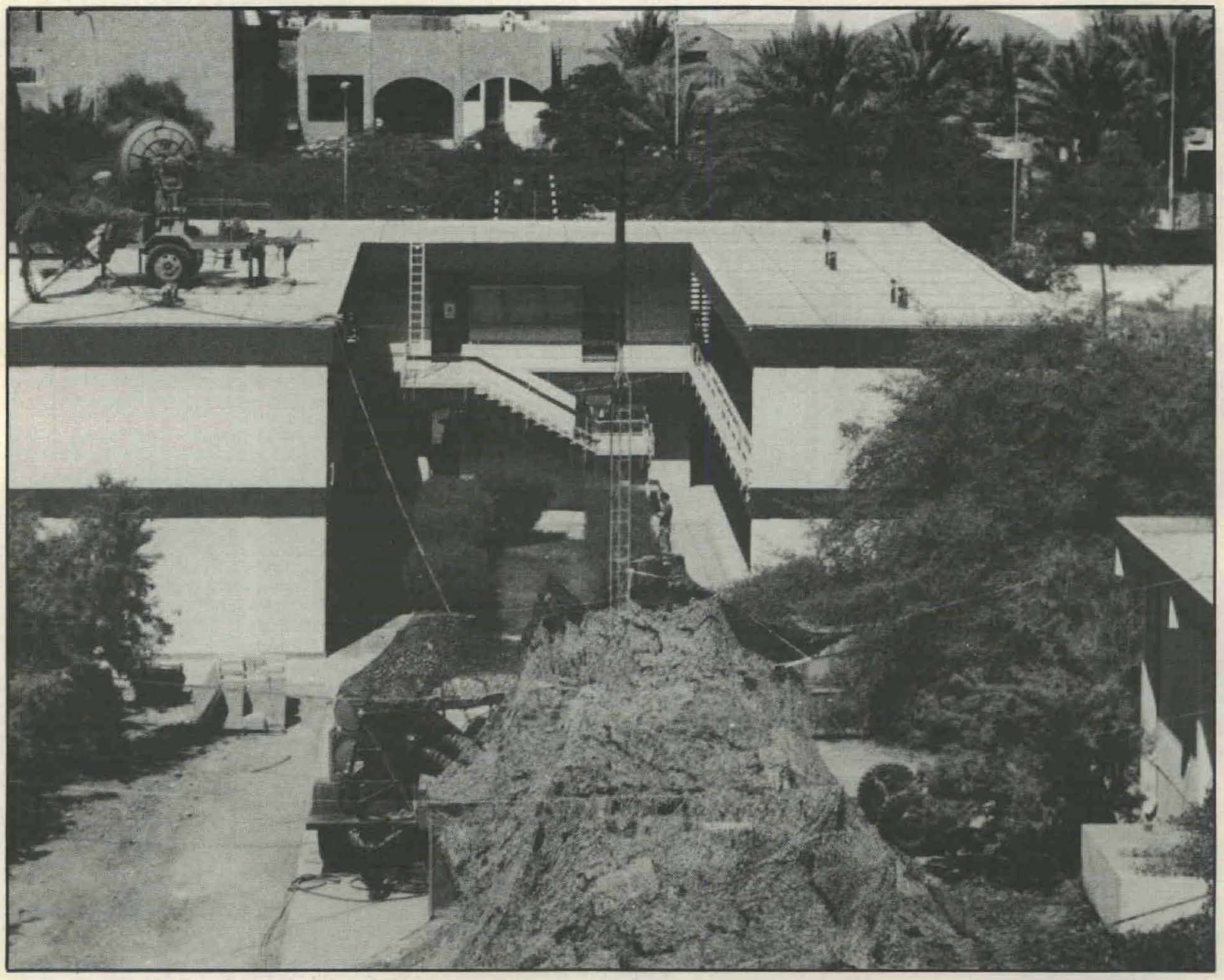
USAETL provided climatological support to help the Strategic Air Command perform B-52 mission planning.

- Acquiring three Earth Resources Data Analysis Systems for the deployed topo field units to produce expedient, specialized photo maps of Desert Storm areas from imagery.
- Assisted in the fielding of three Digital Topographic Support System Prototypes, 10 FORSCOM Automated Intelligence Support Systems, and three Portable Terrain Analysis Systems. All of these systems had appropriate terrain analysis software and digital data bases.
- Releasing an updated 2.0 version of TerraBase software, used by topo field units and others, for automated terrain analyses and terrain visualization.
- Fielding a prototype Quick Response Multicolor Printer to allow deployed topo field units to copy large format MC&G products in full color.
- Providing topo field units with precise Global Positioning System receivers. These were used to establish hundreds of survey control points in Saudi Arabia, Kuwait, and Iraq for artillery control, initiation of aircraft inertial positioning systems, and other functions.
- Deploying desert specialists to Army and Marine Corps units in CONUS and Saudi Arabia to train and assist them in production of terrain analyses.

Joint Operations

To help soldiers and Marines operate effectively in the desert, USAETL's tech base personnel produced the *Remote Sensing Field Guide — Desert* and nine other operational handbooks which were published by the Marine Corps. The Engineer Topographic Labs also updated the Battlefield Environmental Effects Software, incorporating climatology of the Desert Storm countries.

USAETL provided climatological support to help the Strategic Air Command perform B-52 mission planning. The labs also provided climatological support to help the Tactical Air



The Tactical Radar Correlator (TRAC) under camouflage, with its antenna on the adjoining rooftop, provided near real-time image intelligence on Iraqi activities.

Precise Global Positioning System receivers were used in Iraq even before G-hour when the ground war began.

Command obtain optimum weapon and aircraft performance.

Working with the U.S. Marine Corps, USAETL constructed a minefield to determine how well remote sensing techniques could detect land mines. In addition, the labs developed the Terrain Information Extraction System, copies of which were immediately ordered by other agencies to generate high-resolution digital data bases.

With technology from its tech base, USAETL produced military geography studies of countries in the Kuwaiti theater of operations and provided extensive water resources data bases. This allowed coalition forces to know the quantity, quality and availability of surface and subsurface water and existing water facilities.

Four image processing systems developed by USAETL supported Desert Storm, including the "old workhorse" created years ago by USAETL — the Analytical Photogrammetric Positioning System, which was used extensively by all services to derive target coordinates.

Summary

In all, 26 capabilities emerged from the Engineer Topographic Laboratories' technology base programs. These capabilities were expedited to Saudi Arabia by resource leveraging from reimbursable programs, through cooperation and teamwork with other labs and organizations, and through synergism from USAETL's unique combination of R&D and O&M programs. Of these 26 capabilities "up and running" in January, CENTCOM had only two of them on Aug. 2, 1990. This required total commitment and 24-hour a day support from USAETL to transition this technology so rapidly to the field.

After Operation Desert Storm began, the Jan 21, 1991 issue of *Defense News* reported on seven "eyes and ears" of war capabilities vital to the successful "High-Tech Storm" in its early stages. USAETL had contributed significantly to six of those seven operational capabilities. After the ground war began, it was obvious that the Army's topographic engineer community had provided tremendous knowledge of the battlefield so that commanders knew the battlefield terrain, understood the obstacles they would have to overcome, and could exploit that knowledge to achieve a decisive victory with minimum casualties.

Clearly, superior knowledge of the battlefield, provided in large part by USAETL, was a key combat multiplier which provided allied forces with a significant advantage over the enemy. The digital topographic revolution was severely tested in the desert, and it was a huge success.

COL DAVID MAUNE is commander and director of the U.S. Army Engineer Topographic Laboratories. He has a master's and a doctorate in geodetic science/photogrammetry from Ohio State University. He has served in 15 key topographic engineer assignments during the past 28 years.

Desert Storm

FIFTY YEARS OF SERVICE
ARMY RESEARCH INSTITUTE
1940 - 1990

LESSONS LEARNED IN 'FIELDING' RESEARCH KNOWLEDGE

By Dr. Stanley M. Halpin

Introduction

For the past 15 years the Army Research Institute (ARI) Field Unit at Fort Leavenworth, KS has executed a research program designed to answer two simple questions: How does Army command and control work? What changes in procedures, individual and group training, and systems' support will help command and control work better? When President Bush announced he was "drawing a line in the sand" we knew that the value of our efforts was going to be put to the ultimate test by our friends and colleagues in uniform.

In common with the thousands of research scientists and engineers who have contributed to Army doctrine, tactics, techniques, procedures, materiel, and training, we immediately began re-evaluating the products we have produced and those in the pipeline to see what we could do in the short-term to help support Desert Shield. This article provides an overview of the steps we took to provide that support, and discusses the lessons we learned which may apply to others in the R&D community.

The products produced by the ARI Fort Leavenworth Field Unit are somewhat intangible. When the auditors and bean-counters come through, the usual metric of performance is the number of published reports, but the published reports in fact represent a relatively small portion of our production; they primarily serve to document past work for archival purposes.

Our research generates observations and data on human performance in command and control (C^2). Based on that data, we develop concepts, ideas, and suggestions. Our real products are recommendations for changes in tactical-staff techniques and procedures, changes in the systems which support C^2, or changes in individual and group training for commanders and staffs. Such recommendations are more often presented as informal or formal briefings than as reports.

Our research is typically not in direct support of troop units or materiel developers, but rather is done in conjunction with organizations responsible for establishing C^2 systems requirements, establishing C^2 training requirements and procedures, developing C^2 doctrine and procedures, or training individuals and groups in the classroom.

Thus, we faced a compound dilemma. In the first place our products have only an indirect impact on an army in the field; they are designed to support the training, doctrine, and systems development community. Second, many of our products are not neatly packaged as reports which could be sent to troops in the field to read and consider. Third, our usual customers also play an indirect role; they develop and produce requirements and doctrine, not tanks or rifles.

To identify meaningful ways to provide near-term support to our forces in Saudi Arabia, we had to redefine the problem. Rather than asking "what products do we have that will support the commander in the field?" we needed to ask "what do we know that will help the commander in the field?" The search then could focus on a "delivery mechanism" for ideas, not for reports or briefings.

We found that the Combined Arms Command, Fort Leavenworth, had anticipated the requirement and created a solution in the form of Special Editions of the Center for Army Lessons Learned (CALL) Newsletters. The first of these, published in August, 1990 (*Winning in the Desert*; CALL Newsletter 90-7), focused on the physical and geographical factors in desert warfare. The second newsletter (*Winning in the Desert II: Tactics, Techniques and Procedures for Maneuver Commanders;* CALL Newsletter 90-8), published in September 1990, became the vehicle for us to deliver our "products" to the field by highlighting findings and recommendations on human performance in C^2.

Doctrine

Shortly before Operation Desert Shield began, we had provided the Command and General Staff College (CGSC) with the final draft of Chapter 4, "Command and Control Process" in the new FM101-5, *Command and Control for Commanders and Staff.* The integration of our own and others' findings that formed the basis for the doctrinal recommendations in that chapter became the starting place for our input to *Winning in the Desert II*. The goal was not to reiterate standard doctrine, or even to promulgate new doctrine for command and control.

The field commander could be assumed to have a detailed grasp of the current doctrine and could equally be assumed to have the ability to develop new techniques and procedures to meet his unique requirements. Rather the goal was to point out hidden pitfalls which the typical commander may not be aware of, but which could have disastrous effects. For example, most individuals are quite confident of their ability to function effectively for long periods without sleep; however, a large and compelling body of research has shown that one of the early casualties of sleep loss is judgment, including one's judgment about one's own ability to perform complex tasks. Our particular perspective comes from the integration of an understanding of the tasks, functions, and processes involved in command and control with an understanding of human capabilities and limitations when performing these complex tasks. Thus, our goal was to provide the field commanders with the information needed to recognize possible limitations in human capabilities, and to suggest methods for avoiding or alleviating the conditions that reduce those capabilities. The overall rubric for our recommendations was "C^2 Effectiveness Under Stress."

Stress

In preparing our input for CALL, we were sensitive to the "so what" test. We assumed that the target audience, maneuver commanders, already knew Army doctrine, and had already practiced and refined C^2 techniques and procedures in successive levels of command and in frequent map exercises, command post exercises, and field exercises. We assumed that they were competent leaders, able to evaluate the professional strengths and weaknesses of their subordinates. We also assumed that they would be impatient with what might seem to be "blinding flashes of the obvious."

The key element usually missing from training environments is a high level of stress, but these commanders would be operating in an environment under the compound influence of several stressors: sudden transportation across multiple time zones to an unfamiliar area; an unfamiliar culture; and physically fatiguing weather conditions. Furthermore, in combat they would experience all of the stress of combat itself, to include the sleep loss and fatigue associated with continuous operations, intense time pressure, and high levels of uncertainty.

By focusing our recommendations on methods for recognizing and dealing with degradation of performance under stress, we hoped to provide the basis for our audience to gain insights on their own and their subordinates' behavior; those insights could be expected to help them avoid serious command and control problems.

Source Material

The preparation of our portion of the CALL Newsletter involved an intense effort by an ad-hoc team of researchers from within the Field Unit. Headed by Jon Fallesen, the team also included Rex Michel and Jim Lussier; other members of the Field Unit staff contributed suggestions and helped identify appropriate source material. The sources used included:

- Combat lessons learned from World War II, Korea, Vietnam, and the 1973 Arab-Israel conflict;
- Material from the ARI and CALL National Training Center (NTC) data base;
- Data and observations collected by ARI at 13 Division-level CPXs and two Corps-level CPXs;
- Summary assessments from Battle Command Training Program (BCTP) observer/controllers concerning common C^2 problems;
- An in-depth ARI task analysis of the situation estimate process;
- Participation in and observations of simulated-staff classroom exercises in the Tactical Commander's Development Course (TCDC), the Command and General Staff Officer's Course (CGSOC), and the Combined Arms Staff and Service School;
- Data and observations from a series of ARI laboratory and field experiments which have included a total of over 1,500 officers from company grade to General, and which have explored a range of issues including the components of tactical decision making expertise, and decision making under time pressure or under information uncertainty;
- A series of evaluations of decision aids and information technology;
- Hundreds of articles from our own archives and the psychological literature on stress, fatigue, continuous operations, decision making strengths and weaknesses, group decision making, course of action development and analysis, and critical information requirements.

Over a five day period the team reviewed, brainstormed, and distilled this information and wrote what became the bulk of the command and control portion of *Winning in the Desert II*. CALL review of the draft input helped refine the style and sharpen the message for the intended audience.

A complete rehash of the ARI recommendations on C^2 effectiveness under stress is not appropriate here; our focus in this article is on lessons learned in the process of translating intangible, some would say ephemeral, findings and recommendations, taking them out of the R&D or combat development or training development context, and applying them in the "real world" of the field commander. Exploring one of the items will illustrate the process: *The enemy is planning too! Remember to wargame your plans dynamically. Do not just attack a static template or assume he will stand still for you.*

In retrospect, this recommendation might seem to have been 180 degrees off the mark; the Iraqis don't seem to have done much planning, and a static template would have provided an accurate picture of what was faced by our forces. However, the historical record and our laboratory and field data consistently point to problems in this area. It is difficult, particularly under stress, for most people to engage in complex "what-if" mental exercises. The most common failure shows up as a simplifying assumption, usually wrong, that what is now will forever be.

While the concept of "wargaming" is firmly established in our doctrine, in practice it is often neglected or done with such simplifying assumptions. We may never know whether any maneuver commander read and considered the recommendation, but if only one tank company commander was provided with a new insight on the need to avoid such assumptions, then the effort spent on *Winning in the Desert II* was worthwhile.

Our most valuable source of information was that derived from the 1973 Arab-Israeli conflict. That information gave us a benchmark to filter our recommendations, so that we could exclude those which were contradicted by actual experience in war.

Lessons Learned

The process described above and our experience during that intense period in late August and early September provide several lessons for the R&D community. The first is that the "products" which we labor to produce in support of the combat, training, doctrinal, and materiel developers in peacetime will often seem irrelevant to the field army, particularly under wartime conditions. We rely on others to serve as intermediaries, and few laboratory products are identifiable as such when they reach the field. Nevertheless, the data and observations obtained during "product development" represent a wealth of knowledge and experience which can and should be applied directly to problems of the army in the field, in peacetime as well as wartime.

The second lesson is that archival reports seldom can contain more than a fraction of the total "knowledge and experience" which is gained at the cost of much time and the commitment of significant resources. The ARI Field Unit at Fort Leavenworth is particularly fortunate in having had a stable staff consisting of professionals with many years of experience focused on a relatively narrow problem area. The "institutional memory" of the unit is extensive, and in this case was the critical resource which allowed us to respond. Steps should be taken by R&D managers to consciously develop and take advantage of that type of resource; this could include steps to avoid personnel and research program turbulence or steps to capture critical knowledge.

The third lesson is that war is different. Each war is different from all others, each battle within a war has its own unique characteristics. But, most importantly, every war is different from any training exercise or system evaluation exercise.

Conclusion

There is much that can be learned from laboratory and field data collection that will make a difference in wartime, but predicting ahead of time which conclusions will hold up is quite a risky business. Our most valuable source of information was that derived from the 1973 Arab-Israel conflict. That information gave us a benchmark to filter our recommendations, so that we could exclude those which were contradicted by actual experience in war.

As this article is being written, the ARI Field Unit at Fort Leavenworth is again working with CALL, this time to help structure a survey of combat commanders to obtain feedback on their experiences in Operation Desert Storm. Careful planning and appropriate data collection now can help build the historical record of "lessons learned" which will provide the next generation of researchers a "so-what" filter for their work.

STANLEY M. HALPIN has been the chief of the U.S. Army Research Institute Field Unit at Fort Leavenworth, KS since 1983. He has a B.S. in industrial and labor relations from Cornell University (1965) and an M.S. and Ph.D. in social psychology from Purdue University (1970). In his 20 years with the Army (19 with ARI) he has conducted and directed a range of research projects exploring individual and group decision making in the context of computer supported C². Halpin is the co-editor of Information Technology for Command and Control, a book recently published by IEEE Press.

The Army Research Office. . .

SHAPING THE FUTURE THROUGH PHYSICS AND CHEMISTRY

By Dr. Robert W. Shaw
and Dr. Gerald J. Iafrate

This year, the Army Research Office (ARO) celebrates its 40th anniversary. An article in the March-April 1991 issue of *Army RD&A Bulletin*, the first in a series of articles on ARO's current and future efforts, briefly described the formation of ARO, its mission and some of its research activities. This article directs attention to research supported by the Divisions of Physics and Chemistry.

PHYSICS

Among the sciences, physics is the most fundamental. It spans the range from the basic particles and fields of which all matter and energy are composed to the large scale structure of the universe. Physics research supported by the Army Research Office is not so broad, however, but is focused on areas directly related to Army requirements to protect and arm the soldier. This research has led to fundamental advances in the understanding of solid state devices, lasers, and optical imagers.

Of the physics research areas supported by ARO 40 years ago, some have become mature and the ARO physics program has moved into new areas. For example, during the 1950s little was understood about the effects of the radiation accompanying nuclear explosions. Some of the earliest work supported by ARO concerned the effects of neutron and other radiation on materials. These processes are now well understood and physics efforts at ARO have moved on to other areas. The results of this early research, however, remain important — work supported by the ARO Physics Division on the interaction of microwaves with molecules and on magnetic resonance has resulted in the development of research tools now used in many other scientific fields.

Several areas originally identified by ARO physicists as important continue to yield new discoveries and lead to new technologies which remain a focus of the ARO program today. These areas include solid state physics leading to semiconductors and superconductivity, lasers, and detectors for improved sensing of objects, especially at night.

Past Accomplishments

Among the most distinguished scientists supported by ARO over its 40 year history was Professor John Bardeen of the University of Illinois, winner of two Nobel Prizes in physics. Bardeen wrote, "The Army Research Office provided the sole support of my research on solid state and low temperature physics during the period 1952-1975." During that time, Bardeen and his students formulated the Nobel Prize winning theory of superconductivity — a theory that has had a broad impact on many areas of physics and technology.

Another Nobel Prize winner, Leo Esaki of IBM, conceived and engineered the original semiconductor superlattices with ARO support. The accomplishments of Bardeen, Esaki, and other ARO supported physicists have had enormous influence on the development of solid state electronic devices for computing,

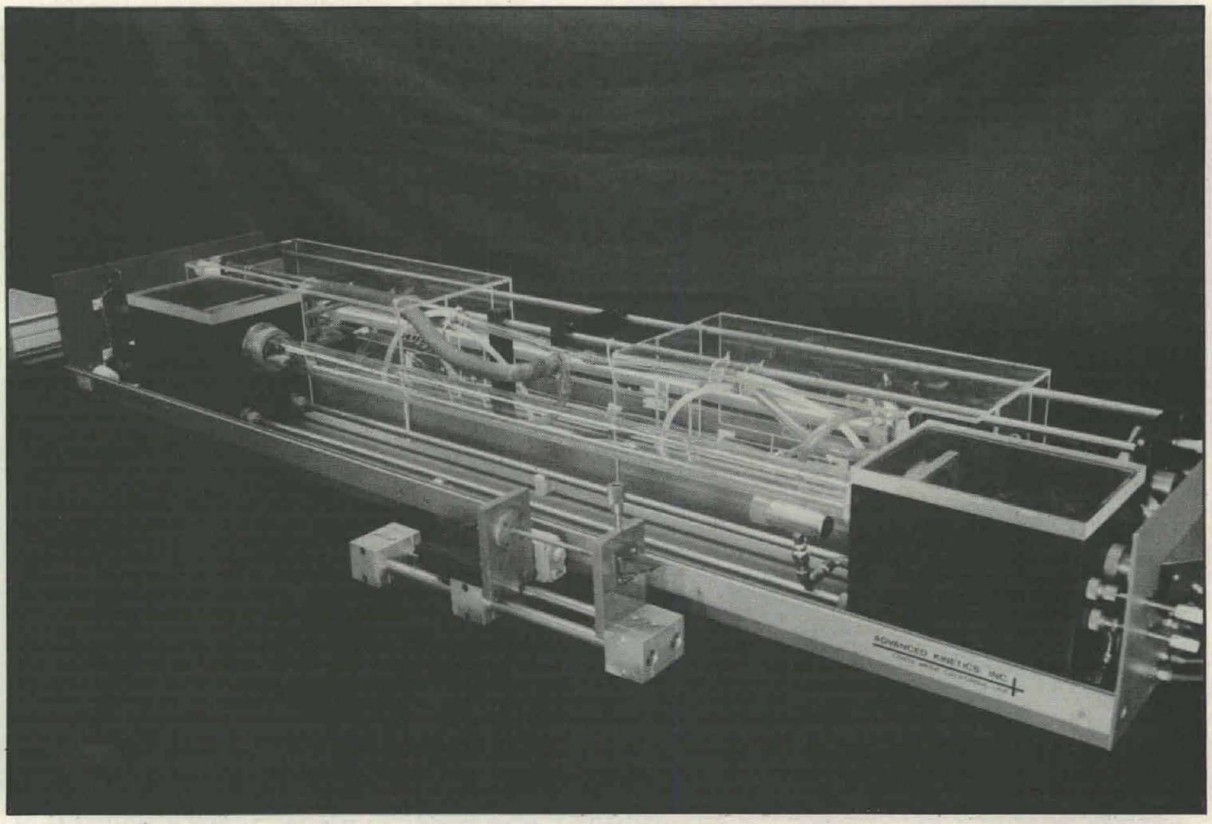


Figure 1. A typical large commercial laser is shown in the background and a new ultra-small laser developed by Professor Frank DeLucia of Duke University in the forefront.

communication, detection and many other applications. This work has contributed, not only to the Army, but also to the economic strength of our nation.

During the early 1970s, ARO scientists judged that lasers would be useful for range finding, target illumination, and intrusion detection. ARO support of Peter Sorokin at IBM led to the first tunable dye laser, a tool now used around the world in basic research and medicine.

In the late 1970s Professor Kikuchi at UCLA was encouraged by ARO to begin work on the fundamental properties of Mercury/Cadmium/Telluride, an important electronic material, but very unstable. Based on this work, great improvements were made in growing crystals of this material which is now used in advanced thermal weapons sights for night vision.

In the mid 1980s, Professor James Scott of the University of Colorado made significant progress in research on magnetic thin films suitable for computer memories with ARO support. Based on this research, memory chips that are radiation hard and have long term stability have been developed. These rugged computer memories will have applications in missile guidance systems, data links, ground computers and many other military devices.

The Current Physics Program

One of the current research areas supported by ARO in atomic and molecular physics includes work on improved semiconductor materials processing and on the growth of diamond thin films — an electronic material of the future. Another area supported by ARO, the development of electrical switches, will increase the power of lasers and new electrical energy storage systems for electrothermal and rail guns. Results of current work are being incorporated into models for calculating electromagnetic pulse (EMP) in the atmosphere. Another area of ARO supported research continues on nearly all kinds of lasers-from X-ray to infrared frequencies. Figure 1 shows two infrared lasers: a typical large commercial laser in the background and a new ultra-small laser developed by Professor Frank DeLucia of Duke University. The new laser is 10,000 times smaller but has 100 times the tuning range of the commercial system. This laser will be an important target acquisition tool.

Millimeter wavelength radiation can penetrate air obscured with smoke, dust or clouds. Research on sources and detectors will enable better target imaging on the battlefield. Some of the research on millimeter wave sources involves new laser technology.

Solid state physics emphasizes changes in structure, properties of surfaces and interfaces, and defects and impurities. Basic understanding of these processes leads to faster, smaller, more stable electronic devices and detectors requiring less power. Recently, a very low noise oscillator developed by Professor Tiersten of Rensselaer Polytechnic Institute was adapted for the target acquiring radar for the advanced Patriot Missile. This research was co-sponsored by ARO and the Army Electronics Technology and Devices Lab.

Optics research seeks to improve "seeing," by the eye and by detectors. Many military systems involve optics, including night sights, rangefinders, target designators and threat warning devices. Optics also has enormous potential in improved communication (e.g., optical fibers) and in electronic devices (e.g., the optical computer). In addition to a large investment in optics research in its regular program, ARO supports two Centers of Optics Research — at the University of Rochester and at the University of Arizona. Recently, responding to a request from the Army Night Vision and Electro-Optics Center, Rochester scientists invented and delivered an effective and cheap detector for finding enemy lasers in a cluttered field with many light sources.

The optics program also supports research to develop new lasers and laser filters to protect people and equipment against laser weapons. This work is of special interest to Army laser defense scientists at Picatinny Arsenal, Natick RD&E Center and the Center for Night Vision and Electro-Optics.

Physics in The Future

In addition to the strong, ongoing research programs described above, the ARO Physics Division has initiated a new program called "Nanotechnology and Microscopic Physics." This refers to very small structures down to the nanometer (one millionth of a millimeter) scale. The understanding of the properties (electrical, magnetic, mechanical, etc.) of such small structures will enable us to build very small, very fast devices with great impact on many of the Army critical technologies, to include signal processing, semiconductor materials, and microelectronic circuits. ARO will continue to emphasize research with high probability of transfer to Army research labs and RD&E centers.

CHEMISTRY

Chemistry is the science of molecular change. It seeks to understand how chemical reactions occur. For the Army, this information enables the controlled generation of energy in propellants and explosives and in fuel cells, the synthesis of new materials such as polymer composites, the development of reactions for decontamination of chemical agents and the destruction of toxic wastes, and chemical analysis and identification of unknown substances. Chemistry research also provides the basic molecular engineering required to produce the materials which make possible modern electronics, lasers, and a host of other space age technologies.

Past Accomplishments

Many chemists supported by the Army Research Office have won international recognition for their work. For example, during the 1950s, both William Lipscomb and Herbert Brown were supported by ARO to do research on compounds of boron. Their work contributed to boron formulations for high velocity rocket propellants and they each received the Nobel Prize for their basic research on boron chemistry.

Other top priorities for the early ARO program in chemistry included high

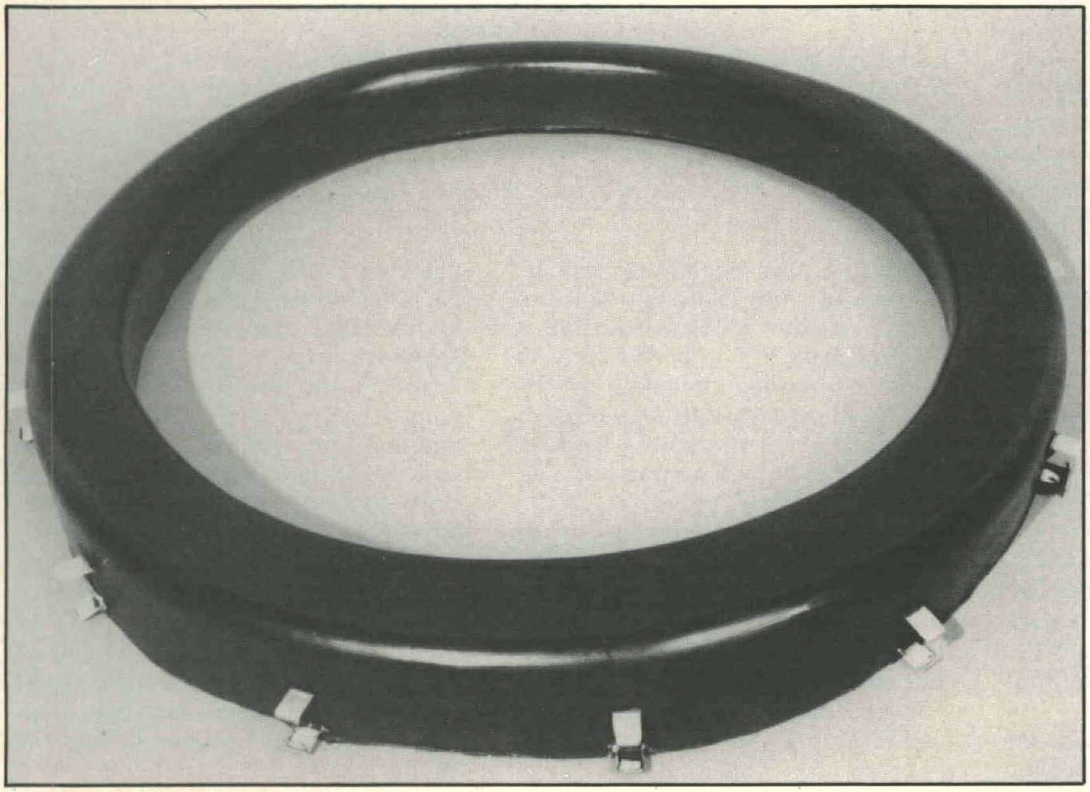


Figure 2. Air Plenum Seal of Phosphazene Fluoroelastomer for M-1 Tank Engine.

pressure and temperature processes leading to new materials, chemical processes leading to corrosion, radiation chemistry, fuel cells and the synthesis of new energetic materials.

Professor Harry Allcock of Penn State University was the first to successfully synthesize polymers with phosphorus in the backbone. These materials have excellent flexibility, over a wide range of temperatures, and are now used by the Army in a number of applications to include the plenum seal for the M-1 tank engine shown in Figure 2.

The Current Chemistry Program

The current polymer chemistry program seeks new high strength, light weight materials. The Army needs equipment that works reliably under extreme conditions not found in normal civilian use and this program seeks to provide materials to support that need. Research includes studies of polymer blends, inorganic polymers (e.g., the phosphorus polymers described above), and liquid crystal polymers.

Fundamental studies relating molecular structure to properties will enable tailoring of polymers for desired properties of high impact strength, thermal stability, and flexibility. The original phosphorus polymer research led to materials now being used by the Army, but work continues on new phosphorus polymers to find new methods of improving their properties and making them cheaper. Work supported by this program has been of special interest to the Army Materials Technology Lab and the Natick Research, Development and Engineering Center.

The physical chemistry program at ARO emphasizes understanding the ignition and combustion of energetic materials — propellants and explosives. Figure 3 shows that, using RDX as an example, we know very little about the steps in combustion that change a starting molecule to its final products. Understanding these chemical processes will provide information for ballistics modelers to develop safer munitions with improved performance.

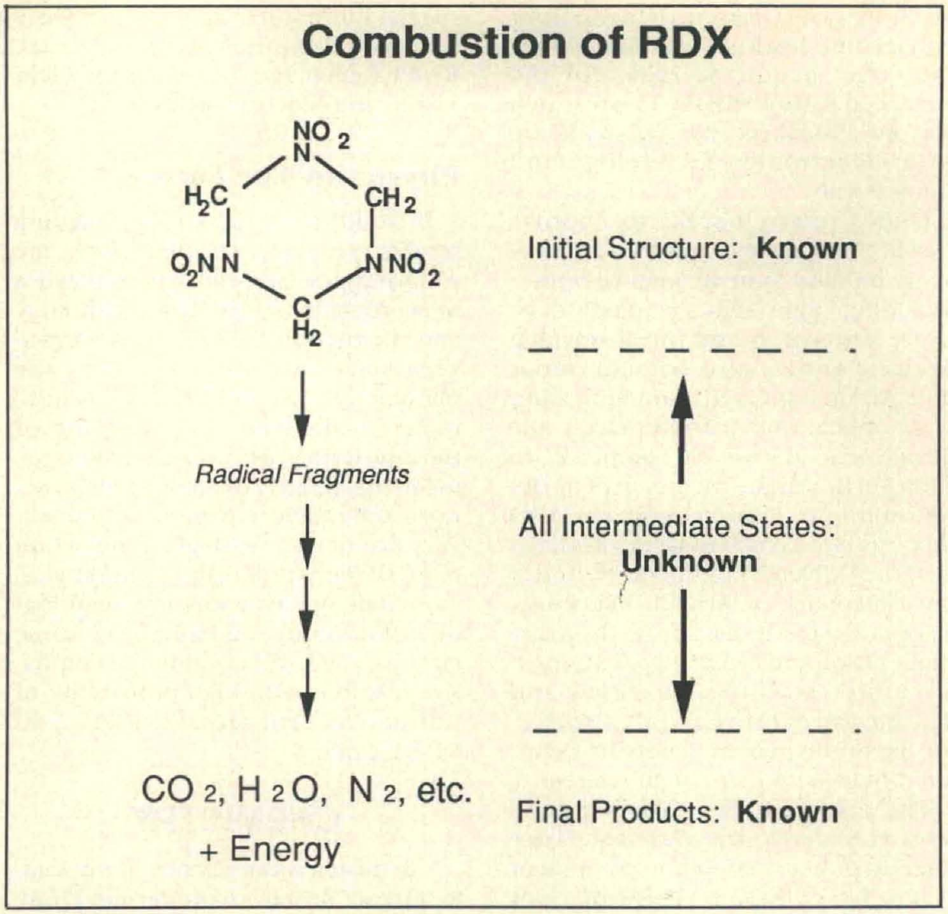


Figure 3.
To design propellants and explosives with better safety and higher performance, we must understand what happens to the molecules when it burns. This figure uses RDX as an example.

Because the chemical reactions involved in gun and missile propulsion and explosions are so fast, it has been difficult to study them. Advances during the past decade, however, in fast laser spectroscopy and more powerful computing have enabled significant progress. The Army University Research Initiative Center for Fast Reactions at the University of Southern California has been a strong contributor to this effort and scientists from ARDEC at Picatinny Arsenal, the Ballistic Research Lab and West Point have traveled there to do experiments.

Chemical synthesis refers to the making of molecules. The synthetic chemistry program at ARO is directed at new, more powerful and less sensitive energetic materials and also at special materials such as the ingredients for new very tough ceramics with possible use in armor. A related effort in chemistry of advanced semiconductor materials seeks to understand the surface chemistry of materials used in computer chips and other semiconductor devices such as infrared detectors for night vision scopes. Results of this work are followed closely by Army scientists at the Electronics Technology and Devices Lab.

The ARO program in electrochemistry emphasizes power generation, storage and conditioning. For power storage and conditioning, new materials for capacitors are sought. For power generation, ranging from low power units for the individual soldier to very large units for armored vehicles, the program seeks new ideas for fuel cells.

Chemistry research for chemical defense is also a major part of the ARO program. This includes a large program devoted to new decontaminants for chemical agents, especially nerve and mustard agents. Some of the most promising work involves the formulation of detergent-like molecules with the power to catalytically destroy

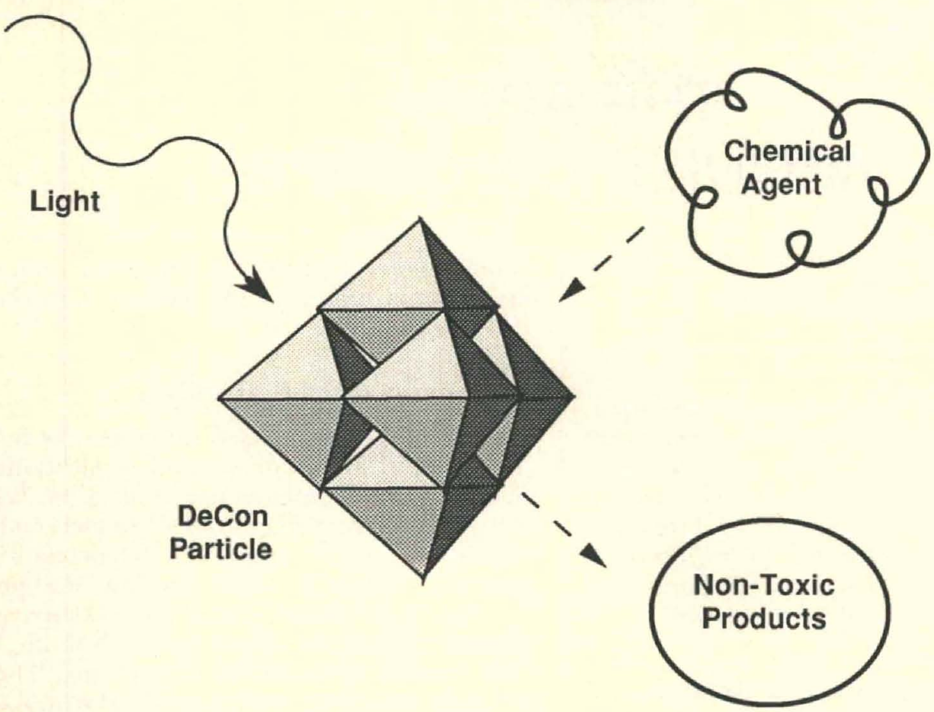


Figure 4. DeContaminating particle traps light and releases it chemically to destroy chemical agent. Chemistry studies the basic processes of energy capture and agent destruction.

chemical agents. ARO supported investigators have cooperated with Army scientists and these new materials have been transferred to the Army Chemical RD&E Center for evaluation and possible development.

Other chemical decontamination research has developed cheap metal oxide particles that can absorb light and generate very reactive chemical species in water. These species can break down toxic molecules, such as chemical agents, into relatively non-toxic products. The process is shown in Figure 4.

ARO Chemistry in The Future

The large, current programs in combustion chemistry, chemical defense, polymer and synthetic chemistry and electrochemistry will continue — they have been productive and the Army's need for progress in these areas remains. These programs will also continue their close cooperation with the Army research labs and RD&E centers.

A relatively new area of chemistry for ARO is that of toxic material destruction. The Army is lead service for energetic materials and chemical defense and is responsible for the disposal of large amounts of obsolete energetic materials and chemical weapons and the clean-up of contaminated areas at production facilities, bases and elsewhere. ARO has begun funding basic research for chemical reactors that would enable the controlled chemical destruction of military toxic materials. This is part of a larger ARO program in environmental research science and we look forward to new initiatives in the Army to support it. We expect close cooperation with Army scientists at Natick and the Chemical RD&E Centers and with the Army Corps of Engineers in the development and enhancement of technology to deal with this major disposal problem.

Conclusions

Physics and chemistry are fundamental sciences — discoveries will have very broad application in our technological civilization. Many of the projects supported by the ARO programs in physics and chemistry have resulted in important discoveries with wide ranging impact on civilian life. This is, of course, good and desirable. As this article has shown, however, ARO emphasizes research to provide the technology to arm and protect the U.S. soldier. We look forward to continuing and improving our efforts to accomplish that mission.

DR. ROBERT W. SHAW is associate director of ARO's Division of Chemical and Biological Sciences. He has a Ph.D. in physical chemistry from the University of Washington.

DR. GERALD J. IAFRATE is director of the Army Research Office. He has a Ph.D. in physics from the Polytechnic Institute of Brooklyn.

PERSCOM UPDATE . . .

THE ARMY ACQUISITION CORPS

By CPT(P) Deborah Chase

The formation of the Army Acquisition Corps (AAC) in January, 1990 necessitated several changes in the mission and organization of the Total Army Personnel Command (PERSCOM). One of the most significant changes that took place to enable the Army, in general, and PERSCOM, specifically, to implement the governing DOD directives was establishment of the Military Acquisition Management Branch.

Military Acquisition Management Branch

The Military Acquisition Management Branch was formed as a sub-element of the Functional Area Management and Development Division (FAMDD) of PERSCOM. It was, initially, our charter to take mathematical models which determined the AAC personnel requirements and access the personnel inventory of the AAC to match the requirements. We accomplished this mission through a series of board actions. The first, annual Qualification/Validation/Certification (Q/V/C) Board converted the 6T additional skill identifier (ASI) to 4M or 4Z. The one time Acquisition Officer Selection Board (AOSB) selected senior officers who had previously held the ASI 6T for the AAC. Finally, a series of pre-PERSCOM Acquisition Accession Boards (PAAB) were convened to access officers in YGs 83 through 71. The Q/V/C Board and PAAB are discussed in further detail later in this article.

The Military Acquisition Management Branch is, in effect, the equivalent of the Basic Branch (Infantry, Armor, et al.) assignment branches, with career management responsibility for all military members of the AAC. The responsibility to revise requirements models and develop personnel inventory has been transferred to the Army Acquisition Corps Management Office (AACMO), also in FAMDD. The AACMO includes both the Military Acquisition Management Branch and the Civilian Acquisition Management Branch (CAMB), a unique combined office which manages all AAC members, military and civilian.

Within the Military Acquisition Management Branch, we are organized such that each functional area of the AAC (51, 52, 53, 97, 15/35) has a designated career manager. The AAC career manager is responsible for all of the career management tasks which were formerly conducted by the Basic Branch career manager to include assignments, schools (military and civilian), records updates, boards preparation, and career counselling. Consequently, members of the AAC should direct all career management inquiries to their assignments officer in the Military Acquisition Management Branch.

Advanced Civil Schooling

A goal of the AAC is to access officers into functional areas 51, Research, Development and Acquisition; 53, Systems Automation; 97, Procurement; and 15/35, Aviation/Intelligence during their eighth year of service. Following accession, our goal is to target the officers requiring advanced degrees to advanced civil schooling (ACS) programs.

While YG83 was this year's target YG, there are still opportunities available for officers in YGs 79 through 82 to attend fully funded advanced civil schooling. The Acquisition Management Branch was allocated 165 school authorizations for academic programs starting in the 1991 fall semester.

Current policy guidance is that most of the AAC officers who attend ACS will pursue courses of study leading to scientific, technical or managerial degrees. Unfortunately, the academic background of the officer corps at large does not, for the most part, support the pursuit of advanced degrees in technical disciplines by those officers. Consequently, in order to ensure that we satisfy our requirement for technical disciplines, we require that all officers who are applying for ACS take both the GRE and the GMAT. The bottom line is that if you have a technical background, you will probably go to a technical graduate degree program.

If you are a member of the Acquisition Corps in YGs 79 through 83 and are interested in pursuing an opportunity to attend graduate school, it is incumbent upon you to initiate the application process by completing the following:

- Take both the GRE and GMAT. Consult your local education center for information and scheduling.
- Complete and submit DA Form 1618-R (signed, dated, and endorsed by the first field grade officer in your chain of command). Include official transcripts from all colleges which you have attended.
- Contact the civilian institutions listed on the Army recommended list of academic institutions which you are interested in and comply with their application requirements.
- Keep your ACS point of contact informed of your progress. There are still school slots available; however, they will not last forever. Don't miss your opportunity; get your applications to us now.

New Legislation

In November 1990, the Defense Acquisition Workforce Improvement Act (DAWIA) was passed. We have received numerous inquiries concerning the effect this legislation will have on the Acquisition Corps. The DAWIA will cause us to

THE ARMY ACQUISITION CORPS *(continued)*

re-evaluate the work that we have done on the AAC to date. We are taking steps to ensure that whatever adjustments that are made has little or no impact on officers currently in the AAC.

PERSCOM Acquisition Accession Board (PAAB)

The purpose of the PAAB is to access officers into the Acquisition Corps in their eighth year of service. The board is held annually in October. While the October 1990 board took a preliminary look at YG84, the October 1991 PAAB will complete the accession of YG84 officers.

All PAABs will enable the basic branches to fill their shortages in year groups 83 and earlier. If you are not already in the AAC but are interested in participating, contact us for further information. Submit your request for nomination through your basic branch.

Qualification/Validation/Certification Board

The Q/V/C Board meets annually prior to the convening of the lieutenant colonel and colonel promotion boards to determine the certification level of AAC officers. The board will review the records of all officers who are to be considered in the primary zone for promotion to lieutenant colonel or colonel in a given year to determine that each officer has met the specific set of qualification criteria established by the proponent. The criteria include 4M/4Z certification in accordance with law and DOD directive.

Other Annual Boards (tentative dates):

- Command and General Staff College Selection Board (TBD)
- Senior Service College Selection Board (September 1991)
- COL PM Selection Board (December 1991)

In order to prepare for all selection boards, the eligible officer should review the Career Management Information File to ensure it includes a current photo and the latest OER and that the ORB and Microfiche are up-to-date.

DSMC Attendance

The AAC is required to "grow" 137 lieutenant colonel 4Zs each year. However, class capacity in the Defense Systems Management College (DSMC) PM Course is limited. Understandably, this presents a challenge; not everyone who is eligible can go to DSMC. Our priority for sending officers to DSMC is to first send colonels and lieutenant colonels who are either currently in a 4Z position or projected to go to a 4Z position as their next assignment. If there are still school

PERSCOM POINTS OF CONTACT

MAJ Bruce Bachus	Chief, Military Acquisition Management Branch	DSN: 221-3131 Comm: (703)325-3131
CPT Cynthia Camperson	FA 53 Assignments	DSN: 221-3114 Comm: (703)325-3114
Ms. Smith	FA 53 Military Personnel Tech.	DSN: 221-2757 Comm: (703)325-2757
MAJ Charles Vondra	FA 52/97 Assignments	DSN: 221-2801 Comm: (703)325-2801
CPT Lacey Hughs	FA 52/97 Assignments Future Readiness Ofc	DSN: 221-3124 Comm. (703)325-3124
Mr. Tabor	FA 52/97 Military Personnel Tech.	DSN: 221-2758 Comm: (703)325-2758
MAJ Corwyn Tiede	FA 51 Assignments (MAJ(P) and LTC) FA 15/35 Assignments	DSN: 221-3129 Comm: (703)325-3129
CPT Gary Kinne	FA 51 Assignments (CPT(P) and MAJ)	DSN: 221-3128 Comm: (703)325-3128
CPT Francis Fierko	FA 51 Assignments (CPT)	DSN: 221-1474 Comm: (703)325-1474
Ms. Haines	FA 51 Military Personnel Tech.	DSN: 221-3125 Comm: (703)325-3125
CPT Deborah Chase	AAC Future Readiness Officer	DSN: 221-2760 Comm: (703)325-2760

ARMY ACQUISITION CORPS *(continued)*

seats available after our first priority is met, we will then send senior majors. Understandably, this is a tough call, and one which we don't like to make. Call your assignment officer for details.

CGSC Attendance

It should come as no surprise to you that if you have not attained MEL 4 status by either resident or non-resident courses you will not be selected for promotion to lieutenant colonel. Historically, this statement has proven to be true. Additionally, without the MEL 4 designation, your chances for being selected for certain key jobs are slim.

Typically, about 48 percent of a given YG is selected to attend CGSC as resident students. Approximately 19 percent of the YG is selected during their first look, 19 percent is selected at the second look, 7 percent is picked up during the third look, and the remaining 3 percent is chosen at the fourth year of eligibility. The numbers should state clearly to you that, while there is still a chance for selection after two looks, that chance is very slim. You should immediately enroll in the non-resident course if you are not selected to attend the resident course by your second board.

There are several options available to you for attaining MEL 4, the most common of which is the CGSC correspondence course. You can obtain an application form from DA Circular 351-3, or you may write to the following address: Commandant, USACGSC, ATTN: ATZL-SWE-R, Fort Leavenworth, KS 66027. (For enrollment information call DSN 552-4451 or commercial (913) 684-4451)

AAC Personnel Model

The heart and soul of AAC inventory development is the 4Z critical position list. There are approximately 440 military critical positions in the AAC. The function of the AAC Target Inventory Development Model (TIDM) is to calculate the correct numbers and types of captains (by branch and functional area) to access into the AAC so that all of the critical positions can be filled by the time the cohort YG of captains is promoted to lieutenant colonel or colonel.

The TIDM is requirements driven in that it starts with the desired end product of lieutenant colonels and colonels then determines, through the use of Army average promotion and attrition rates, the number of captains to access into the AAC at the eighth year of service. This process is not complicated. As updates are made to the number of critical positions, or to promotion and attrition rates, the model can be readily updated.

CPT(P) DEBORAH CHASE is the AAC future readiness officer at PERSCOM. She has a master's degree in aeronautical science from Embry-Riddle Aeronautical University.

ACS Reporting Requirements

Officers assigned to AAC graduate degree programs are advised that AR 621-1, Training of Military Personnel at Civilian Institutions, requires that they submit DA form 2125, Report to Training Agency, upon arrival at the College or University, but before the beginning of the academic year. Reports will be submitted in three copies: Copies one and two are submitted to the student liaison officer (SLO) at the college or university. The SLO will then consolidate all of the DA Forms 2125 and submit them to HQ PERSCOM, ATTN: TAPC-OPB-D, 200 Stovall Street, Alexandria, VA 22332-0400. Copy three is mailed to Director, Army Acquisition Executive Support Agency (AAESA), 5001 Eisenhower Avenue, Alexandria, VA 22333-0001.

Officers are required to submit subsequent reports (same addressees) upon completion of each academic term. Subsequent reports will contain grades received in each course and number of hours of each course. Additionally, reports will include a list of approved courses for the next academic year.

The purpose of these reports is to establish a line of communications between training agencies (PERSCOM/AAESA) and the officer attending graduate school. This line of communication allows the training agencies to monitor the officer's progress as well as the core curriculum and its relationship to the needs of the Army Acquisition Corps. Training agency POCs are: Karen Walker, AAESA, DSN 284-9572 or (703) 274-9572; MAJ Jill Whisker, PERSCOM, DSN 221-3140, or (703) 325-3140.

FY 1990 Senior Service College Selection Board Results

Analysis of the results of the FY 90 Senior Service College selection board reveals an average AAC select rate of 4.9 percent, compared to an average Army select rate of 5.9 percent.

Overall, the Army considered 5,333 officers and selected 319 to meet FY 90 SSC requirements. Of the 361 AAC (4M/4Z) officers considered by the board for SSC, 18 were selected. One single track officer (FA 97) was included in the AAC selectees.

Functional Area selections for AAC officers are as follows:

Funct. Area	No. Sel	Army Sel Rate	AAC Sel Rate
— FA 51:	10	3.0%	4.6%
— FA 97:	6	4.2%	8.6%
— FA 53:	1	3.0%	2.6%

The following AAC officer selection breakout by branch reflects those officers selected who are, or have served as battalion or equivalent level commanders, and/or product

COLLEGE SELECTION . . . *(continued)*

managers. Also listed are those officers who have completed the PM Course at DSMC (PMC):

Branch	Cons	Sel	Cmd	PM	PMC
IN (11)	23	1	1	0	0
AR (12)	16	0	—	—	—
FA (13)	26	0	—	—	—
AD (14)	30	3	3	1*	3
AV (15)	60	4	1	3	4
SF (18)	1	0	—	—	—
EN (21)	16	0	—	—	—
SC (25)	59	1	1	0	1
MP (31)	4	0	—	—	—
MI (35)	16	1	0	0	1
AG (42)	5	1	1	0	1
FC (44)	1	0	—	—	—
CM (74)	10	1	1	0	0
TC (88)	5	1	1	0	1
OD (91)	56	3	2	1	3
QM (92)	33	1	1	0	1
S/Track	—	1	1	0	1
Totals	361	18	13(72%)	5(28%)	16(89%)

* Serving PM who previously commanded a battalion.

Ask PERSCOM... AAC CAREER MANAGEMENT QUESTIONS

Q: How can I get into the AAC?

A: Tell your basic branch career manager that you want to be nominated to the next PERSCOM Acquisition Accession Board (PAAB). Each branch has its own quotas for the AAC. If you are branch qualified and your basic branch has quotas in your year group (YG) and functional area (FA), they may elect to nominate you for the AAC.

Q: Why wasn't I considered for the AAC?

A: There are a number of reasons that a specific officer is not considered for the AAC. Some of the most common reasons include:

- You didn't request consideration.
- Your basic branch had no requirements for officers in your YG or FA.
- Your basic branch had more volunteers for the AAC then they had requirements. In this case, the branch typically prescreens the nominees and submits the best qualified officers for consideration by the board. This policy prevents a situation in which the branch is over strength for a particular YG; a situation with undesirable results for the basic branch, the AAC, and the officers involved.

Q: Can I work in my functional area without being in the AAC?

A: Absolutely. There are many opportunities for officers who are not members of the AAC to work in their functional area. For instance, we have many more positions which require an FA 51 officer than we have FA 51 officers in the AAC. Consequently, we rely heavily on non-AAC officers to help us fulfill these requirements.

Q: If I'm not in the AAC will I get "dead end" functional area assignments?

A: This is a matter of one's perspective. There are many challenging and rewarding functional area assignments that are not targeted for AAC officers to which you could go. Remember, if you are a dual tracked officer with primacy in branch assignments, you may work in your functional area, but your competitive path is in your branch.

Q: If I'm selected for the AAC, is that the end of my contact with soldiers and warfighting?

A: Not necessarily. Our current development template includes an opportunity for AAC officers to return to an assignment with their branch for two years as a major. Every officer's assignment history is different and not all officers will have time to complete the "user assignment." However, it is our goal to offer this opportunity to all those for whom it is feasible.

Q: Where do AAC officers in my functional area get assigned? Are there any assignments overseas?

A: The driver for assignments is your branch affiliation. If you are a 13/51, you will be assigned where field artillery systems are managed, etc. There are some branch immaterial positions, but as a rule, we are growing you to be the future PMs of your branch's systems. There are limited overseas assignments available.

Q: What military schooling is required/available for my functional area?

A: The answer to this question is different depending on your FA. One course that applies to all FAs is the PM Course at the Defense Systems Management College, Fort Belvoir, VA which is a 6-month course for senior field grade officers who are projected to go to 4Z positions. If you are an AAC officer, we will project you to attend DSMC at the appropriate time.

FA 51: The Materiel Acquisition Management Course is a 9-week course given at Fort Lee, VA which is available to company grade and junior field grade officers. We will attempt to send all officers who are going to their first AAC and/or FA 51 assignment in a TDY enroute status.

FA 53: Materiel Acquisition Management Course.

FA 97:

- The Management of Defense Acquisition Contracts (Basic) is mandatory for all officers in FA 97 prior to their assignment to a FA 97 job. It is a 4-week course given at Fort Lee, VA.
- Other courses available for FA 97 officers are Materiel Acquisition Management (MAM), Contract Law, Defense Cost and Pricing, and Management of Defense Acquisition Contracts (Advanced).

FA 15/35: Military Acquisition Management Course.

ASK PERSCOM *(continued)*

Q: Will I ever go to a joint assignment?

A: Whether or not an AAC officer goes to a joint assignment is dependent on the officer's functional area. There are a significant number of joint assignments available for FA 97 officers, but not very many for FA 51s. You should not be concerned if you can not get a joint duty assignment. TITLE IV of the DOD Reorganization Act makes AAC officers eligible for a science and technology waiver to the joint duty requirement for promotion to general officer.

Q: If I don't get accepted to graduate school, does that mean that I'm not in the AAC anymore?

A: No. Our long range goal is for every AAC officer to have a master's degree. However, this does not necessarily mean that if you can not get into graduate school that you can not make a contribution to the Army in the AAC. For YGs 83 and later, the Army offers a fully funded advanced degree to academically qualified officers. Equivalent education such as training with industry (TWI) may be available to some officers. We encourage as many officers who qualify to attend graduate school, either through fully funded programs or on their own, in order to increase the overall professionalism and abilities of AAC members.

Q: What jobs are critical to my career?

A: The branches have key developmental assignments at each grade. So does the AAC. Your career should be well rounded, spanning as much of a system life-cycle as possible from concept development through fielding. Just as there are key branch assignments, there are some positions which are key to the AAC in the matrix support commands and the PM/PEO structure. Your career should take you through those key positions as a senior captain or major.

Q: How are AAC officers promoted?

A: Joining the AAC is a major career decision. While most officers are not obsessed with tracking promotion rates and statistics, opportunities for advancement is always a concern. The Defense Acquisition Workforce Improvement Act requires the Secretary of Defense to ensure that the qualification of officers selected for the Acquisition Corps are such that those officers are expected as a group to be promoted at a rate not less than the rate for all line officers both in the zone and below the zone.

Q: I'm a YG 70 but not in the AAC. Should I forget about ever coming into the AAC?

A: Not necessarily, but it is very unlikely that you would be accessed. Your qualification for membership in the AAC at this time is dependent on the requirements of your basic branch and your previous acquisition experience. Law mandates that you meet certain education and experience requirements prior to selection to PM positions at the lieutenant colonel and colonel level. If you can meet the requirements, it may be possible for you to participate in the AAC. Also, year group inventories in both the branch and AAC must be considered.

Q: Do I still wear my branch insignia? What about regimental affiliation?

A: AAC officers wear their basic branch insignia and retain their regimental affiliation. Retaining branch identity is a vital ingredient in the AAC program.

Q: Is the Medical Service Corps going to participate in the AAC?

A: At this time, the Medical Service Corps is not a participant in the AAC nor is there any plan, in the near term, for MSC to be included in the AAC.

Q: What is a developmental position and what counts for acquisition experience for 4M/Z certification?

A: The answer to this question varies depending on your functional area:

FA 51: Any position which is primary or secondary coded 51 in the position requirement code (PRC) on the applicable authorization document.

FA 53: Selected positions in ISC (ISEC), AMC, AAESA, and SARDA. In the future, positions coded 53B or 53C will count.

FA 97: Any position primary or secondary coded 97.

Q: How does the Defense Acquisition Workforce Improvement Act (DAWIA) affect those already in the AAC?

A: The DAWIA will enhance the professionalism of the AAC. Currently, the Office of the Secretary of Defense and the services are studying the legislation to specify changes to the program. Once these studies are complete, revisions to the program will be announced.

Q: Must I have a master's degree in order to compete for PM?

A: No. Experience and performance are primary considerations for selection. Civilian education level may become a factor for consideration by future boards and we would certainly encourage you to work toward a graduate degree.

Q: Will the AAC be affected by the builddown?

A: Yes. The AAC has a requirements based personnel inventory. As the force structure (number of PMs) decreases, the personnel inventory requirement also decreases. However, the AAC officer inventory is below strength in most year groups. As you know, Desert Storm caused a deferment in the Army build-down plans. As plans are solidified and pending a review of critical acquisition positions, we will keep you informed of the effects on the AAC.

TWI Reporting Requirements

Officers in the TWI program are reminded to familiarize themselves with the provisions of AR 623-1, Academic Evaluation Reporting System. This regulation prescribes policy and performance appraisals for students attending courses at civilian educational, medical or industrial institutions. Additional Academic Evaluation Reporting procedures for TWI officers are outlined in the instruction pamphlet issued by

TWI REPORTING REQUIREMENTS *(continued)*

the U.S. Army Soldier Support Center, Fort Benjamin Harrison. Officers are asked that they ensure compliance with the provisions of the pamphlet. Training agency POCs are: FA 51 — Karen Walker, AAESA, DSN 284-9572 or (703) 274-9572; FA 97 — CPT Andy Mills, Contract Support Agency, DSN 289-2796, or (703) 756-2796; PERSCOM — MAJ Jill Whisker, DSN 221-3140 or (703) 325 3140.

64 Graduate From MAM Course

On March 8, 1991, 64 students graduated from the Materiel Acquisition Management Course at the U.S. Army Logistics Management College, Fort Lee, VA. Graduates will proceed to a variety of weapon system acquisition work assignments in research and development, testing, contracting, requirements generation, logistics and production management.

Anthony Valletta, program executive officer for Standard Army Management Information Systems, Fort Belvoir, VA, gave the graduation address and presented diplomas. The Distinguished Graduate Award was presented to CPT Steven E. Lopez who is assigned to the Test and Experimentation Command, Fort Hood, TX.

The 9-week Materiel Acquisition Management Course provides broad based knowledge of Army materiel acquisition. It covers national policies and objectives that shape the acquisition process and the implementation of these policies and objectives by the U.S. Army. Areas of coverage include acquisition concepts and policies; research, development, test, and evaluation; financial and cost management; integrated logistics support; force modernization; production management; and contract management. Emphasis is placed on developing mid-level managers so that they can effectively participate in the management of the acquisition process. It is the basic qualifying course for all members of the Army Acquisition Corps and officers in Functional Area 51, Research, Development and Acquisition.

Army Acquisition Career Management Conference

More than 100 of the Army's senior leadership from the acquisition community attended the Acquisition Career Management Conference March 25-26, 1991, at Fort Belvoir, VA. The objectives of the conference were: to review critical positions in the Army structure; to involve the Army leadership in laying out the framework for education, training, selection, certification and assignment of civilian and military members of the Army Acquisition Corps (AAC); to develop and propose a management framework to assure effective oversight for the AAC; and to establish a mechanism for feedback and continued improvements.

The sponsor of the conference and director of the AAC, LTG August M. Cianciolo, welcomed the attendees. Cianciolo stressed that in today's environment, although the size of the force and the available dollars for modernization are shrinking, the imperatives applicable to the AAC — particularly, the business of bringing quality people into the AAC — are not changing and need to be addressed.

Other conference speakers included: COL Al Greenhouse, deputy director of the AAC; LTG William H. Reno, Army deputy chief of staff for personnel; Kathleen Garman, a staff member on the House Armed Services Committee; Dr. James S. McMichael, director, Department of Defense Acquisition Education, Training and Career Development Policy Office; LTG Leon E. Salomon, commander, U.S. Army Combined Arms Support Command; and the Hon. Stephen K. Conver, assistant secretary of the Army (Research, Development, and Acquisition).

Functional chiefs and proponents presented briefings on their career programs. The briefings highlighted the integration of acquisition tracks targets for entry into the Acquisition Corps. Some of the issues that would be presented and perhaps resolved during conference work group discussions were also highlighted.

Work groups were established to identify action items and initiatives related to position management, personnel management, career development training/education, and management oversight. These groups met simultaneously to devise implementation plans for resolving specific issues.

In addressing the attendees during the second day of the conference, the Hon. Stephen K. Conver emphasized that fairness and equity should be the principle that underlines all our dealings with people. He also stressed a need for developing more of a teamwork approach between the civilian and military communities and for treating military and civilian employees as equals. Conver called for more interchangeability between major subordinate commands and the PEOs. Conver also pointed out that with important events in acquisition now occurring, "We will need even better leaders in the future to carry out future challenges."

"With reduced dollars, it's more important that we very carefully manage all the scarce resources that remain available to us, and in this declining budget environment, it is even more important that our acquisition leaders be the most capable people possible to make sure that we use the taxpayers' money wisely," Conver said.

In the final session of the conference, work group reports were presented by each group leader. These reports highlighted 23 issues among which are: Alignment of positions with the AAC Leader Development Model; Alternatives to 20-week PM course for Acquisition Corps personnel; methods to ensure high quality personnel are available within the AAC candidate development pool; Central selection of civilian PMs; Establishing the Defense Acquisition University Senior Course; Greening opportunities for the civilian AAC members; Developmental assignments; Increasing the number of civilians in PEO/PM/Deputy PM positions; Role of Management Oversight Organization;

All conference issues will be addressed and feedback provided to conference attendees at a follow-on conference presently being planned for September 1991.

Correction

On page 19 of the March-April 1991 issue of *Army RD&A Bulletin* (article titled "Shaping the Future Through Basic Research") the second sentence of the second paragraph under the heading "The Future" incorrectly listed "political imagers" as one of several requirements for effectively arming and protecting our soldiers. The correct term is "*optical* imagers." We apologize for this error.

SPEAKING OUT...

What Advice for Success Can You Offer to Potential Future PMs?

***Army RD&A Bulletin* recently posed the above question to a number of Army PMs. Their responses follow.**

COL Larry Day
Project Manager
Medium Tactical Vehicles

First and foremost, know the budget process, the POM cycle, and what a Nunn-McCurdy breach is (and how to avoid it). In addition, understand what total quality management is, what the TEMP approval and update process is, and recognize that a budget analyst and all testors will "run your program" if you don't. The DLA organization (especially DEPROS) should be managed and cultivated as an extension of your management team — they can and will provide professional support!

Matrix management is your programs' key to success and to a great degree totally dependent upon your personal dynamics and those of your staff. With shrinking budgets, force structure reductions and the resulting drop in total acquisition dollars, non-developmental item acquisition is the acquisition multiplier you must employ. Use commercial quality standards (most meet ANSI standards) to the maximum extent possible, shorten the acquisition cycle by "levering" the commercial market place, and don't forget to take the "menu" away from the user community before you finalize your solicitation. Have fun doing your job, but when it ceases to be fun — get out!

COL Ronald L. Williams
Project Manager
CH-47

Get to the DSMC and absorb everything it has to offer. Challenge the users' requirements and ensure they are valid and salable. You must sell them. The user states the requirement and leaves the scene — over budget by 20 percent. There is a mindless bureaucracy out there that will rip you off for 10 percent before funds are appropriated and you will lose another 10 percent to valid higher priorities. Obligate funds as soon as you get them, then you can be a valid higher priority.

Be constantly alert to problems and fix them as soon as you can. They never fix themselves. There are no problems serious enough to justify reducing the logistics effort in development. Finally, no matter where you are in the career progression ladder, now is the time to start reading. DSMC has recommended reading lists; OSD has published a list of total quality management readings and professional publications. Regularly review appropriate new books. You can never know enough about the acquisition process.

LTC Gary J. Hagan
Product Manager
Hypervelocity Launcher

Keep your sense of humor — the DOD acquisition process is complex, cumbersome and may appear specifically designed to frustrate your best intentions. Don't take yourself too seriously — a majority of successful PMs lead effective government-contractor teams — nobody is indispensable. Possess or achieve technical literacy — you shouldn't be frightened by words such as kinetic energy, photon or EM spectrum. Continually develop and refine your briefing skills — you'll be briefing people who (a) want to kill your program, (b) support your program or (c) don't care about your program (personnel in categories a, b and c interchange periodically). Be able to reduce your program jargon and "techno- babble" to clear English — if you can explain the gist of your program to your spouse in 10 minutes, you're probably there. Enjoy, don't endure, your assignment unless you're one of the anointed few who both commands at battalion/brigade level and is selected as a PM, this is the best job you'll ever have.

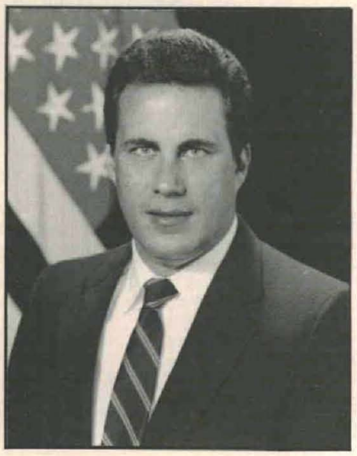
COL Stanley J. Souvenir
Project Manager
Unmanned Aerial Vehicle

In doing battle, you must "know your enemy" . . . the acquisition equivalency is to "know the acquisition environment." You must understand who can make things happen and what the windows of opportunity are to make it happen. To miss an opportunity could mean significant delays to your program.

The second point is that policy and regulations are guidance. Don't be afraid to do do what is smart and get relief from the bureaucracy. It can be done . . . MS 0, MS I, MS II, and MS IIIA in less than a year . . . believe it or not!!

COL Gary M. Stewart
Project Manager
Airborne Surveillance Testbed

Like most good jobs, being a PM is tough but doable and rewarding. There are few secrets to being a successful PM, and it does not necessarily require a lot of sophisticated schooling. It's just hard work. Always plan for the worst and occasionally you will be pleasantly surprised. Quickly form an open, honest relationship with your contractor as you work to forge a team effort. Always keep a close eye on your contractor. Remember his perspective is different than yours. He is out to make money while you are about spending the taxpayers' dollars wisely to get the product the government needs. Always do what seems right; don't break any laws; surface bad news immediately; and keep your boss informed. Most importantly, never forget that there is simply no substitute for good, old fashioned common sense. I am convinced that is all you need to be a successful PM. One other thing, a little good luck now and then helps too.



FROM THE ARMY ACQUISITION EXECUTIVE...

This issue has given us an opportunity to reflect on the research, development, and acquisition community's many contributions to the success of Operation Desert Storm. The world marveled at the performance and reliability of our weapon systems and equipment, and the brave men and women in uniform who wielded them so skillfully.

The performance of our systems in Southwest Asia has validated many of the issues that have been the underpinnings of our defense acquisition strategy for a number of years. There were those who argued that it didn't make sense to rely upon high technology weaponry — that, in fact, this high technology was more expensive and we would not be able to buy equipment in sufficient numbers as to be militarily significant. They even argued that the equipment was too complex for our soldiers to use and that it would break down frequently. In fact, our strategy of substituting high technology for quantity has proven to be a wise solution.

We have, quite simply, the finest military equipment in the world. For the years prior to Operation Desert Storm, I heard that the Defense Department didn't know what it wanted, and even if it did, our defense industry couldn't build it right away. I read about the complexities of our weapon systems and the difficulties in maintaining them. I heard about weapons that broke down too often and wouldn't work in combat. Now that Desert Storm has ended, I hear about the accuracy and lethality of our missiles; the mobility and effectiveness of our combat vehicles; the success of our communications and logistics systems. These reports are not only gratifying, but they also validate Army research, development, and acquisition programs over the years. While there is always room for improvement, I am very pleased and very proud of our Army team.

Let me highlight a few of our weapon systems deployed in Southwest Asia. While the technical performance data is currently being evaluated, preliminary information reinforces earlier reports of systems performance.

- Joint Surveillance and Target Attack Radar System (JSTARS). This new capability was tested in combat and proven to be a spectacular success story. One of many reports states that in response to the Iraqi incursion into Khafji, JSTARS reported to the Marine forces fighting there that there were no approaching enemy follow-on forces to back up the initial attack. The commander was given perfect knowledge about the battle and did not have to concern himself about enemy reserves.
- Apache (AH-64). Commanders and crews were extremely pleased with the system's lethality, survivability, and reliability. Armed with the Hellfire missile, the AH-64 is credited with the first hostile action of Operation Desert Storm. On the night of Jan 17, eight Apaches fired 27 Hellfire missiles at two Iraqi early warning radar sites in western Iraq and destroyed both within minutes. The mission created a corridor used by the Air Force to begin the air campaign.
- Multiple Launch Rocket System (MLRS). Although specific battle damage assessment is not available, MLRS's overall performance was outstanding. Our early information indicates that the artillery fired more than 10,000 rockets against such high value targets as howitzer and rocket battalions, air defense artillery battalions, command and control facilities, and logistics facilities. It was called the "rain of steel" by the Enemy Prisoners of War.
- Army Tactical Missile System (ATACMS). In January, ARCENT requested that the Army send to Southwest Asia all available ATACMS to support critical theater deep battle and suppression of enemy air defense operations. The system was used against surface-to-air missile sites, logistics sites, SCUD positions, howitzer and rocket batteries, and tactical bridges. Viewed as a precious asset, ATACMS was placed under ARCENT control to limit expenditures to high value targets. Indications are that ATACMS destroyed, or rendered inoperable, all of its targets.
- Bradley Fighting Vehicle and Abrams M1A1 overall operational readiness rates remained at 90 percent or above prior to and during combat. In a night move by the 3rd Armored Division covering 200 kilometers, not one of the more than 300 Abrams tanks in the division broke down. Other M1A1 crews reported being hit by T72 tanks, sustaining no damage. Bradley crews reported that the infrared sights were very effective, even during sand storms, and that the 25mm Bushmaster cannon was more lethal than expected. There were no reports of transmission failure during offensive operations. In short, these two fighting vehicles performed superbly.

As we reflect on our success, we must also consider the importance of our work today. Many of the highly capable systems I mentioned are the products of efforts in R&D and the technology base a decade or more ago. Operation Desert Storm has made it evident that we must all work together to preserve and protect our precious technological edge. We simply cannot take our success for granted. Keep up the good work. Our soldiers deserve nothing short of the very best.

Stephen K. Conver

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