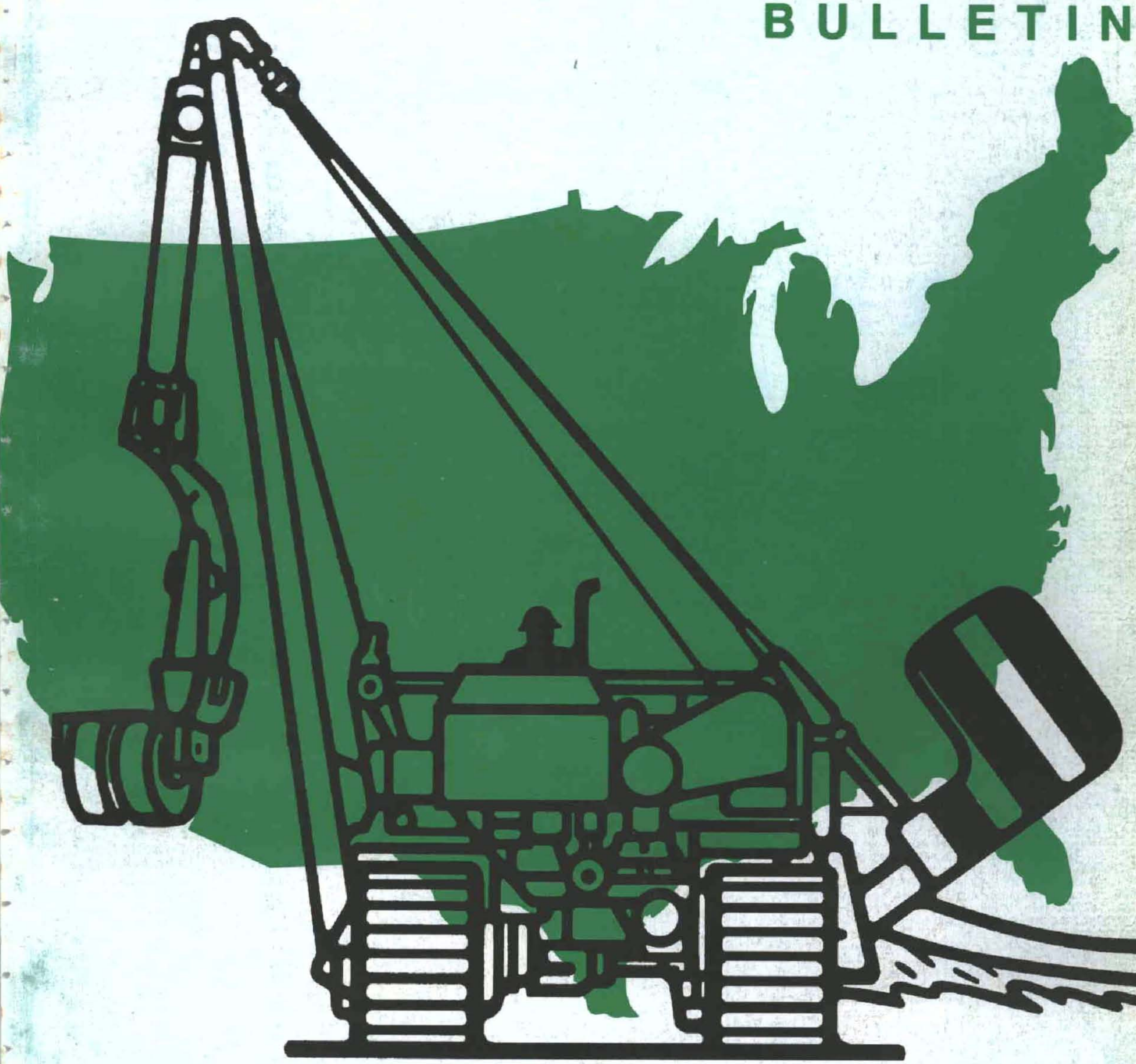
Headquarters Department of the Army
PB 70-92-5

ARMY RD&A BULLETIN

SEPTEMBER - OCTOBER 1992



REBUILDING THE NATION'S INFRASTRUCTURE

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ARMY
Research Development Acquisition
RD&A
BULLETIN

Professional Bulletin of the RD&A Community

FEATURES

DEPARTMENTS

COVER

The U.S. Army Corps of Engineers' Repair, Evaluation, Maintenance and Rehabilitation Research Program is providing significant benefits as a guardian of the nation's aging infrastructure. Initiated in 1984, the program has saved an estimated $140 million.

REPAIRING THE NATION'S INFRASTRUCTURE

By Lee Trussell Byrne

Introduction

By the year 2000, almost half of the Corps of Engineers' 269 lock chambers along inland waterways will be at least 50 years old, thereby reaching or exceeding their design service life. Without question, the nation's infrastructure is growing old. Unless maintenance and repair measures are taken, fatigue, wear, and corrosion will take their toll on the more than 700 corps locks and dams.

In response to growing awareness of this problem, the corps initiated the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program in 1984. This program, which is managed by the Waterways Experiment Station (WES) in Vicksburg, MS, has been a major success and is yielding significant benefits to the corps and the nation.

"We have had a lot of success stories under the REMR Program and have implemented some innovative technology transfer efforts," stated William F. McCleese, REMR program manager. "I attribute our success rate to an extensive effort to identify field needs before formulating the program and to the placement of a lot of emphasis on technology transfer."

The REMR Program has repeatedly lived up to its potential to be one of the most cost-effective research programs funded by the corps. Numerous successful applications of REMR technology have been documented.

When the Chicago River flooded a service tunnel under Chicago in April, a concrete mixture developed under REMR for placement underwater was employed in the repair work. The precast concrete stay-in-place forming system used in the rehabilitation of the Troy Lock chamber in the New York District is another example of the application of REMR technology; Troy Lock was the second corps lock to be resurfaced using this technique. The blended chemical high-temperature process to restore the flow capacity of collector wells at a superfund site in Michigan is a REMR research product. These are just a few instances when REMR technology was successfully applied by those who needed it.

Goals

The primary goals for the REMR Program are to develop technology that will remedy common maintenance problems, save dollars, and extend the service life of existing corps civil works structures. Since the inception of the REMR Program, the corps has endeavored to make the technology produced readily available to those who can benefit from it. Although REMR research is primarily directed toward corps civil works water resources projects, much of the technology has applications outside the corps.

Realizing that it is generally less expensive to repair existing structures than to replace them, the corps was one of the first federal agencies to consider rehabilitation as a viable alternative to rebuilding. In the mid-1970's, research in maintenance and repair was mainly funded through work units under existing programs. This research increased awareness that the technologies needed for rehabilitation are often different from those used in new construction.

REMR Management Structure

The result was the REMR Research Program, a six-year, $35 million effort that introduced several new concepts in program management. Based at WES, this program was designed to involve many different disciplines and all four corps research and development (R&D) installations.

"REMR wasn't the first corps research program to have a program manager," McCleese explained. "However, it was the first program requiring the coordinated efforts of all four corps R&D installations, problem area leaders, and technical monitors for seven broad technical areas, a field review group member from each civil works division, an Overview Committee, and the Directorate of Research and Development. It sometimes seemed like a balancing act to keep everyone satisfied, but everyone involved turned out to be a team player, which made the job much easier."

For management purposes, the program was organized into seven broad problem areas: concrete and steel structures, geotechnical, hydraulics, coastal, environmental impacts, electrical and mechanical, and operations management. These have since been reduced to six; environmental impacts of products and procedures are now evaluated routinely in the problem area under which they are produced rather than separately. Each problem area is under the purview of a laboratory problem area leader and a headquarters technical monitor.

The Overview Committee makes final decisions pertaining to the scope and direction of the program. "It [the Overview Committee] is a great assistance to me when hard decisions have to be made concerning funding distribution for the various problem areas," McCleese stated.

The Field Review Group (FRG) is composed of representatives from each corps division. It provides broad technical reviews of REMR research and continuous field input, recommends R&D priorities, and aids in technology transfer. The FRG meets two times a year to review progress within each work unit.

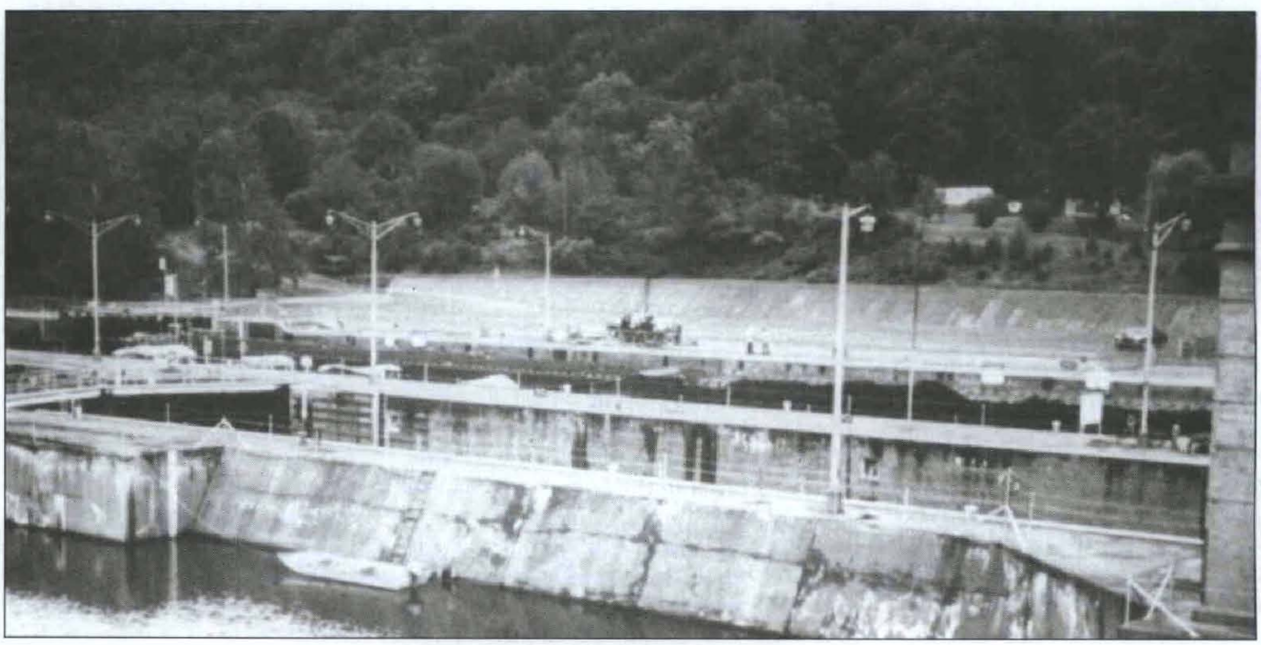
Principal investigators are responsible for the research conducted under the work units that have been approved by the FRG and Overview Committee.

With the completion of the first phase of the REMR Program in FY89, a follow-on program was implemented. The second phase, called REMR-II, allows REMR research efforts to be continued through 1997. The emphasis is still on developing useful technology and making it available to others. This phase of the program operates under the same management structure as the initial plan.

Problem Areas

The REMR problem areas address specific needs of aging infrastructures. Within each problem area, work unit objectives focus on products that are what people in the field want and can use. Under the concrete and steel structures problem area, studies have focused on methods for assessing the condition of structures above and below water and techniques for maintaining, repairing, and rehabilitating concrete and steel. REMR technology was successfully used at Gavins Point Dam, SD, to make underwater repairs; at Crow Dam, MT, to rehabilitate a badly deteriorated gate tower; and at Dworshak Dam, ID, to monitor structural deformation.

In the repair of the stilling basin at Red Rock Dam, IA, application of REMR technology saved time and money when an underwater concrete mixture was pumped to the repair area and placed by divers. Ongoing studies are addressing improved nondestructive testing systems; dynamic stability assessment and upgrading concepts; and maintenance, repair, and rehabilitation of concrete and steel structures.



The nation's aging infrastructure.

Geotechnical

Under the geotechnical problem area, remedial treatment of foundation problems has been a primary concern. Revised stability criteria for existing gravity structures have resulted in significant dollar savings by eliminating unnecessary remedial stability programs. Application of these criteria at Troy, Snell, and Eisenhower Locks have resulted in cost avoidances of over $20 million. Current studies are dealing with reservoir shoreline erosion, vegetation on levees, levee rehabilitation, geomechanical modeling, impact of drains on uplift, and geophysical evaluation techniques.

Hydraulic

Under the hydraulic problem area, REMR concerns have included minimizing scouring problems and improving navigation conditions. During repair of scoured areas below Emsworth Dam on the Ohio River, REMR technology called for the use of grout-filled fabric bags, addition of an end sill to modify the spillway apron, and construction of a secondary stilling basin immediately downstream.

The computer model STREMR was developed to analyze flow conditions near hydraulic structures. This two-dimensional hydrodynamic code was used with a physical model to find the best approach design for the Clover Fork Rediversion Channel at Harlan, KY. It has been provided to the Bureau of Reclamation and several universities. Ongoing studies in this problem area are addressing ways to improve navigation conditions of waterways and the effectiveness of hydraulic structures.

Electrical and Mechanical

Under the electrical and mechanical problem area, the investigation of maintenance techniques and replacement materials and procedures for electrical and mechanical parts of corps projects have been a top priority. Underwater coatings for corrosion susceptible surfaces have been tested, and while not as effective as coatings applied above water, they can be used to increase the service life of structures when dewatering is not practical. Current studies in this problem area include removal techniques for lead pigmented paints, development of paint systems for damp surfaces and volatile organic compound compliant coating systems, and the use of vibration signatures as a maintenance tool.

The REMR logo and orange color make it easy to identify REMR products.

Coastal

Under the coastal problem area, the impact of the aging process on coastal navigation structures is recognized. Of the 265 coastal navigation projects constructed in the United States, 56 percent have already reached their 50-year design life. The coastal structure acoustic raster scanner (CSARS) is an example of new technology that has been developed through REMR. By means of CSARS, an evaluation of the underwater condition of a coastal structure is made possible.

Operations Management

Under the operations management problem area, management systems have been developed for concrete lock walls, miter lock gates, timber dikes, steel sheetpile structures, and coastal breakwaters and jetties. These systems typically consist of four modules: inventory and data management, condition inspection and assessment, maintenance and repair alternatives, and life cycle cost analysis units. They provide engineers with practical decision-making procedures for identifying cost-effective maintenance and repairs for civil works structures. Further, they provide the capacity to make quantitative comparisons of the current condition of structures and structure components, the ability to predict the future condition or expected service life of a component, and a means towards efficient and optimal maintenance planning.

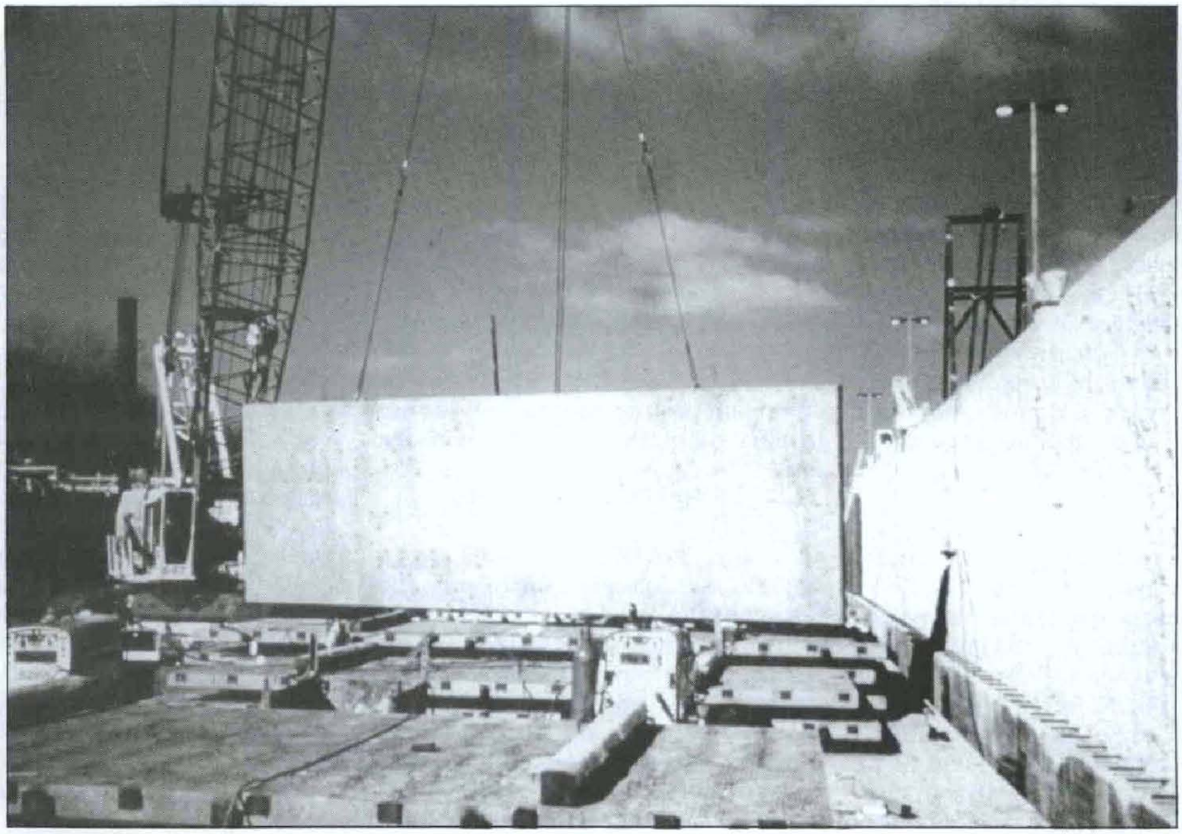
Technology Transfer Products

McCleese attributes much of the success of the REMR Program to the early recognition of the importance of technology transfer. During the planning stage of the program, a technology transfer plan was developed that emphasized the significance of information exchange. This plan was perceived as being intrinsic to the overall program management. From its beginning, the REMR Research Program has been committed to the timely transmittal of its research results. This technology transfer plan received the Federal Laboratory Technology Award in 1986 and has been used as a model by other research efforts.

Technology transfer in the REMR Program uses a multimedia approach. REMR products include *The REMR Bulletin*, *The REMR Notebook*, technical reports, executive notes, video tapes, workshops, symposia, field demonstrations, PROSPECT training courses, input to engineering and technical manuals, engineering technical letters, an on-line materials database, a REMR hot line, and articles published in technical journals.

The REMR Bulletin is an information exchange bulletin published four times a year. It contains two to three technical articles written in layman's language. About half the articles are generated by REMR research staff and the remainder are contributions submitted by field personnel about their maintenance and repair experiences. The bulletin encourages all readers to share their REMR-related experiences and success stories.

The REMR Notebook is a collection of fact sheets in looseleaf binders. This publication now consists of three volumes and includes five supplements. A new supplement is issued each year. Designed to provide the reader with concise information about specific products and techniques, it contains technical notes and material data sheets. The notebook is very popular with the corps, other federal agencies, and engineering



Precast concrete stay-in-place forms were used for the resurfacing of Lock 22 on the Mississippi River.

consulting firms; in fact, The Bureau of Reclamation is using some of the technical notes to update their *Concrete Manual*.

REMR technology is regularly documented in technical reports that undergo extensive review by the FRG and headquarters before publication. These works provide a record of the research techniques and findings that have been derived from REMR studies. To date, 126 REMR technical reports have been printed, and at least that many more will be published in the next six years. These and other REMR publications are listed in the *Index to REMR Publications*. The Annotated Bibliography of REMR Technical Reports is planned for distribution within the current year. Executive notes, which are concise briefings about key events and products, are periodically sent to top-level managers who may not have time to read lengthy publications.

In addition to these printed resources, REMR offers video reports for use in training courses and displays that are available for loan. Field demonstrations, another mode of REMR technology transfer, provide investigators with an opportunity to share REMR technology with field personnel and often allow the technology to be fine-tuned before use on a large-scale effort. Workshops and technical presentations are forums for the dissemination of REMR information. PROSPECT training courses are continuously updated to include the latest research results. A REMR hot line provides field personnel with a single laboratory point-of-contact for each REMR problem area.

The REMR maintenance and repair materials database offers instant access to information about commercial products and their use for specific applications. "We developed the database to give the people in the field a place to find answers to their questions about what might be the best product for their specific needs," explained McCleese. This database is now available by remote access at no cost to the user other than the cost of a long distance telephone call. All of these methods are efforts to share the techniques and findings gained from REMR investigations.

Conclusion

To date, REMR technology has been used at over 130 corps projects with dollar savings estimated to be approaching $140 million. In addition to dollar savings, however, REMR has offered other benefits, such as improved safety and reliability, reduced manpower requirements, and improved operational capabilities. In the years to come, the REMR Research Program will continue to serve as a guardian of the nation's aging infrastructure.

LEE TRUSSELL BYRNE is the technology transfer specialist for the REMR Research Program at WES, Vicksburg, MS. She received a B.A. degree from Mississippi College and an M.S. degree from Mississippi State University. She has been an editor for the Information Technology Laboratory, WES, since 1986 and has held her present position since 1991.

Interview With...

LTG THOMAS P. CARNEY

Army Deputy Chief of Staff for Personnel

Q. How would you describe your management philosophy?

A. I learned a long time ago from my experience as a lieutenant and a platoon leader that as you get promoted, you recognize very quickly that unless you empower your subordinates to accomplish their mission, you won't accomplish anything. So, I guess you would call my management philosophy one of decentralization.

Q. What impact is the DOD drawdown having on the Army's ability to attract and retain quality personnel?

A. At this point in time, in recruiting soldiers, it appears not to have a significant impact. Although advertising resources have been significantly reduced, the word still seems to be out there on the street that the Army is still a great place to serve and to be all you can be. So, this year we are recruiting the best and the brightest we've ever recruited. The recruitment of 100 percent high school graduates is one major factor that has contributed to a great Army.

We are concerned with the future because of today's relatively high unemployment rates. We are concerned because of the substantial budget cuts to the recruiting effort imposed by the House. We are also concerned to some degree about our ability to recruit as the country returns to a full employment level. I'm confident that we will.

"Although advertising resources have been significantly reduced, the word still seems to be out there on the street that the Army is still a great place to serve and to be all you can be."

Bringing in bright, young civilians, particularly through our intern program, is also of concern, principally because of our hiring freeze policy. It restricts our ability to hire people off the street at this point in time. So, I think this is the major impact of the drawdown on the recruitment of quality people.

Q. In recent years, what changes have been made to insure a better match between the soldier and his Army job?

A. Back in the early 80's, we began a serious effort to match the required skills of a soldier applicant, as measured by the Armed Services Vocational Aptitude Battery [ASVAB], more closely to the job, or Military Occupational Specialty [MOS], that we wanted that applicant to serve in. Consequently, the marriage between the person's aptitude and the job that he enters when he joins the Army has been rather dramatically improved.

Secondly, we continue to study how to better match a person's qualifications with the jobs the Army has to offer. ARI [Army Research Institute] and the Rand Corporation continue to do studies in that area. The business of MANPRINT [Manpower and Personnel Integration] began in the early 80's as well, when we began developing systems with a greater understanding of the soldier-machine interface.

MANPRINT has six domains: manpower, personnel, training, human factors engineering, safety, and health hazards. Recently, I have moved to add a seventh domain which, essentially, is soldier survivability. Although this has always been a concern, we believe that what the American people want now more than ever from their Army is decisive victory with minimum casualties. So, I want to state explicitly that in the manpower business, soldier survivability is a high priority in program development. I consider the business of reducing casualties from friendly fire to be included in soldier survivability.

Q. With regard to soldier performance, what are some of the "lessons learned" from the Gulf War?

A. I think lessons learned from the Gulf War generally confirmed that what we began to do in the 80's with the business of matching soldiers to their jobs paid off enormously. Everyone I have talked to who was involved in Desert Storm has praised soldier performance. So, I just say the lesson learned is that we're pretty much doing the right thing.

Q. What is the DCSPER's role relative to implementing the Army Acquisition Corps?

A. I am a member of the Army Acquisition Corps Board of Directors and have the personnel responsibility for the Acquisition Corps, as I do for the entire Army—military and civilian. As DCSPER and as a member of the board, I am responsible for personnel plans and policy for the Acquisition Corps. More specifically, we're in the business of identifying which jobs are coded to be Acquisition Corps positions. We, in the personnel community, run the system that selects people to enter the Acquisition Corps, and we are developing the systems to manage those people. In my role as civilian personnel training director, I distribute the ACTEDS [Army Civilian Training, Education and Development System] dollars, the Army's civilian professional development in the Acquisition Corps, as well as the funds for the officers who will be part of this career field.

Q. From your vantage point, what is the biggest chal-

"I think lessons learned from the Gulf War generally confirmed that what we began to do in the 80's with the business of matching soldiers to their jobs paid off enormously."

"I think today's soldier is the ultimate soldier with the ultimate soldier's attributes. He's a soldier who comes in with all the things that just about anyone would look for—He's bright, alert, dedicated, motivated, and has a can-do kind of attitude, wanting to be all he can be."

lenge in building both the military and civilian Acquisition Corps workforce?

A. There are really three broad categories—one is the administrative business; the second is the selection of the right people; and the third is the training that goes into their professional development. We're heavily involved in the administrative side of it right now, which includes coding all of these positions, establishing PERSCOM policies for the Acquisition Corps, developing the systems for selecting people for job vacancies, and so forth. The selection business is a very important one. We have elected to use the Army selection board procedure, which has served the Army well for many years, in evaluating the qualifications of applicants. That is an ongoing process. In the training regime, and in conjunction with the board, we are defining the training requirements for each of the subcomponents of the Acquisition Corps that are important for professional development.

Q. In view of the broad range of individuals seeking membership in the Acquisition Corps, how would you assess Army efforts to eliminate career barriers for females and minorities?

A. We are still in the process of making these selections, so the jury is still out. But, as I said before, we are using the long-established selection board procedures which include directives concerning what selection board members should consider regarding females and minorities. Since it's a system that has served the Army well in every other field in promoting equal opportunity, I am confident that equal opportunity will prevail in the Acquisition Corps as it does in the Army. Preliminary results are very positive.

Q. If you were tasked with designing the "ultimate" soldier, what attributes would he or she have?

A. I think today's soldier is the ultimate soldier with the ultimate soldier's attributes. He's a soldier who comes in with all the things that just about anyone would look for—He's bright, alert, dedicated, motivated, and has a can-do kind of attitude, wanting to be all he can be. That, to me, is the definition of the ultimate soldier.

Q. What advice would you offer to someone considering a career in the Army and, in particular, the Army Acquisition Corps?

A. To join the Army is to dedicate oneself to a profession, not a job. So, my advice for those who are considering it, is to make sure they are willing to make this commitment. It can be a very professionally rewarding experience. For the Acquisition Corps in particular, I see an exciting opportunity. I would say to civilians considering a career in the Acquisition Corps (and I presume that most of them have had some dealings in the acquisition business or they wouldn't be interested applicants), that if they like it, then apply to be a member because we're going to be in the acquisition business. A lot of folks believe that with the current budget we won't be, but I believe that we will.

For officers, we're looking for people who are proficient in their branch so they can bring that branch expertise to the table as we develop future systems.

Q. Is there anything else you would like to comment on?

A. There have been two controversial issues as we have gone through the development of this program. One is the size of the civilian Acquisition Corps. (The officer Acquisition Corps is sized at about 2,500.) We are still defining what the civilian number is. However, until that number is clearly defined, our earlier selection boards will be considered only preliminary. In other words, if an applicant was not accepted the first time, I truly believe that over the next several months there will be other opportunities to be selected. Don't be discouraged and, if you're still interested, reapply.

Secondly, I have heard from several sources that asking members of the Acquisition Corps to sign mobility statements is of some concern. All we are hoping for is an Acquisition Corps which will be professionally oriented and wants to be all it can be. Members must want to progress professionally. Therefore, we want them to be mobile enough so that we can develop them professionally and match them to more career-enhancing positions. That is the only reason for a mobility statement in the Acquisition Corps. How that will play out over time will be determined, but if I were asked to sign such a thing, I wouldn't fear it.

30 Years Into The Future...

STRATEGIC TECHNOLOGIES FOR THE ARMY OF THE 21st CENTURY

By Richard E. Smith
and LTC Albert A. Sciarretta

"The nature of national defense demands that we plan now for the threats on the horizon" and "To prepare to meet the challenge we may face in the future, we must focus on research—an active and inventive program of R&D."—President George Bush, Aug. 2, 1990, Aspen, CO.

Introduction

In 1988, Dr. Jay R. Sculley, former assistant secretary of the Army (research, development, and acquisition), directed the National Academy of Sciences (NAS), National Research Council (NRC) to conduct a study to look out approximately 30 years and provide to the Army advice to improve its capabilities to incorporate advanced technologies into its weapons, equipment and doctrine. Visionary participants from the NRC membership were called on in the belief that their projections would provide a "crystal ball" look at the 21st century Army. Specific objectives were to:

- Identify advanced technologies most likely to be important to ground warfare in the 21st century;
- Suggest strategies for developing the full potential of these technologies; and
- Project implications for force structure and strategy of the technology changes.

During the three years it took to complete the Strategic Technologies for the Army (STAR) 21 Study, profound political changes, particularly in Europe, occurred. Additionally, the Persian Gulf war demonstrated the need for the Army to be flexible in responding to threats that had not seriously been envisioned even months before the start of a conflict. These events highlighted the timeliness of the study findings. No one has a crystal ball to look 30 years into the future, but weapon systems often take 10 or more years to develop, and those fielded by 2020 will be based on technologies that are being conceived in Army laboratories today.

In the year 2020, the technical capabilities of systems that the U.S. Army puts into the field will result from the interplay of two processes—of scientific research and technological innovation that determine what is possible, and a wide array of factors that affect what is needed. These factors include requirements driven by the Army's mission, by the threats it faces, by political and economic changes at home and abroad, and by changes in a potential opponent's accessibility to high technology systems.

The STAR Study

The interplay of technology push and requirements pull has been a central theme in reports prepared by scores of experts who volunteered to participate in the NRC's Committee on Strategic Technologies for the Army. To conduct the study, the NRC organized nine science and technology groups and eight systems panels (Figure 1).

The description below of STAR study results is drawn from *STAR 21: Strategic Technologies for the Army of the Twenty-First Century, Volume 1, Summary Report.* The complete set of STAR reports can be ordered through the National Academy press of the NAS. The reports are an independent assessment by the NAS and do not necessarily represent the Army's position.

The Future Environment

How the Army uses technology in the future will be influenced by five major factors:

- An expanding number of technology options, as the pace of scientific and technological progress continues to accelerate;
- Changing military obligations, as the past scenario of mid-European conflict with the Soviet Union is replaced by a broad spectrum of possible contingency operations anywhere in the world.
- Diminishing funds for advanced technology as shifts in national priorities and a changing world economy increase the pressure to curtail military spending.
- Closer interservice cooperation in developing military technology and systems, in response to all three of the preceding factors; and
- Globalization of commerce, which means the United States can no longer assume an unchallengeable technology advantage on the battlefield.

The Army will need the flexibility to reconfigure units rapidly for maximum effectiveness in a particular assigned mission to respond to this environment. The Army must be able to deploy forces rapidly anywhere in the world, with the firepower to hold ground against an opposing force that may be larger and well armed.

Applications of Advanced Technologies

Selected systems concepts from the systems panels reports are presented under five headings: systems to win the information war, integrated support for the soldier, systems to enhance combat power and mobility, air and ballistic missile defense, and systems for combat services support. A brief discussion of each of these follows.

The Information War

Real-time intelligence will be crucial to winning the information war "C³I/RISTA" is the term used here to embrace the entire range of information-gathering functions included under the acronyms C³I (Command, Control, Communication and Intelligence) and RISTA (Reconnaissance, Intelligence, Surveillance, and Target Acquisition). In the future, a highly networked system will be needed to integrate these functions. The C³I/RISTA effort will include large numbers of optical, infrared, radar, acoustic, and radio-intercept receivers. Airborne and ground-mobile robotic vehicles will also become increasingly important as carriers of in-theater sensors. They will be augmented by satellite-based sensor systems and systems operated by the other services.

Integrated Soldier Support

The increasing technical sophistication of Army systems will not eliminate the involvement of the individual soldier. An integrated systems approach to meet the needs of the individual soldier is essential. Combat systems include the sol-

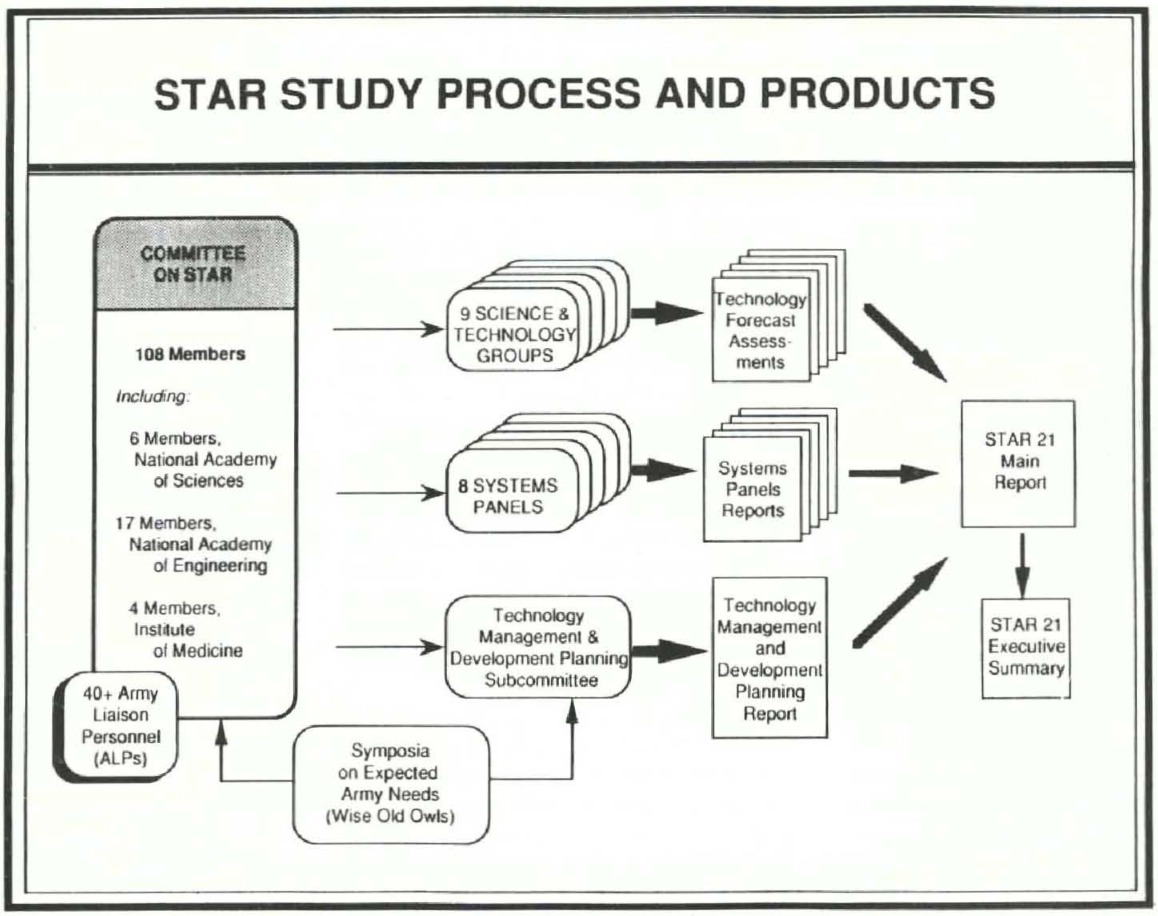


Figure 1.

Integrated Soldier Support

SYSTEM OPPORTUNITIES

- Modular Distributed Architecture
- Integral Sensors - Night and Day
- Individual and Group Training: Simulation
- Protection: Ballistic, CTBW, Trauma Treatment
- Navigation and Terrain Knowledge
- Weapons for Anti-seeker, Nonlethal Incapacitation, Defeat of Ground and Air Threats
- Battle Management Information--Command, Memory, Pocket-Size
- Rations and Pure Water
- Robotic Helper

HIGH PAYOFF TECHNOLOGIES

- Integrated systems design
- Genetically engineered and developed materials and molecules
- "Designer" materials
- Secure, wide-band communications
- Terahertz-device electronics

Figure 2.

dier's personal weapon and a smart helmet (Figure 2), which incorporates an audio system for communications and a visor for laser protection and built-in night vision aids. On the helmet and elsewhere, soldiers will have sensors and sensor-data display devices, plus systems for navigation (mapping and positioning) and Identification of Friend or Foe (IFF).

Enhance Combat Power and Mobility

Transport aircraft will continue to be used for quick deployment of light-to-medium forces. Sea transport will still be needed for heavy armored units to reinforce the air-deployed force, and for the logistics support of deployed forces. Technology can help by allowing more systems and platforms to be air-transportable, decreasing the logistics tail required to support combat operations, and improving control of materiel that is prepositioned or in the logistics pipeline.

Manned rotary wing aircraft (helicopters) will remain important in selected missions, although unmanned air vehicles (UAVs) may replace the human in some roles and complement them in others. For example, helicopters probably will continue to be used for gunships and become more important in heavy-lift transport. However, their scout and observation missions may be better performed by a range of sensor- carrying UAVs, particularly as enemy air defenses improve.

The dynamic battlefield of the future will require a highly maneuverable, armored vehicle for both assault against enemy positions and defense against opposing armor—a system with the capabilities of today's main battle tank. Future tanks will be lighter and more agile while at the same time increasing lethal power. Stealth technology, advanced materials, and new propulsion concepts can maintain or increase tank survivability and mobility.

The next three decades will see the evolution from today's smart munitions to brilliant ones, with advanced sensors and guidance systems allowing them to be autonomous. An advanced indirect-fire platform with multiple options for warheads will give light and medium forces the capability to hold ground and interdict a much heavier and more numerous force.

Air and Ballistic Missile Defense

An integrated system-of-systems will become essential for theater air and missile defense. Ground-based target acquisition and interceptor systems will predominate. The Army must have these elements integrated into its defensive operations. A wide range of potential threats—from tactical ballistic missiles to stealthy, low-flying aircraft, manned or unmanned, and stand-off platforms—will require a correspondingly diverse array of sensor systems and interceptors (Figure 3).

Combat Services Support

Health and medical military technology, such as vaccines for indigenous diseases, better prosthetic devices, and artificial tissues (e.g., skin and blood), will yield benefits for civilian medicine as well. Trauma treatment research by Army personnel should be supported by cooperative efforts with civilian hospitals in creating trauma treatment centers.

Other in-theater support systems that will benefit from new technology include: electronic terrain data systems; improved tactical shelters using composite materials; ammunition supply management systems; munitions made smarter by advanced microelectronics; improved fuel supply logistics through a computerized supply tracking system; and engines designed to use locally available fuels.

Training systems will continue to advance as more powerful computers, better software, and greater knowledge of human-machine interactions are incorporated into training methods. Simulation technology is experiencing revolutionary advances, and the Army needs to continue to exploit it.

Technology Forecast Assessments

The STAR Study addressed the following eight technology areas where advancements are likely to occur by the year 2020.

Computer Science, Robotics, and Artificial Intelligence

Major advances will occur in integrated systems development, knowledge representation and special-purpose languages (such as battle management language). Advancements will also be made in network management of diverse kinds of processors, distributed processing over multiple processors on a network, and human-machine interfaces. In these areas, the Army must be prepared to invest in R&D for requirements not having commercial counterparts.

Electronics and Sensors

The three electronics technologies predicted to have the highest impact for Army applications are devices operating at terahertz (a trillion cycles per second) speeds, high-speed computer architectures capable of performing a trillion operations per second (teraflop computers), and high-resolution imaging radar sensors. Teraflop computing will require a hundred or more processors operating in parallel at terahertz speeds. The high-resolution sensors will require both terahertz devices and teraflop computing capability.

Optics, Photonics, and Directed Energy

In optical sensor and display technology, major advances are forecast for laser radar; multidomain sensor datafusion (performed in real time at the sensor); infrared search, track, and identification systems; focal planes designed for massively parallel data processing; and helmet-mounted or similar "heads-up" display techniques.

In photonics (the use of light photons to transmit, store or process information) and electro-optics (combined use of electronic and photonic devices), the important technologies will include fiber optics, diode lasers and solid state lasers, electro-optical integrated circuits, optical neural networks, and acousto-optics for signal processing and high-speed information processing.

Biotechnology and Biochemistry

Biotechnology offers advantages over more traditional engineering and manufacturing methods for creating extremely complex substances in pure form and for very compact systems engineered at the molecular level. The successes of biotechnology to date have been in medicine, agriculture, and bioproduction of specialty natural chemicals. Applications that could be fielded within the STAR timeframe include deployable bioproduction of military supplies, biosensor systems, enhanced immunocompetence (resistance to disease and many CTBW agents) for personnel, novel materials with design-specified properties, battlefield diagnostic and therapeutic systems, performance-enhancing compounds, and bionic systems.

Advanced Materials

In materials technology, three pervasive trends are forecast: the use of supercomputers to design materials and model performance; technology demonstrators to hasten transfer of new materials and methods from laboratory to production; and materials and structures designed for multiple purposes.

Five materials technologies were identified for special consideration: affordable resin matrix composites, reaction-formed structural ceramics, light metal alloys and intermetallics, metal matrix composites, and energetic materials. These technologies are forecast to alter substantially the state-of-the-art for many Army applications. These include armor materials, ballistic protection for the individual soldier, and weight-strength relations for vehicle and propulsion system structural design.

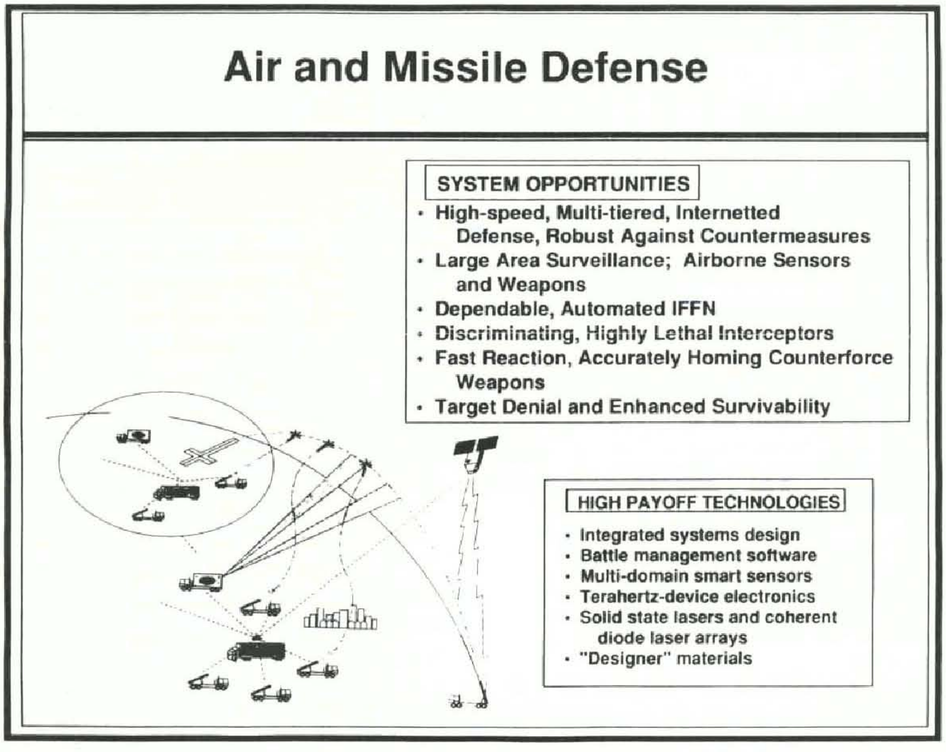


Figure 3.

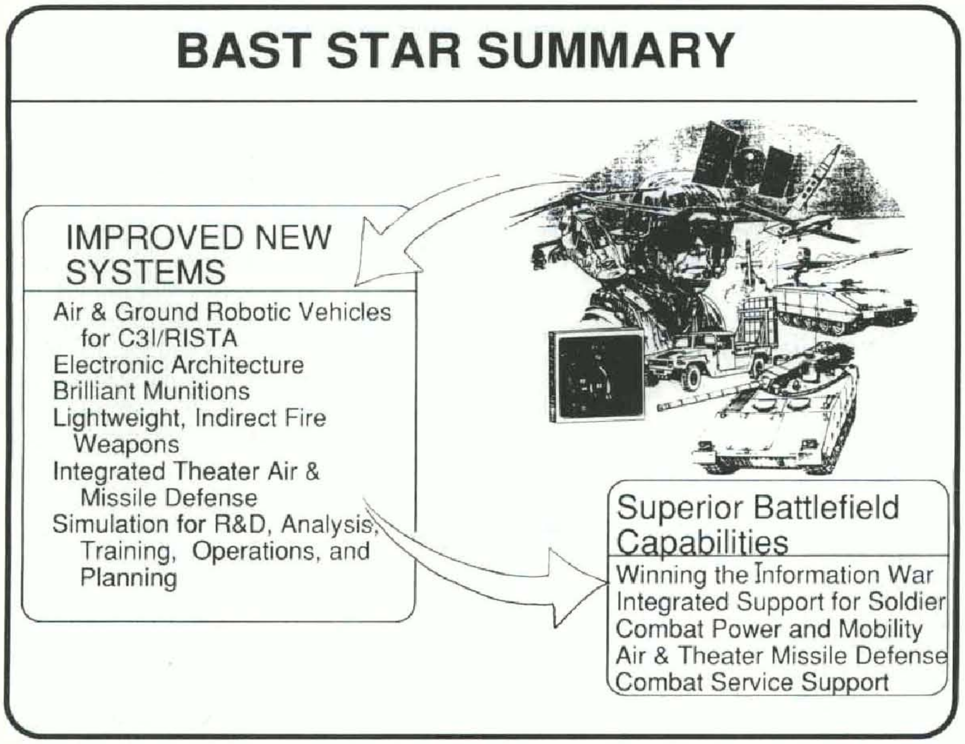


Figure 4.

Propulsion and Power

For rocket propulsion, gel propellants are the most promising new technology for Army applications, although evolutionary improvements to solid propellants will continue. Technologies for propulsion of air-breathing missiles, turbine engines and ducted or air-augmented rockets show the most potential. In manned aircraft propulsion, gas turbine engine technology was again the most significant technology, for both fixed and rotary-wing aircraft. For unmanned air vehicles used in surveillance from high altitudes, high-power microwave transmission from a ground station was selected for special attention.

For surface vehicle propulsion, two concepts received highly favorable assessments: the integrated propulsion system and hybrid electric propulsion. The recommended configuration combines an advanced diesel or gas turbine engine with all-electric or hybrid-electric power distribution.

Battle zone electric power includes primary power generation and technologies for energy storage and recovery. For continuous power generation, gas turbine engines offer more potential than other alternatives. Gas turbines for primary power and flywheels for storage would be combined with power conditioning units to supply the pulsed, short-duration power needed by high-power systems such as directed energy weapons. Rechargeable batteries are an alternative to flywheels for energy storage, in both stationary and vehicle applications.

Advanced Manufacturing

Intelligent processing systems, which use a control system to combine sensor technology with robotics, will be the key to the next generation of manufacturing capabilities. Microfabrication, which manipulates and fabricates materials at a scale measured in microns, will be feasible. These methods of manufacturing, controlled by advanced information systems, can be combined with specific process technologies. Examples include distributed and forward production facilities, rapid response to operational requirements generated in the field, and parts copying from an existing part without the need for plans and specifications.

Environmental and Atmospheric Sciences

Terrain-related technologies most important to the Army are a terrain data base that can be queried directly from the field and used to generate hardcopy maps at any scale; terrain sensing; and computerized real-time analysis of changing terrain conditions, using both the terrain data base and data from terrain sensors.

Among weather-related technologies, the Army will need atmospheric sensors flown into forward battlefield areas, either as airborne UAV sensors or ground sensors dropped in place. Satellite sensors will be used for remote sensing by laser and radar imaging. Although the Army can use advances in civilian-oriented weather modeling and forecasting, it is also concerned with modeling and forecasting on smaller scales.

Summary

In summary, the STAR Study concluded that technology will continue to be the key to achieving superiority on the 21st century battlefield. Improved new systems (Figure 4) will yield superior battlefield capabilities. The STAR Science and Technology Subcommittee identified nine of the most important technologies as a short list of special interest to the Army. These nine high-payoff technologies are: multidomain, smart-sensor technology; terahertz device electronics; secure, wide-band communications technology; battle-management software technology; solid state lasers and/or coherent diode laser arrays; genetically engineered and developed materials and molecules; electric drive technology; material formulation techniques for designed materials; and methods and technology for integrated systems design.

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THE ARMY RESEARCH LABORATORY

By John E. Holmes, Anne Barnett and Dennis McGurin

Background

During this century, the Army has faced diverse technical challenges and evolution in the way in which war is fought. The rate of growth and diversification of military technology in this century is unparalleled in history.

World War I forced the Army to expand its technology to include tank/anti-tank warfare, gas warfare, effects of prolonged periods of battle on humans, and introduced multi-dimensional air-land warfare. By the Second World War, the Army was conducting extensive research into all these, plus radio communications, proximity fuzes, radar, atomic warfare, and many others.

The period of the Cold War created a frenzy of demand for ever increasing varieties of and improvements to, military technologies. Thus, the types, complexity, and interrelationship of technologies the Army required increased by orders of magnitude in response to varying threats, over relatively short periods of time.

The demand for technology resulted in the creation of more facilities, or the expansion of existing ones. During the evolution of this growth, many laboratories expanded research into multiple areas of broad military interest in response to the growing technology appetite of modern war. This led to the Army having many small laboratories, geographically dispersed, with differing management structures. These laboratories covered a broad range of technology areas and, in many cases, with duplication of resources, especially those required to support the infrastructure.

In 1985, the Army created the Laboratory Command (LABCOM) to address some of these inefficiencies by aligning seven laboratories engaged in various technology and research areas under one headquarters. The formation of LABCOM provided the central management needed to direct research efforts along proper channels and to assure transition of technology into fielded systems.

LABCOM headquarters and the Harry Diamond Laboratories (HDL) were located at Adelphi, MD, the Ballistic Research Laboratory (BRL) and the Human Engineering Laboratory (HEL) at Aberdeen, MD, the Vulnerability Assessment Laboratory (VAL) and the Atmospheric Sciences Laboratory at White Sands Missile Range, NM, the Electronics Technology and Devices Laboratory (ETDL) at Fort Monmouth, NJ, and the Materials Technology Laboratory (MTL) at Watertown, MA.

In addition to the laboratories, LABCOM managed the Army Research Office (ARO) in North Carolina, and other smaller special technology offices. None of these organizations were physically relocated with the formation of LABCOM. However, while centralized oversight created a management synergy, the geographically dispersed nature of the LABCOM research organizations inhibited research synergy among the laboratories.

During the period of 1988 to 1991, many national and world events unfolded that helped shape the requirements and nature of laboratories for the future. Declining resources in combination with the wide geographical dispersement of the laboratories made the issue of resources a significant one. In addition, the collapse of the Soviet Union and the Warsaw Pact as an apparent major military adversary caused many to question the resource levels being devoted to the maintenance of the military. However, American military technology did prove itself in Operation Desert Storm by being decisively superior to the Soviet technology employed by the Iraqis. The best motivated, trained, and professionally led armed forces in the history of the United States, teamed with the overwhelming application of superior technology and firepower, quickly decided the issue. The necessity of maintaining the technology edge was clearly demonstrated.

Decision to Consolidate

In February 1989, President George Bush directed the Secretary of Defense to develop a plan to accomplish full implementation of the recommendations of the Packard Commission and to realize substantial improvements in defense management. Subsequent Army management reviews were initiated in reaction to that guidance and, as a result, the Army chartered a LAB-21 Study to consolidate and streamline its laboratory system. The LAB-21 study was conducted from November 1989 to February 1990. A second study, the Laboratory Consolidation Study, in July 1990, endorsed the Army's plan to reduce and consolidate laboratories.

All of these studies were driven by the executive vision of the future wherein the Army would have to provide continued superior military capability and technology, be able to project American military power anywhere on the globe rapidly, and do it all with much fewer resources. In an era of financial austerity, the Army could not afford research programs with the overhead burden of many laboratories, and keep the fighting forces in an acceptable state of readiness.

The LAB 21 study recommended the creation of a centralized "flagship" research and analysis laboratory, a world class facility. The new laboratory was to be composed of the LABCOM laboratories plus other research and analysis functions from within the Army Materiel Command (AMC), the

Army Research Institute (ARI), and the Information Systems Command.

Base Realignment and Closure Action

The National Defense Authorization Act for Fiscal Year 1991, Public Law 101–510, enacted new base realignment and closure (BRAC) guidance whereby all military installations inside the United States must be equally considered for base realignment and closure. PL 101–510 also established the Federal Advisory Commission on Consolidation and Conversion (FACCC) of defense research and development laboratories to study the DOD laboratory system and provide recommendations to the secretary of defense on the feasibility and desirability of various means to improve the operation of the DOD laboratories.

The LAB 21 Study was submitted for BRAC consideration as an effective means for timely implementation of the laboratories consolidation. Therefore, the Army laboratory consolidation plan was submitted to the BRAC and subsequently forwarded to President Bush and to Congress. Neither President Bush or the Congress disapproved the recommendations.

The FACCC supported the proposed consolidation, but recommended that an independent review of the advantages and disadvantages of a single microelectronics research facility for all three services be conducted and to defer the Army's capital investment until the review is completed. This recommendation was accepted and the Army has deferred all but planning and initial design studies of the facility, a critical component of the laboratory consolidation strategy, until the review is completed.

Implementation of the Army Research Laboratory

The Army Research Laboratory (ARL) will be implemented in compliance with the Base Realignment and Closure Commission recommendations and DMRD 922 savings. ARL will be a world class Army applied research laboratory with strong analysis capabilities in technology, MANPRINT, survivability/lethality, and the battlefield environment.

The combination of research and analysis will provide the Army a strong cadre of in-house scientists, engineers, and analysts to assure quality technical smart buyer services and technology development not accomplished in the private sector. The ARL will consist of approximately 3,000 people, be institutionally funded, and have the majority of its personnel conducting in-house applied research.

The Army Research Laboratory will be an in-house corporate asset committed to generating new scientific and engineering knowledge for the soldier.

The ARL will maintain basic core competencies and capabilities essential to the Army well into the 21st century in support of other entities of the Army acquisition system. These core competencies are: advanced computational and information sciences; battlefield environment effects; electronics and power sources; human research and engineering; materials; vehicle structures; sensors, signatures, signal and information processing; vehicle propulsion; survivability and lethality analysis; and weapon technology.

ARL will be constituted from the AMC Laboratory Command and elements of the Army Research Institute; Belvoir Research, Development and Engineering Center; Night Vision and Electro-Optics Directorate; Tank-Automotive Command; Aviation Systems Command; Chemical Research, Development and Engineering Center; and Army Institute for Research in Management Information, Communications, and Computer Sciences.

Missions, functions and personnel will be consolidated at two major sites: Adelphi, MD, and Aberdeen Proving Ground, MD, with adjunct capabilities at White Sands Missile Range, NM; NASA Langley Research Center, Hampton, VA; and NASA Lewis Research Center, Cleveland, OH.

A board of directors will oversee and manage a significant portion of the technology programs of the ARL. Research quality and directions will be established with the advice and guidance of a scientific review board comprised of distinguished and respected research leaders from industry, academe, and the national laboratories.

Implementation costs (approximately $385M) are primarily for movement of personnel and equipment (some out of the labs and into development centers) and construction of a Materials Research Lab at APG and a Microelectronics Research Facility at Adelphi. Savings of approximately $55M per year will result from the reduction in the number of sites and the elimination of over 700 manpower spaces, primarily in management and operational support resulting from the consolidation.

Construction and consolidation will occur in compliance with the implementing legislation of BRAC 91 which requires all actions to be completed by July 1997.

When completed, the Army Research Laboratory will be a more efficient, leaner, and more capable organization focused on the core technologies required for the future Army. ARL will be an in-house corporate asset committed to generating new scientific and engineering knowledge for the soldier. It will enable the Army to be a smart buyer and user of state-of-the-art technology. It will have a more productive management and operational structure and be able to support the Army at a significantly reduced cost.

Supported by state-of-the-art facilities, ARL's quality staff will work in partnership with the rest of the acquisition community to generate essential capabilities in a timely manner and at an affordable price. Their mission will be to provide America's soldiers the technology edge.

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MANPRINT IN THE ARMY RESEARCH LABORATORY

By Dr. Thomas H. Killion

Introduction

The purpose of the Manpower and Personnel Integration (MANPRINT) process is to ensure that soldier capabilities and limitations are adequately addressed throughout the materiel development and acquisition process. MANPRINT is a critical part of the concurrent engineering process. One of its goals is to achieve system designs which optimize the soldier's performance, rather than force-fitting soldiers into inadequately designed systems through elaborate training or after-the-fact fixes.

A second MANPRINT goal is to reduce the cost of ownership of systems by quantifying the human components of performance and identifying the long-term personnel and training costs associated with design alternatives.

Soldier Design Issues

The MANPRINT program addresses a wide spectrum of soldier-related design issues falling within six domains: manpower, personnel, training, human factors engineering (HFE), safety, and health hazards. Principal Army organizations representing these domains today are the Army Research Institute (ARI), the Human Engineering Laboratory (HEL), the Army Safety Center (ASC), the Corps of Engineers (COE), and the Surgeon General (SG).

Overall responsibility for the MANPRINT program rests with the Army's deputy chief of staff for personnel (DCSPER). Figure 1 provides an overview of the six MANPRINT domains and the Army organization(s) charged with primary research responsibility.

As the figure indicates, HEL has traditionally conducted research in the HFE areas of human performance capabilities and limitations, soldier-technology integrations, and advanced HFE tools, models and simulation development. The "application" of HFE research data to optimize Army materiel soldier-system interface design is executed through HEL's field elements. These elements support both the combat developers (i.e., TRADOC centers and schools) and materiel developers (PEO/PMs and Army Materiel Command (AMC) research, development and engineering centers). Human factors engineers have "implemented" MANPRINT into materiel development by ensuring the integration of soldier concerns into the otherwise hardware oriented process.

ARI has traditionally conducted research in the manpower, personnel, and training (MPT) arenas in direct support of TRADOC and DCSPER. ARI has also established significant research capabilities for addressing system design issues.

ARI's Systems Research Laboratory and its field units have led research efforts to optimize system design based on the concept of manned-system performance (now called total system performance) and MPT life-cycle costs. In addition, ARI's Manned Systems Group has developed a series of tools, most recently HARDMAN III, for projecting and examining tradeoffs among manpower, personnel and training (and their costs) affecting total system performance for new systems. ARI's field units, which are primarily research-oriented, also provide advice and counsel to the combat and materiel developer communities.

Lab 21 Recommendations and ARL

In 1989, the Lab 21 Task Force was chartered to make recommendations regarding the future organization of the Army's R&D process. In the combat materiel domain, the task force recommended formation of a "flagship" research laboratory within AMC. This laboratory would be established around the existing Army laboratories (currently part of the Laboratory Command (LABCOM)) and selected elements from other R&D agencies. The purpose of this consolidation would be to provide a "critical mass" of research capabilities in specific technology areas.

Because of the desire to make the soldier more efficient, effective, and survivable, one of the areas highlighted was life sciences. Creation of the Army Research Laboratory (ARL) responds to the Lab 21 recommendations. (For additional information on the overall Army laboratory system reorganization, see the article in the September-October 1991 issue of *Army RDA Bulletin*. A related article on the ARL also appears on page 13 of this issue.)

During the review of the Army's laboratory system, the Lab 21 task force identified technological areas in which HEL and ARI activities overlapped. The task force recommended that those portions of the ARI research program which directly address materiel development and acquisition be transferred to AMC and integrated into the ARL. ARI MANPRINT functions would then be combined with the existing HEL capabilities to form the Human Research and Engineering Directorate (HRED).

What HEL brings to the new organization is its expertise in human factors engineering, soldier-focused research, and the soldier-machine interface. The integration of ARI elements will allow the new directorate to encompass all areas of MANPRINT. The new directorate will serve as *the* focal point for identifying and resolving MANPRINT issues in systems development and acquisition.

Directorate Organization

The planned organizational layout of the Human Research and Engineering Directorate (HRED) is shown in Figure 2. Its basic mission will be to conduct a broad-based program of scientific research and technology development to optimize soldier performance and soldier-machine interactions for maximum battlefield effectiveness. Its research products will be the knowledge, theories, and models of soldier and unit performance. Applications (in the validation of research products and invited participation in advanced technology transition demonstrations) will affect new system development, product improvements, and soldier-machine interface designs. The directorate will also provide the Army and ARL with MANPRINT leadership to ensure that soldier performance requirements and MPT implications are adequately addressed in technology development and system design. This mission will be accomplished through the activities of a Soldier Performance Division, a Technology Interface Division, and a MANPRINT Division.

Soldier Performance Division

This division will conduct a comprehensive, soldier-oriented R&D program responsive to current and future Army needs regarding soldier integration issues in materiel design and acquisition. It will carry out the directorate's 6.1 basic research program to extend the knowledge of fundamental soldier performance capacities (such as information processing) and limitations (such as sound pressure levels). These knowledge products will be linked to

DOMAIN	DEFINITION	R&D CENTER(S)
Manpower	The number of human resources, both men and women, military and civilian, required and available to operate, maintain and support Army systems.	ARI
Personnel	The aptitudes, experiences, and other soldier characteristics necessary to achieve optimal system performance.	ARI
Training	Media and methods for imparting the requisite knowledges, skills, and abilities needed by available personnel to operate, maintain and support systems under operational conditions.	ARI
Human Factors Engineering	The comprehensive integration of soldier characteristics into system definition, design, development, and evaluation to optimize the performance of soldier-machine combinations.	HEL
Safety	The inherent ability of the system to be used, operated, and maintained without accidental injury to personnel.	
Health Hazards	Inherent conditions in the operation or use of a system (e.g., shock, recoil, vibration, toxic fumes, radiation, noise) that can cause death, injury, illness, disability, or reduce job performance of personnel.	SG COE

Figure 1.
Definitions of MANPRINT domains and responsible research agencies.

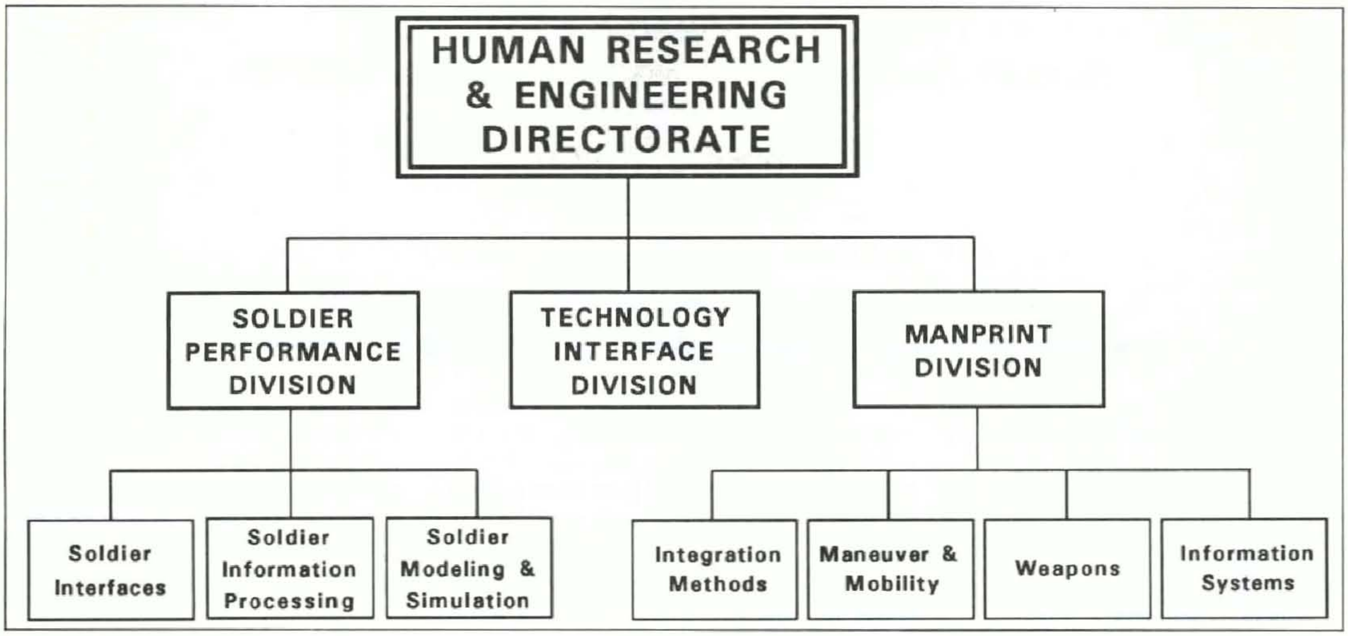

Figure 2.
Human Research and Engineering Directorate Organization.

military technology-base concepts (like automatic target recognizers) to assess the impact of emerging technologies on soldier performance.

The Soldier Performance Division will also maintain a body of knowledge regarding basic human performance capabilities and limitations in the perceptual, cognitive, and psychomotor domains. It will work with the other divisions of the Human Research and Engineering Directorate to identify critical technology interface and MANPRINT issues requiring basic and applied research and develop programs to address them. Essentially, this division will be the Army's primary human performance research link to the scientific community and serve as the recognized military authority on human performance.

This division will also conduct modeling and simulation for two major purposes. The first purpose is to use innovative soldier models and simulations to identify and resolve soldier-machine interface issues early in the materiel design process. These models are generally designed for use in CAD/CAM environments. The second purpose is to create unique and innovative synthetic environments for measuring and characterizing soldier performance. These environments, popularly known as "virtual reality," provide excellent tools for testing the limits of human performance under safe, controlled conditions, or for evaluating the soldier-related aspects of alternative system designs in the early stages of conceptualization. These products will eventually find direct application in predicting total system performance.

Technology Interface Division

This division will conduct analyses and soldier-in-the-loop experiments to establish achievable soldier requirements, provide input for interface design criteria, and validate soldier model/simulation predictions. It will also address soldier interface issues associated with improvements in military capabilities. This will be achieved through field experiments and simulations of soldier-system performance.

In each functional area (e.g., aviation, air defense, fire support), the thrust will be to match human capabilities with emerging technologies, particularly from other ARL directorates. Where appropriate, the Technology Interface Division will also develop testbeds, representing generic battlefield systems, to support research regarding the application of technology enhancements and their impact on soldier performance.

Critical soldier interface issues will be jointly researched with the Soldier Performance Division. The results, in terms of performance data and soldier interface design criteria recommendations, will be provided to the third division, the MANPRINT Division, for application to current battlefield operating systems and next generation systems. The Technology Interface Division will serve as a focal point for soldier-system integration issues pertinent to future systems, particularly with regard to the impact of new technologies.

MANPRINT Division

The MANPRINT Division will perform both a 6.2 tech base research program and a 6.5 analysis effort. The former will develop tools and methods for integrating, in a single project, the six technologies of manpower, personnel, training, human factors, health hazards, and system safety. Consisting of psychologists, engineers, operations analysts, trainers, and software designers, this division will develop and package the MANPRINT technology base for projects under development within the AMC RDECs. Its field units will provide on-site assistance to combat and materiel developers.

The 6.5 analysis effort will address soldier and unit performance within the Battlefield Operating Systems designed by TRADOC (and, at this writing, being considered for adoption at

The Army Research Laboratory Human Research and Engineering Directorate is designed to meet the needs of the modern Army to maximize the utilization of its most important asset—the soldier.

the tri-Service level as a means of improving inter-Service coordination during joint operations). Data for these analyses will be developed from cost and operational effectiveness studies and from MANPRINT assessments of projects being developed within AMC's major subordinate commands.

To support the MANPRINT analysis function, the division will develop and transition computer-based tools to facilitate the insertion of MANPRINT goals, constraints, and human performance requirements into materiel designs.

The MANPRINT Division will also provide data to support the development, verification and validation of MANPRINT tools and methods, and will provide a liaison to ARI, the Surgeon General, the Army Safety Center, the Corps of Engineers, and other DOD agencies and industry.

Integration of HEL Functions

All current HEL functions will be integrated into the new directorate. Existing field offices and detachments will remain, but their role will be expanded from human factors assistance to MANPRINT research. Field offices will also provide direct support to combat and materiel developers. HEL basic and applied research and exploratory development functions will be realigned to suit the new organization. This will allow ARL to maximize the expertise and facilities developed by HEL in support of its current mission.

Integration of ARI Functions

The specific functions within ARI which have been identified for transfer to ARL include those of the Systems Research Laboratory headquarters (SRL HQ) group, the Manned Systems Group (MSG), and the MANPRINT Coordination Office (MCO) which are currently located in Alexandria, VA; the Fort Sill, Fort Huachuca, and Fort Hood Field Units; and the contingent at the Army Aviation Systems Command. Most of these functions will be integrated into the HRED MANPRINT Division.

The Systems Research Laboratory headquarters, the Manned Systems Group, and the MANPRINT Coordination Office functions will move to the existing HEL facility at Aberdeen Proving Grounds (APG), MD, which will be the site of the HRED. Transfer of specific field unit functions to APG will depend on the cost and mission effectiveness of maintaining current facilities.

Implementation Plan

The ARL implementation plan calls for operational control in-place over applicable manpower and personnel resources to be initiated in the second quarter of FY92. Program transfer of funding, manpower spaces, personnel and equipment to the ARL Table of Distribution and allowances (TDA) is scheduled to be effective Oct. 1, 1992. A Memorandum of Agreement between AMC and the DCSPER is in coordination to facilitate the smooth transition of ARI personnel and facilities, and to maintain existing support arrangements (such as office spaces, supplies, and computer support) in the interim period. The relocation of appropriate personnel from Alexandria, VA, to the APG site is expected to occur in the second quarter of FY93, dependent on the outcome of environmental impact studies.

Summary

The Army Research Laboratory Human Research and Engineering Directorate is designed to meet the needs of the modern Army to maximize the utilization of its most important asset—the soldier. The directorate provides ARL with an organization which has: well defined customers, to include the final customer—the U.S. Army soldier (or civilians in some acquisition programs); well identified products aligned with the R&D plans of the Army; a staff of minimum critical mass; and minimum overhead.

The new directorate will maximize the expertise and experience of its parent organizations, HEL and ARI, to provide a single focal point for the Army and industry regarding the application of MANPRINT to the materiel design process.

The ultimate benefactor of the MANPRINT effort will be the U.S. soldier.

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Technology Demonstrators...

MEETING THE LOGISTICS OVER-THE-SHORE CHALLENGE

By Brian David

Introduction

The U.S. armed forces' ability to deliver massive amounts of materiel during Operation Desert Shield/Desert Storm was an acknowledged logistics triumph. According to the Maritime Administration, the organized sealift delivered approximately 10 million tons of supplies to the modern Saudi Arabian ports of Ad Dammam and Al Jubayl. In fact, strategic sealift is required for 95 percent of our force deployment and resupply throughout the world, according to the 1991 Army Posture Statement.

With this strong dependence on sealift in mind, questions arise: What if a more capable Iraqi military had targeted the Saudi ports, destroying the cargo-handling infrastructure? Can we assume there will always be modern deep-draft ports and host-nation support to offload our military sealift ships?

Without commercial ports, offloading of containerized cargo, tanks, and other vehicles from supply ships is done in-the-stream, in unsheltered water, miles from the shore. In what is known as a Logistics Over-The-Shore (LOTS) operation, shallow-draft or amphibious marine craft called "lighters" carry military equipment and supplies from vessels to shore.

Challenges

Two major challenges confront a LOTS operation: cargo offload during heavy weather and cargo delivery over shallow and/or soft beach slopes. These two problems, born in 1944 during World War II's D-Day action, still hamper LOTS operations almost half a century later.

To address these challenges, the U.S. Army Belvoir Research, Development and Engineering Center is developing three innovative technology demonstrators: the Pontoon Air Cushion Kit (PACK), the Screw Integrated Control System-Pontoon Air Cushion Kit (SICS-PACK), and the High Sea State Container Transfer System (HISEACOTS).

These systems are designed to provide: heavy-lift, amphibious offload capability; improve offload productivity; and extend the ability to offload cargo into sea state three (wave heights of 3.5–5 feet from crest to trough) and worse. Although unique in concept and mission, each system shares common technology and hardware components.

Heavy Lifting

The PACK is a heavy-lift (140 tons), amphibious, non-self- propelled hoverbarge created by integrating a flexible skirt and lift system with barge platforms made from standard Army modular pontoons. These same pontoons are also used to construct causeway piers, causeway ferries, warping tugs and Roll-on/Roll-off (RO/RO) discharge facilities for LOTS operations.

Because its air-cushion skirt enables it to "fly," the PACK is especially valuable in shallow water, where much of the Army's lighterage encounters severe problems. Its role is critical because 90 percent of the world's beaches suitable for LOTS operations have quite flat beach gradients, according to the Naval Coastal Systems Center.

A full-scale PACK demonstrator was tested in 1990 at Fort Eustis, VA, under a Training and Doctrine Command Concept and Evaluation Program (CEP). Despite structural problems with the first skirt system, the PACK transported the Army's 250-ton-capacity crane—weighing 130 tons—over the beach at nearby Fort Story and then over water to the Norfolk Naval Base. This feat set a U.S. military record for the heaviest payload carried by an air-cushion vehicle (ACV). An Army Landing Craft Utility (LCU-2000) served as tug.

An upgraded PACK also participated in the September 1991 Joint Logistics Over-The-Shore (JLOTS) III tests at Fort Story. It incorporated a reinforced skirt design, improved attachment hardware, redesigned push knees, and several other modifications.

During the first heavy-lift demonstration, the PACK transported a second beach crane weighing 130 tons from

PACK being towed with two M1A1 Tanks on board.

Fort Story to Norfolk. It was also used to carry the Army's 140-ton-capacity beach crane from a military sealift Auxiliary Crane Ship (T-ACS) to the beach. In addition, the PACK carried two M1A1 tanks and, in a special loadout, took a D-7 bulldozer, Rough Terrain Container Crane, and its portable beach ramps as the "first load in" over a beach accessible only to ACVs.

The PACK can be towed or pushed over water to the beach by most of the Army's lighterage. On land, it can be towed by an assortment of material handling equipment, including the D-7 bulldozer.

In addition, the PACK can be deployed fully assembled aboard a T-ACS or can be stored inside container cells and assembled on deck, making it ideal for prepositioning. It can also be configured to fit any size modular platform. A causeway pier can be constructed over extremely shallow beach gradients and marginal terrain (mudflats, marsh) by using the PACK system to emplace causeway sections.

The technology demonstrator is durable, reliable, affordable, and can carry all the Army's heavy and outsized equipment in a worst-case LOTS environment. Secondary uses include missions related to construction, salvage and general heavy-lift operations over marginal terrains.

Churning Water

The SICS-PACK, being developed as a low-cost, pre-planned product improvement (P3I) to the PACK, is designed to provide the PACK with self-propulsion. As discussed earlier, the PACK is a non-self-propelled hoverbarge. The demonstrator will provide a "powered module" for PACK propulsion similar to commercially available waterjet-powered modules.

The SICS-PACK will use screw rotors that are integrated inside Army modular pontoons for propulsion. Also known as Archimedes' screws, they are the only proven propulsors capable of high-efficiency performance during both low-speed and high-speed operations over water, mud, marshes, loose sand, packed sand, clay, shale, and snow.

Rotors on earlier screw-rotor vehicles had to buoy the platform as well as propel it. However, with the PACK, the rotors are exclusively propulsors, allowing greater freedom in their design and use.

The SICS-PACK will be capable of six knots overwater speed with a 140-ton payload in sea state two (up to 3.5-foot waves), and able to climb a 1:10 sandy beach slope. (Gradient drops 1 foot for every 10 feet of beach width.)

Screw rotor modules will retain their International Standards Organization compatibility and, therefore, be capable of storage inside container ships for prepositioning along with other PACK components.

A ⅕-scale model of the SICS-PACK underwent testing this past summer. A full-scale SICS-PACK is scheduled for demonstration in late FY93, funding permitting.

Defeating High Seas

Offloading of containers and heavy, outsized equipment in high seas or large ground swell is severely limited. Currently, LOTS offloading operations virtually cease in sea state three. This can be anticipated 75 percent of the time at LOTS sites worldwide, according to the Naval Coastal Systems Center.

Individually, the Army's lighterage

and its sea-lift crane ships can operate in sea state three. What they can't do is interface to offload cargo. However, the High Sea State Container Transfer System stabilizes this interface in rough seas.

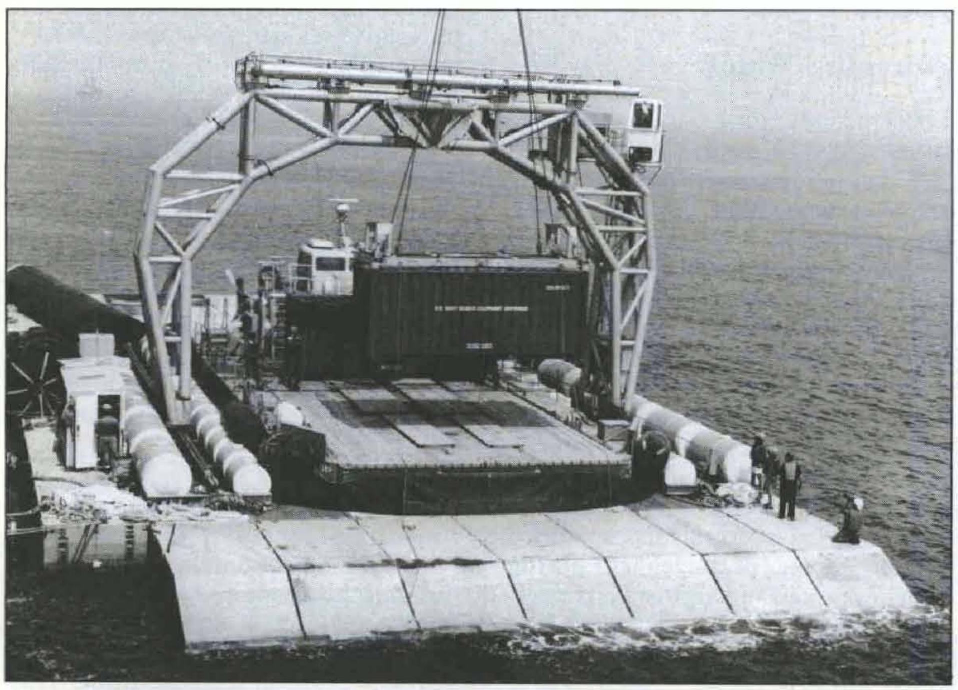
The HISEACOTS is a 160-foot by 72-foot platform assembly of modular pontoons. A unique gantry crane is mounted on this barge platform to transfer cargo, and can handle containers up to 50,000 pounds. Moored alongside the supply ship, the HISEACOTS provides a relatively stable platform for the air-cushion lighters to fly onto during offload operations.

When an ACV sits on the HISEACOTS with pontoons moored alongside the supply ship, all three move largely in unison with the waves and swell. Containers are sling-loaded out of the supply ship to the HISEACOTS gantry crane. When the sling cable reaches the gantry crane, friction of the sling against the gantry crane's pendulation bar stabilizes the cargo's swinging motion. A specially designed truss assembly catches and secures the sling to a pair of hydraulic arms, eliminating the container's pendulation and allowing the crane operator to safely spot it on the carrier craft for the move to shore.

In 1991, a full-scale HISEACOTS platform with gantry crane underwent a five-week CEP test at the James River Ready Reserve Fleet near Fort Eustis. The system was moored next to a T-ACS, where a Lighter, Air-Cushion Vehicle-30 Tons (LACV-30) flew onto its platform 57 times. A 34 percent reduction in cycle time compared to the average time recorded in calm water during the 1984 JLOTS II was demonstrated.

The HISEACOTS full-scale technology demonstrator deployed in the 1991 JLOTS III exercise and moored to a T-ACS off Fort Story, VA, completed four complete fly-on//fly-off operations. However, a severe storm shut down the exercise before a container transfer could occur. The storm lasted for 36 hours, generated a sea state four condition (5- to 7-foot wave heights) according to the JLOTS Test Directorate, and damaged a majority of the JLOTS equipment, including the HISEACOTS platform. Engineers corrected certain platform design deficiencies found to be contributing factors to its damage.

The HISEACOTS full-scale technology demonstrator was tested successfully in the 1992 Commander-in-Chief, Atlantic Fleet "Ocean Venture" exercise off Camp Lejeune, NC, as it transferred Load-on//Roll-off tracked and wheeled vehicles from a fast sealift ship onto the Army's LACV-30.



HISEACOTS loading second 20-foot container onto LACV-30 using a gantry crane.

Additionally, the HISEACOTS was used to transfer 20-foot containers from a T-ACS ship onto the LACV-30's. At one point during the operation, the HISEACOTS was the only method of offloading containers due to the ground swell conditions affecting the ship's roll and cargo pendulation.

Although HISEACOTS increases offload productivity in calm water and in moderate ground swell conditions, it remains unproven in elevated conditions (sea state three). The gantry crane successfully reduces cargo pendulation. The modular fly-on/fly-off platform clearly reduces the LACV-30's approach and moor time and its cast-off and clear time. The platform also reduces the likelihood of damaging the LACV-30's propellers when mooring in high seas or ground swell.

Without the gantry crane, the HISEACOTS can perform an alternative role as a fly-on/fly-off platform to accept vehicles from RO/RO ships. The HISEACOTS is compatible with all current and anticipated Army and Navy ACVs.

Conclusion

With a world in flux and an increase in third-world military capability, our national strategy requires a modern and mobile strategic land force for deterrence and defense. Global instabilities emphasize the need for a LOTS capability to resupply our forces where port facilities are inadequate or nonexistent. The PACK, SICS-PACK and HISEACOTS will ensure that the Army can resupply our soldiers over shallow beach gradients and in high seas—the most likely scenario—anywhere in the world.

BRIAN DAVID is a project engineer for the Marine Development Team at the Belvoir Research, Development and Engineering Center. After working for General Dynamics' Electric Boat Co., he came to BRDEC in 1982. He holds a B.S. in aerospace and ocean engineering from Virginia Polytechnic and State University and a master's of engineering administration from George Washington University.

SMART PROPULSION FOR SMART MISSILES

By Dr. William D. Stephens

Introduction

Historically speaking, solid fuel rocket motors have been the propulsion system of choice for most of the tactical missiles in the current U.S. Army inventory. The choice of a solid rocket motor, over other forms of propulsion, is due to the simplicity of the propulsion system once the missile is fabricated and placed in service.

Many solid rocket propellants, such as those used in the Multiple Launch Rocket System (MLRS) and the Army Tactical Missile System (TACMS), are made simply from rubber, powdered aluminum, and a crystalline oxidizer. An artist's concept of an internal-burning solid propellant rocket motor is shown in Figure 1A, while Figure 1B shows a schematic of an "end-burner."

The U.S. Army has traditionally placed high emphasis on simplicity, ruggedness, reliability, maintainability, and long service life. Consequently, for tactical missiles, solid fuel rockets have almost always been the power plants selected.

In the past, tactical missile propulsion research has been characterized by trends which identify the technical goals during a particular phase in the history of the art. Currently, an impor-

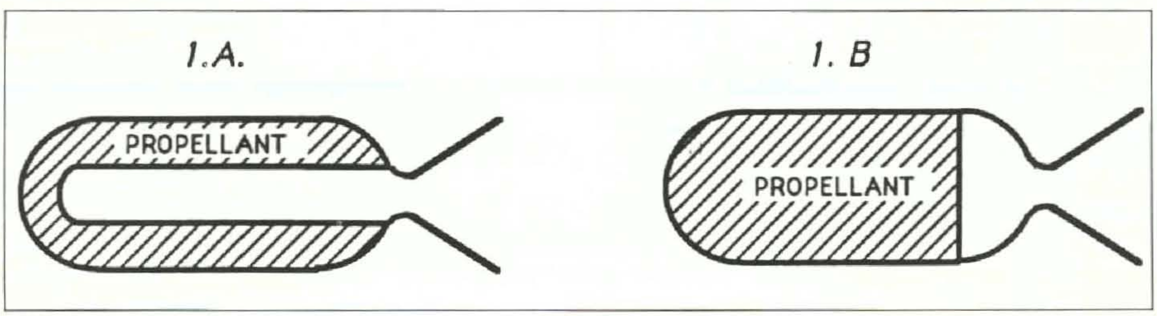


Figure 1.
Solid propellant rocket motors

tant trend in tactical missile propulsion research is insensitive munitions (IM).

The Army and the other services are currently working aggressively to develop new solid rocket propulsion systems which are safer in peacetime, and more survivable on the battlefield. The objective is to prevent the catastrophic loss of a weapon system because of detonation, explosion, or violent fire from on-board munitions.

Another trend in current missile propulsion R&D is multi-mission missiles. Decreases in defense budgets and a desire for logistics simplicity have highlighted the need for development of missiles which could perform more than one role on the battlefield. This could, in an extreme case, result in a missile used to attack either a submarine or a satellite.

Unfortunately, solid propulsion systems are not ideally suited to missiles which must perform multiple roles. For many years rocket engineers and scientists have sought ways to modulate or vary the energy output (or thrust) of a solid rocket motor.

In the early development of air-launched missiles, an initial concern was that fighter aircraft speeds were so great that the aircraft might overrun a missile which had just been launched. One of the first efforts at modifying the thrust of the rocket motor was the design of a two-level propulsion system. This provided an initial rapid launch capability to move the missile away from the aircraft at a very high rate of speed, followed by a slow-down sustaining velocity to carry it to target. Called a boost-sustain rocket motor, it is typical of Sidewinder and other air-to-air systems. The boost-sustain thrust sequence was obtained through the design of the internal geometry of the combustion surface.

Figure 2A illustrates a thrust-time profile for a simple solid rocket motor. There is an early ignition spike, and then constant thrust until burn-out. Figure 2B shows a boost-sustain profile with high initial thrust, followed by a longer sustaining thrust at a lower level.

Preprogrammed Thrust

One of the principal characteristics of solid propellant systems is that they have a preprogrammed thrust level. The amount of force, energy, or thrust from a solid rocket motor is determined by only two factors: the chemistry of the solid propellant, and the geometry (shape and volume) of the rocket motor. Since neither the chemistry nor the geometry of the solid propellant can be changed once it is loaded into the rocket motor case, the rate at which the energy is delivered (normally called the thrust profile) is fixed. This is described as a preprogrammed increment of thrust.

If an automobile is designed to go to the grocery store, which is 10 minutes away, at 30 miles an hour, but the car can only go 30 miles an hour for 10 minutes—nothing more or less, then the car has a preprogrammed increment of thrust—just as current solid propellant rocket motors have. This is a serious deficiency in a propulsion system for use with a multi-mission missile. This preprogramming means that the propulsion system is unsuited to multi-mission roles and cannot adapt to changing situations.

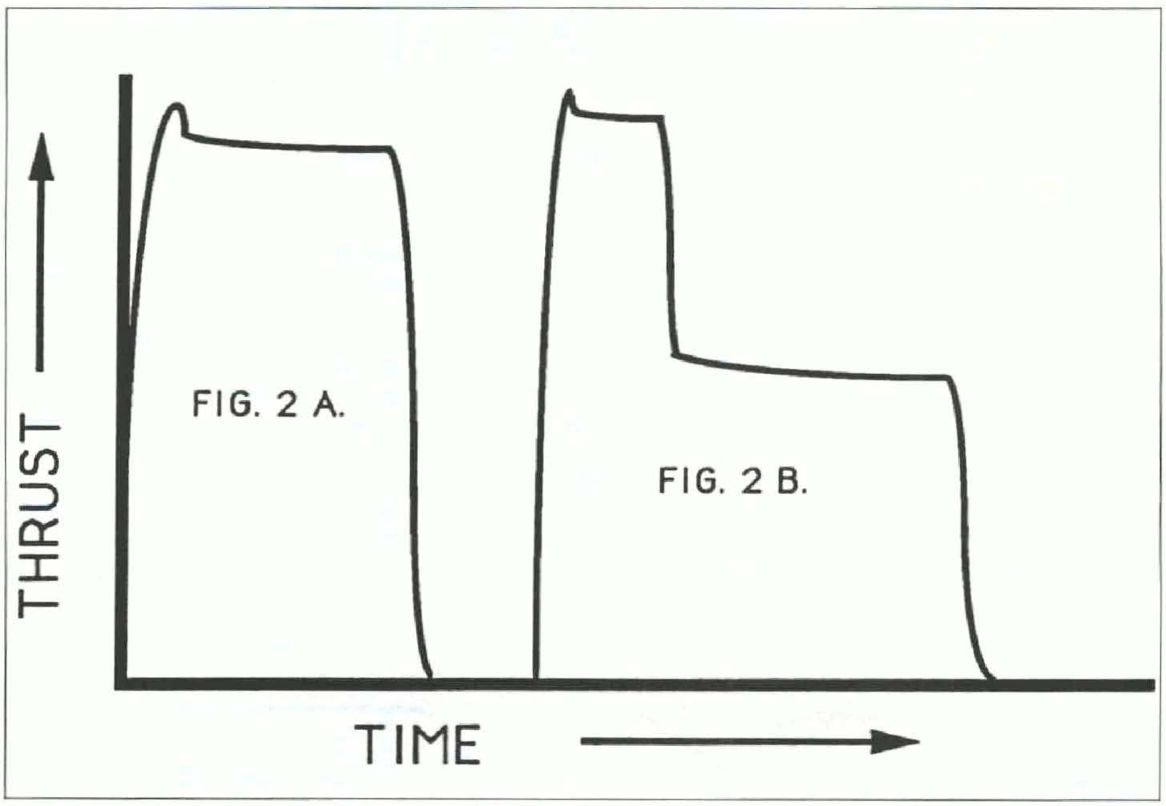


Figure 2.
Thrust versus time profiles.

Earlier attempts by the research community to moderate the thrust profile have met with only modest success. The term "energy management" is used to describe systems having some limited ability to alter the thrust profile during flight. For instance, pulse motors are solid rocket motors with two distinct propellant charges which can be burned independently. This design permits a burn-coast-burn profile. However, the only flexibility available is the length of coast time between burns. Each burn, or pulse, is a preprogrammed increment of thrust.

Smart Missiles Are Getting Smarter

The accelerating pace of progress in software development, logic and control engineering, and decision capability suggests that the "brains" in future missiles will be substantially advanced over current ones. Technical capabilities in various stages of development include automatic target recognition, tracking and glide-path projection, the ability to identify friend or foe, the judgement required to decide whether to abort the mission, multi-mission capability, and numerous others.

Figure 3 illustrates a situation in which a smart missile is fired at a target, has the ability to recognize the target, and knows the most vulnerable angle of attack for this target. Within the field of view of the onboard seeker, a higher-value target appears. The onboard controller recognizes the new potential target, determines its velocity and direction of travel, determines that it is a higher valued target, determines that the missile's propulsion system has enough thrust to catch and destroy the new target, and relays a message to the launch point.

Without further instructions from the launch point, the smart missile tracks and destroys the new target and relays information back to the fire control center. If interceptors, decoys, or other countermeasures are taken, the smart missile recognizes these and responds to them.

Liquid Propellents

While the technology for controllable liquid rockets has existed for some years, the military has been reluctant to accept weapons based on these systems because of the potential for a spillage. However, the recent emphasis on insensitive missile propulsion, has shown that the possibility of a catastrophic event can be eliminated by proper use of a two-part liquid propulsion system. If the problems resulting from spillage of liquids could be overcome, the substantial gains from the controllability of liquid rockets could be achieved without concurrent penalties. Thus, the propulsion system would permit a missile to change targets in the middle of flight, or respond instantaneously to the demands of an onboard (or remote) controller.

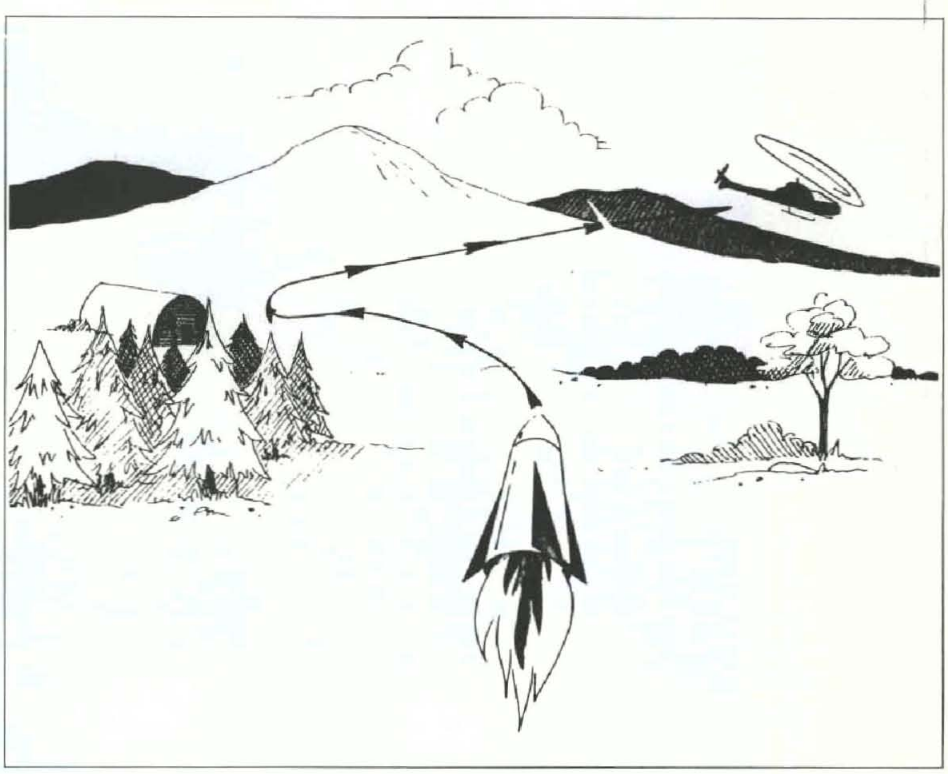


Figure 3.

Enter Gels

A team of rocket scientists lead by Dr. Barry Allan at the U.S. Army Missile Command in Huntsville, AL, has discovered a way to circumvent the problems of liquid spillage. They have devised a way to convert liquid rocket fuels and oxidizers into gels with unique physical characteristics distinctly different from liquids. The consistency of these materials is somewhere between that of toothpaste and jello. If a coffee cup full of gel is turned upside-down on the table and the cup is removed, the gel would retain the shape of the inverted cup, but it would not run across the table as liquids do (see Figure 4). These materials are known as thixotropic gels.

The term thixotropic describes a resistance to liquid flow which is unique to these materials. They will flow when they are under pressure, worked, or vibrated. In other words, they behave as liquids when some force is acting on them, but behave as solids when they are undisturbed.

If a bullet penetrates a tank of gelled fuel or oxidizer, a small amount of material will flow out of the hole, for a few seconds, and then the drainage process would stop. Unless one gel contacted another, there would be no fire. And even if there was contact, the fire would last only for a few seconds until the area of contact had burned away. The gels will not run together to continue the combustion process. This type of system basically becomes a self-protection propulsion system with a high degree of safety.

In the early 1980s, a Soviet nuclear submarine near Cuba developed leaks in a liquid rocket. Fuel and oxidizer mixed and exploded in the bottom of the launch tube, blowing a large hole in the deck. The Russians ended up towing the sub to deep water in the Atlantic to scuttle it and to keep the U.S. from recovering and inspecting the submarine. If the fuel and oxidizer had been gelled, spillage and leakage would have been a minor problem, and the submarine would not have been lost.

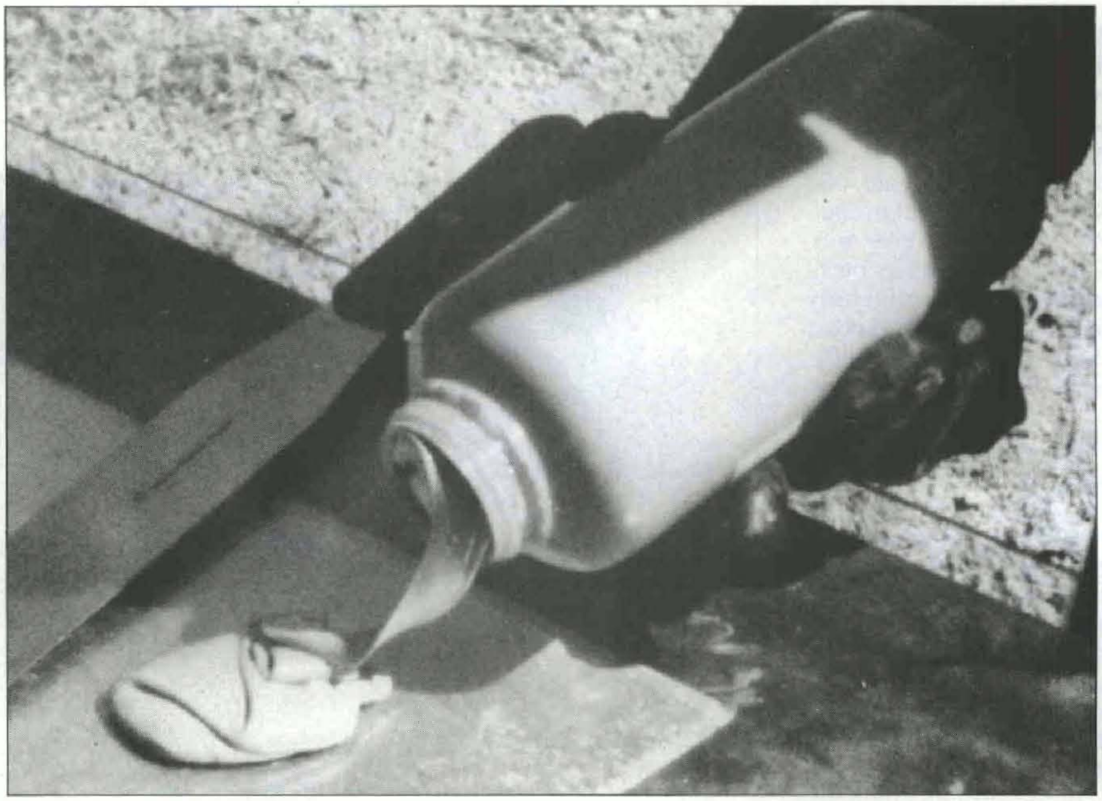


Figure 4.

TYPES OF MISSILE PROPULSION → / PROPULSION CHARACTERISTICS	LIQUID ROCKET	GELLED LIQUID ROCKET	AIR AUGMENTED GEL	HYBRID ROCKET	AIR AUGMENTED HYBRID	SOLID ROCKET	SOLID BOOST/ SUSTAIN	SOLID PULSE MOTOR	TURBOJET	AIR TURBO ROCKET	PULSE JET	DUCTED ROCKET	RAMJET SOLID/ LIQUID
HIGH ENERGY	X	X	X	X	X	X	X	X	X	X		X	X
LOW COST						X	X	X	X	X	X		X
MINIMUM SIGNATURE	X	X	X	X	X				X	X	X	X	X
INSENSITIVE		X	X	X	X				X	X	X	X	X
ENERGY MANAGEMENT		X	X	X	X		X	X	X	X	X	X	X
MANEUVERABILITY	X	X	X	X	X								
SMART - RESPONSIVE	X	X	X	X	X				X	X			
LONG RANGE			X		X						X		
LONGEST RANGE									X	X		X	X

Figure 5.
Propulsion characteristics.

Smart Propulsion

Smart propulsion will have capabilities not now available to missile propulsion systems. These capabilities will include the ability to react instantaneously to commands, the ability to stop, coast, restart, to loiter, speed up, slow down, change to an unplanned thrust level, abort the mission, and change mission during flight. All of these added capabilities are intended to provide propulsion which is compatible with future smart weapons.

Smart propulsion systems based on thixotropic gels will cost more than solid propulsion systems. However, the cost of propulsion is a minor part of the cost of a smart missile, and even though the propulsion system cost might increase by 30 percent, the gains in mission flexibility, survivability, smokelessness, and overall system performance will result in much greater weapon system effectiveness. Increases in system effectiveness will more than offset increases in propulsion cost.

A New Effort

A new R&D effort in smart propulsion is required. Such an effort will examine not only thixotropic gels, but hybrid propulsion systems and air-augmented smart propulsion systems. Hybrid propulsion systems will utilize a gelled liquid oxidizer and a solid fuel. Reverse hybrid propulsion systems will utilize a gelled liquid fuel and a solid oxidizer.

With air-augmented propulsion, extremely long range is possible since it is not necessary to carry the oxidizer onboard. Air-breathing systems scoop air from the atmosphere and supply it for the combustion process in the rocket engine.

The automobile is a useful analogy. The range of the car is limited by the amount of fuel it carries. With a 20-gallon tank filled with fuel, the range of the car is 400 miles because the gasoline engine is an air-breathing engine. If it was necessary to carry the oxidizer onboard, the 20-gallon fuel tank might contain 15 gallons of oxidizer and five gallons of gasoline. This means that the propulsion system (which is not an air-breather) would have a range of only 100 miles. Examples of air-breathing missile propulsion systems include turbojets, airturbo rockets, pulse jets, ducted rockets, air augmented hybrids, solid fuel ramjets, and air augmented bipropellant gel systems.

A Wide Range of Options

Figure 5 relates missile propulsion attributes to types of propulsion. While it is difficult to achieve all of the desired attributes in a single propulsion system, it is clear that smart missile systems of the future will require responsive and reactive propulsion with reduced or no signature, high energy, and a degree of insensitivity which enhances the survivability. Figure 5 shows that the best prospects for obtaining the technical capabilities required by the smart missile weapons of the future lie in the area of gelled liquid propulsion.

Few systems have gone through the detailed analysis required to assess the advantages of gelled systems by comparison with existing propulsion. However, this analysis has been done on the liquid-fueled LANCE missile, one of the Army's oldest missiles. This study has shown that the range of the LANCE can be more than doubled by use of a gelled bipropellant system. Several contractors have had a continuing effort in the area of gelled systems and the Army has demonstrated the successful firing of a LANCE-sized gelled bipropellant system.

Additional work is required. While the technology of bipropellant liquid rocket systems is well known and well developed, the exploitation of gels will require further technology efforts in several areas. These include gel tank systems based on modern composites, and will require engineering efforts to match the chemical compatibility of fuel and oxidizer gels to the materials of the tank, expulsion, valving, and engine requirements.

Effort is required in on-demand solid propellant or gel propellant gas generators which pressurize tanks to cause the gel to flow at the proper rate and time. Gel oxidizer and fuel materials themselves will require chemical R&D in several areas including storage stability, plume characterization, density, and rheology or flow properties.

Chemical technology in the automotive motor oil field has produced multiviscosity oils which behave as lightweight oils at low temperature, and behave as higher viscosity, thicker oils at higher temperatures. One of the principal jobs in developing smart propulsion is to apply the research and technologies of multi-viscosity oils to gelled liquids. This will provide for uniform and reproducible flow properties across the operable temperature ranges required for worldwide deployment. Ultimately, engine system, hot firing tests, and tests for insensitive munitions requirements must be performed.

Conclusion

Although additional R&D on solid propulsion systems is needed, it is clear that the emphasis in propulsion research is moving decidedly towards gelled systems. In 1991, the Army was given sole service responsibility for developing these systems for missile propulsion.

DR. WILLIAM D. STEPHENS is director of the Propulsion Directorate, Research, Development, and Engineering Center, U.S. Army Missile Command. An internationally recognized authority on catastrophic explosions and accident investigations, he holds a B.S. degree in chemistry from Western Kentucky University and a Ph.D. in chemistry from Vanderbilt University.

IMPORTANT NOTICE

The Army RD&A Bulletin office has relocated to Fort Belvoir, VA. All correspondence should now be addressed to:

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PROGRAM EXECUTIVE OFFICER — CRUISE MISSILES PROJECT AND UNMANNED AERIAL VEHICLES JOINT PROJECT

PEO-CU

RADM George F. A. Wagner

A 1962 graduate of the U.S. Naval Academy, Rear Admiral (RADM) George F. A. Wagner holds a master's degree in naval architecture and marine engineering and a naval engineer's professional degree from the Massachusetts Institute of Technology. Wagner, who is a designated surface warfare material professional officer, has served as the program executive officer for the Cruise Missiles Project and Unmanned Aerial Vehicles Joint Project (PEO-CU) since February 1991, when he was promoted to Flag rank. His previous key assignments include: director, force engineering, Space and Warfare Systems Command; director of material professional personnel policy, Office of the Deputy Chief of Naval Operations (Manpower, Personnel and Training); and program manager of the Navy Ship-Launched Tomahawk Cruise Missile Program.

Missions

PEO-CU expediously develops, acquires and supports quality cruise missiles, unmanned aerial vehicles (UAVs), and target systems with which the operating forces, in support of our unified commander and allies, can train, fight and win.

PEO-CU Guiding Principles

The following are PEO-CU Guiding Principles which assist in successfully and efficiently achieving the PEO-CU mission:

• We shall develop affordable, interoperable families of cruise missiles and UAV systems.

• We shall actively pursue use of non-developmental items and commonality to achieve the optimal trades between system ownership costs and operational performance.

• We shall continuously improve the processes to design, develop, test, produce, deploy, and support all current and future cruise missile, UAVs, and target systems.

• We shall continuously address and support the expectations of our customers in all that we do. Stakeholders in our processes are our partners.

• People are our primary assets. Our managers will lead the organization by searching out challenging opportunities to change, grow, innovate and improve. We will provide the kind of leadership that motivates employees to do their jobs in a superior way and remove barriers to increase performance.

• We operate in an honest and straight-forward way. Open communication is promoted. We interface with each other, our customers and stakeholders, with integrity.

• We are committed to being the best in all we do.

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PM, Close Range UAV	COL P. K. Tanguay, USA	Redstone Arsenal, AL (205)895-4449
PM, Very Low Cost UAV	LTC Jim McCord, USMC	Quantico, VA (703)640-2581

CRUISE MISSILES PROJECT

Photo courtesy of U.S. Navy

PENGUIN MK2 MOD7

The Penguin is the U.S. Navy helicopter-launched variant of the Norwegian missile. A short-range, inertially-guided anti-ship missile, the Penguin seeks and intercepts targets on the water surface using an infrared scanning seeker for terminal guidance. The Penguin is designed to be operated from the Light Airborne Multipurpose System MK-III SH-60B helicopter. Primary targets are escort vessels, fast patrol boats, and landing craft. However, it can also be used against other naval or merchant vessels. Designated AGM-119B for the U.S. Navy, it employs a free rolling airframe, with folding wings developed for helicopter usage.

Photo courtesy of McDonnell Douglas Corp.

STANDOFF LAND ATTACK MISSILE (SLAM)

SLAM was developed to fill a long-standing need within the U.S. and allied armed forces for a precision, man-in-the-loop, strike missile capable of land and ship attack during the day or night, or in adverse weather, and from true standoff distances. SLAM is a derivative of the Harpoon anti-ship missile. It was developed using the Harpoon airframe, propulsion, warhead and control systems, and adding a Maverick infrared seeker, Walleye data link and Global Positioning System receiver/processor to give it the standoff land attack capability.

HARPOON

The versatile Harpoon missile is a proven effective all-weather, anti-ship weapon designed for use by aircraft, ships, and submarines. Launched from standoff ranges, it provides the U.S. Navy and its allies with new dimensions in accuracy, firepower, and survivability for countering the threat of missile-launching ships and maintaining world-wide freedom of the seas. The Harpoon can be launched in a variety of launch conditions (i.e. altitudes, attitudes, airspeeds, sea states, submarine depths) and uses a low-level cruise trajectory, active radar guidance, and terminal maneuvering to effectively seek out and destroy fast-moving, maneuvering vessels—even at ranges in excess of 50 nautical miles.

Photo courtesy of McDonnell Douglas Corp.

Official U.S. Navy photo

TOMAHAWK

The Tomahawk family of cruise missiles is comprised of low-flying missiles designed to perform a variety of ship and land attack missions. Armed with either a conventional or nuclear warhead, the missile can be launched from surface ships and submarines. It is designed to fly at extremely low altitudes at high subsonic speeds, and is piloted over an evasive route by either of two mission tailored guidance systems. In any weather, day or night, Tomahawk can fly up to 1,350 nautical miles to deliver its payload with incredible accuracy. During Desert Storm, 288 Tomahawks were launched against enemy facilities and approximately 85 percent arrived on target.

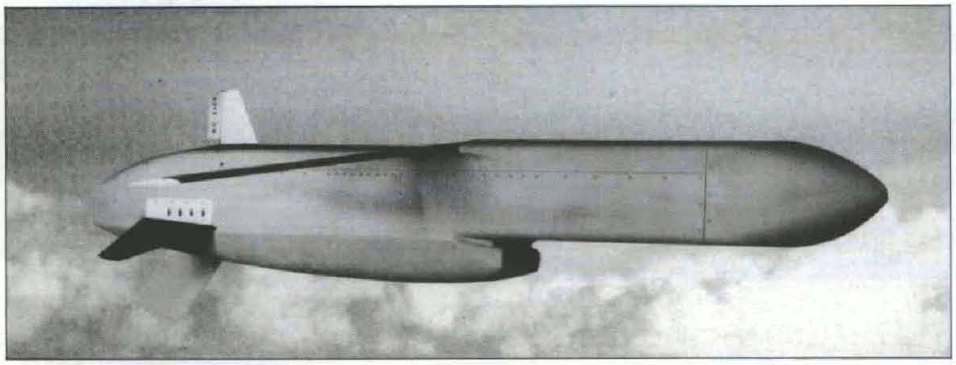


Photo Courtesy of Brunswick Defense Corp.

TACTICAL AIR LAUNCHED DECOY (TALD)/IMPROVED TALD (ITALD)

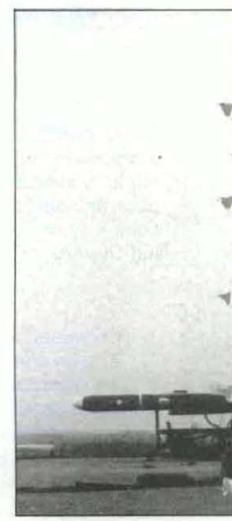
During Desert Storm, 137 TALDs were launched by both Navy and Marine Corps aircraft. The decoys were used in a Suppression of Enemy Air Defense (SEAD) role to aid in the destruction of the enemy integrated air defense system. TALDs used a combination of preprogrammed maneuvers and radar enhancements to simulate attacking aircraft. TALD excitation of defense radars allowed pinpointing of their location and increased their vulnerability to High Velocity Anti-Radiation Missiles (HARM). TALD also confused and deceived enemy radar operators by mimicking the attack force which resulted in launches of Surface to Air Missiles (SAMs) at the decoys rather than the actual attack force. ITALD (shown above) will add a great deal of simulation fidelity which will be more effective against longer range, more sophisticated air defenses.

SHORT RANGE (

The SR system is the developmental baseline for the fam
sance, surveillance and target acquisition capabilities
Corps expeditionary brigades put to 150 km beyond the
conditions. SR is intended for use in environments where
aircraft are unavailable, or excessive risk or other conditi
The SR acquisition strategy ensures interoperability and
evaluation of an initial baseline configuration, followed by
ments. The SR system takes maximum advantage of ex

CLOSE RANGE (CR) SYSTEM

The CR acquisition strategy is to procure a cost effective system consisting of integrated off-the-shelf technologies with a high degree of interoperability and commonality with the Short Range (SR) system, as the baseline for the family of UAVs. The CR system will provide near-real-time reconnaissance, surveillance and target acquisition capabilities that meet the requirements of Army and Marine Corps commanders at division and subordinate levels of command. The CR concept, system requirements, and acquisition/risk management planning have been significantly influenced by SR progress, formal studies experimentation with existing domestic and foreign systems, budget realities and lessons learned during Desert Storm.



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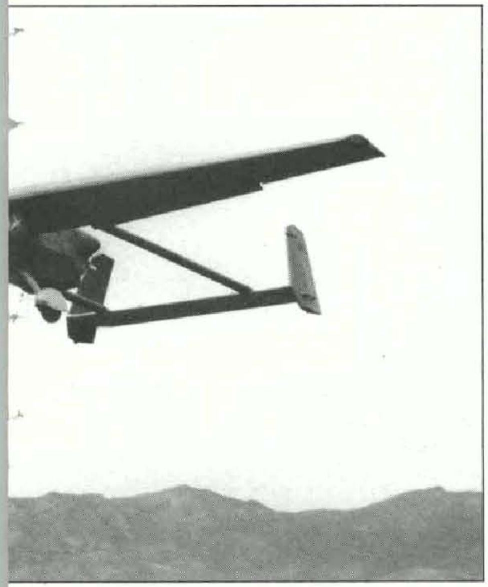

Photo Courtesy of TRW, Inc.

Photo Courtesy of AAI Corp.

PIONEER

A Pioneer system consists of at least five air vehicles, a ground control station, a portable control station, two remote receiving sets, and pneumatic or rocket-assisted launchers. A Pioneer system is transported using two five-ton trucks and two HMMWVs with trailers. Pioneer air vehicles are capable of operating for up to five hours with either day television or night forward-looking infrared sensors. Pioneer flies between 1,000 and 13,000 feet above sea level, 60–95 knots, and up to 220 km for a GCS. During Desert Storm, Pioneer UAVs flew over 300 missions. Only one air vehicle was shot down, and three others were hit by ground fire during combat missions. The phenomenal success of Pioneer in supporting combat operations and providing the battlefield commander critical intelligence information has shown the capabilities of UAVs within the battleforce structure. The first surrender of enemy troops to a UAV took place on Faylaka Island, located just off the coast of Kuwait City.

;R) SYSTEM

y of UAVs. SR will provide near-real-time reconnais- Army echelons above corps, divisions and Marine FLOT, day or night and in limited adverse weather nmediate information feedback is needed, manned ns render use of manned aircraft less than prudent. naximizes commonality, including the fielding and block upgrades to meet the full operational require- sting off-the-shelf technologies.

Photo Courtesy of Northrop Corp.

BQM-74 TARGET

ible, subsonic target capable of speeds up to mach to 40,000 feet. It is used for weapon system test and and mobile sea range operations.

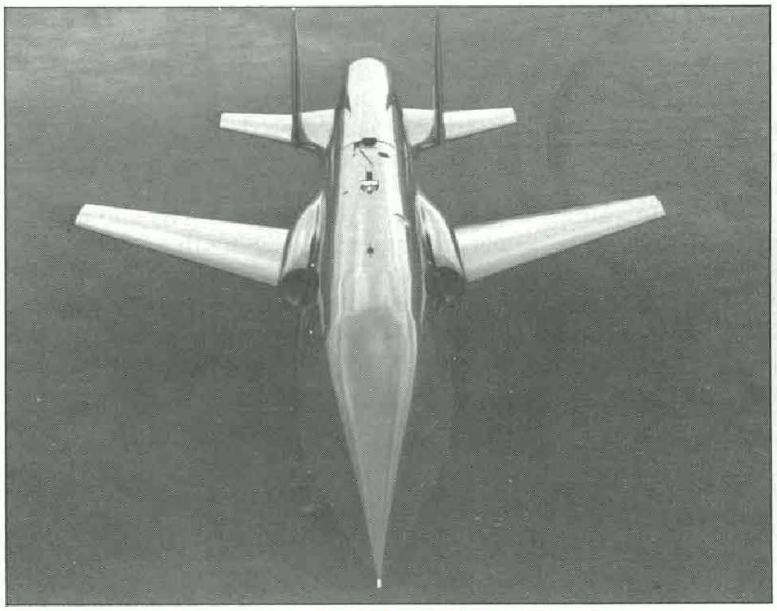

Photo Courtesy of Teledyne Ryan Aeronautical

MEDIUM RANGE UAV (MR UAV)

The MR UAV, designated BQM-145A, is being developed to perform Navy, Marine Corps and Air Force reconnaissance missions in the late 1990s and beyond. A complementary asset to manned tactical reconnaissance, it will provide a quick response capability to obtain high quality imagery in high threat environments. The system provides multi-function support to the C^3I operations of Carrier Battle Groups, Marine Air Ground Task Forces, and Tactical Air Force units, with target acquisition (pre-and post-strike) and battle damage assessment being two of its primary missions. The MR UAV will be tasked to collect imagery data on fixed targets/locations at ranges up to 350 nautical miles from launch point.

NATURAL GAS: AFFORDABLE FUEL FOR OPERATION AND SUPPORT

By Asad Asadi

Worldwide geopolitical and environmental changes entwined with diminishing natural resources were the realities that greeted us right at the entrance to this decade. Driven by economics and the quest for clean air, politicians on the national and local level are encouraging the use of alternative vehicle fuels to help lower emissions and reduce American dependence on imported petroleum.

A year ago, the Army's senior leaders endorsed and enunciated the ongoing Operating and Support Cost Reduction (OSCR) Program and recognized it as a way to save money while maintaining readiness. In the Army today, one of the Generic Cost Drivers (GCD) for Operating and Support (O&S) is fuel and its distribution.

The purpose of this article is to provide some information and justification that will support Army-wide proposals to initiate retrofit technology-based activities or research in the area of conversion and/or utilization of vehicles to run on only natural gas (NG) (dedicated), gasoline or NG at the flip of a switch (bi-fuel), or on diesel and NG simultaneously (dual-fuel).

In order to meet the future energy needs of the Army's day-to-day operations and *peacetime training purposes*, feasibility studies or pilot programs for wider usage of NG should get underway. It is obvious that a definitive commitment to OSCR will entrust NG in becoming the most affordable fuel, both in growth and importance.

In order to meet the future energy needs of the Army's day-to-day operations and peacetime training purposes, feasibility studies or pilot programs for wider usage of natural gas should get underway.

Availability

According to the Society of Automotive Engineers (SAE), NG is becoming recognized by far as the cleanest, lowest cost, and most abundant of the alternative fuels. U.S. utilities are rapidly expanding fueling facilities and have the potential to fuel millions of vehicles. Based on a 1982 American Gas Association (AGA) study, the conventional economically recoverable world NG resource is 9,439 trillion cubic feet, which is nearly a 200-year supply at today's consumption rate.

In a 1989 report of the Potential Gas Committee (Colorado School of Mines), the estimated total U.S. recoverable NG resources is 983 trillion cubic feet (58 times the current annual production level). Of this amount, about 739 trillion cubic feet is easily recoverable gas, enough domestic gas to adequately support the mobility and transportation energy needs of the U.S. and U.S. Army for 46 years.

Additionally, the present national NG transportation network of 1.2 million miles of underground pipeline system, which is already in place, has been essential for NG availability in all 50 states and major metropolitan areas.

From 1988, NG production has surpassed oil production in the U.S. on an energy-equivalent basis. This, in fact, contributed to establishing an infrastructure which allows more accessibility to an affordable fuel with the lowest possible cost.

Advantages

As a fuel for vehicles, Compressed Natural Gas (CNG) carries an octane rating of 130, compared to 87 to 95 for gasoline. This higher rating means the end of engine knock, longer spark plug life, up to 24,000 miles between oil changes, and instant winter start-ups, because CNG is gaseous and mixes uniformly with air. In addition, clean-burning gas is less likely to clog engines. Moreover, NG utilization will lower the maintenance cost of operating vehicles. But most importantly, the CNG is safer than gasoline because it's lighter than air and dissipates quickly when accidently released. Its ignition point of 1,200 degrees Fahrenheit is far higher than that of 600 degrees Fahrenheit for gasoline. Additionally, NG has a narrow range of flammability—in concentrations in air below about five percent and above 15 percent—NG will not burn. The limited range of flammability along with a very high ignition temperature makes accidental combustion of NG less likely than gasoline.

Examination of the key factors governing engine emissions, including chemical composition of the fuel, homogeneity of the air/fuel mixture, and ignition timing has revealed that the primary advantage of gaseous fuels comes from their availability to better mix with air. This has enhanced the availability of oxygen and its binding with carbon, favoring the bi-product of CO^2 over CO.

Also, because NG is carbon poor compared to gasoline, it produces about one third less CO^2. The superior mixing of NG with air also lowers emissions of unburned hydrocarbons (HC) because combustion is more complete, compared with gasoline. As a result, total HC emissions can be reduced 35 to 50 percent. Moreover, the remaining HC emissions are largely non-reactive, rather than reactive, which would help to reduce smog.

Conversion

As stated earlier, in order to use NG as an affordable transportation fuel for the Army's vehicles, the retrofit programs and conversion to dedicated, bi-fuel, and dual-fuel options should get underway. For application of these conversions, some basic design changes may be required. Additional changes could become necessary to allow retrofiting of the steel or aluminum tanks/cylinders that store the CNG. Usually the tanks/cylinders can be located in the bed of a truck, in the trunk of a car, or on the top of a vehicle. Tests have shown that CNG fuel tanks/cylinders are far safer and more durable than conventional gasoline tanks.

According to the Society of Automotive Engineers, natural gas is becoming recognized by far as the cleanest, lowest cost, and most abundant of the alternative fuels.

The travel range of each vehicle should be considered as one of the main parameters in determining the number of tanks fitted onto the vehicle. Other functional restraints such as weight, size, and safety may also be inhibiting factors during the retrofiting process. But generally for passenger cars, jeeps, and light trucks, two typical NG cylinders will provide the equivalent of 10 gallons of gasoline.

Heavy trucks and other large vehicles can be equipped with more (or larger) cylinders/tanks to provide up to a 400-mile range. The fact of the matter is that with the available current technology, we can convert many machineries to run on NG, even a lawn tractor or fork lift. For most of the conversion tasks, retrofit kits which contribute negligible weight, take up little space, and require very short installation time are marketed by over 20 privately-owned companies.

For the Army's OSCR Program, initially we should convert the vehicles that require the minimum time for retrofit and have the potential for quick payback. But for the vehicles that require fundamental redesign or modification, the conversion process should become a long-term project.

The commitment to convert the Army's diesel engines should get underway in the very near future, although it may require further study and analysis. However, if engineered and retrofit correctly, diesel engines are ideally suited for NG use in a broad range of applications. Besides, NG fuel operates at a high compression which is common to contemporary diesel engines.

The fact of the matter is that unlike gasoline engines, where the fuel is ignited by a spark plug, diesel engines ignite fuel by compressing it without a spark. Because of this difference, greater modifications are required to accommodate NG in diesel engines. Current dual-fuel diesel engines run on a mixture of 20 percent diesel fuel and 80 percent NG.

From an environmental quality standpoint, the benefit of converting a single diesel truck is twice as much as a single gasoline truck or van. Also among all vehicles, heavy duty diesel engines, though relatively small in number, account for a disproportionately large percentage of vehicular emission. By 1994, all new vehicles must meet the EPA emission standards promulgated in 1987. Therefore, conversion to dual-fuel diesel engines will be a sensible cost savings and a sound environmental approach to take.

Finally, under the OSCR Program, the NG utilization and conversion should be considered as an investment that can lead to a significant return. When it comes to giving genuine and unequivocal support to find an alternative fuel, NG is the answer, and the U.S. Army should lead the way for the rest of the nation.

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CECOM WORKS TO ELIMINATE 'NOT SO FRIENDLY' FIRE

Providing Better Combat Identification and Situational Awareness on the Battlefield

By Mark Coyne

Introduction

In an Aug. 13, 1991 news conference, Department of Defense officials announced that during the Persian Gulf War 35 Americans were killed and 72 wounded by "friendly fire."

In response to this information, elements of the Army Communications-Electronics Command (CECOM) have been tasked to help with efforts to eliminate friendly fire incidents.

As part of the overall Army task force on combat identification led by the Army's Training and Doctrine Command, CECOM's Electronic Warfare/Reconnaissance, Surveillance and Target Acquisition (EW/RSTA) Directorate at Fort Monmouth, NJ, and CECOM's Night Vision and Electro-Optics (NVEO) Directorate at Fort Belvoir, VA, have increased their efforts aimed at preventing such battlefield casualties.

CECOM is making efforts to eliminate "friendly fire" by developing a capability to differentiate electronically between friend and foe and by providing better situational awareness on the battlefield. CECOM's efforts, and those of the rest of the Army Materiel Command and other services, to find solutions to the problem, are coordinated by the U.S. Army Laboratory Command (LABCOM) in Adelphi, MD.

Eugene Famolari Jr., director of the EW/RSTA Directorate said, "During the war, we did not lose a single helicopter to enemy air defense actions. A lot of missiles were fired at our helicopters, but the self-protection gadgetry worked one hundred percent—nothing ever hit. The missiles aimed at our helicopters were electronically deflected and fell to the ground missing the aircraft. That same sort of self-protection technology is being adapted for tanks and for ground units. We're starting that process."

Quick Fixes

According to Willie Johnson, chief of the EW/RSTA Directorate's Combat Identification Division, "When incidents of fratricide occurred in Operation Desert Storm, a great deal of activity took place quickly to obtain quick reaction solutions. A number of solutions were provided to the troops."

These solutions included: The BUDD Light, which was developed by and named after Budd Croley of the NVEO Directorate, and which can be seen at night with night vision goggles; the DARPA Light, developed by the Defense Advanced Research Projects Agency, and which is similar in concept to the BUDD Light; and tape which can be detected by thermal night vision devices.

According to Famolari, CECOM officials are continuing to work on identification processes and, are now looking for more sophisticated and reliable means of combat identification, particularly for ground forces.

"We look at both electronic warfare self-protection technology and combat identification technology as two complementary approaches to solving the same combat problem for both air and ground warfare. Fratricide is part of that basic problem. To defeat an incoming missile, you must recognize that you are being looked at or shot at and then employ countermeasures to defeat the weapon. During this recognition process, electronic signals could be exchanged to determine if you are friendly and if so, to call off the engagement before the weapon is fired and before using countermeasures," Famolari said.

Famolari noted that there is very effective electronic self-protection in aircraft today because the threat was recognized 20 years ago.

"However, our ground forces have defended themselves very well and up until recently, the requirement to protect our tanks with electronics in the same way we protect our aircraft was not recognized," Famolari said.

The new requirements apply to both self-protection and combat identification equipment. As the Gulf War progressed, the need to protect our ground forces became a more obvious priority.

"We have developed some concepts already, have experimented with them, and some of them are on their way to production. Self-protection devices for ground equipment work the same way as the protection on the aircraft," said Famolari.

"If someone shoots at one of our tanks, the missile is electronically defeated and goes into the ground. At the simplest level, it's a sophisticated 'Fuzz Buster' warning you that you are being looked at by a radar or laser. There are more complex versions of onboard equipment designed to defeat the attacking weapon or target acquisition device by electronically confusing it," added Famolari.

"When incidents of fratricide occurred in Operation Desert Storm, a great deal of activity took place quickly to obtain quick reaction solutions. A number of solutions were provided to the troops."

Two Approaches

According to Willie Johnson, chief of the EW/RSTA Directorate's Combat Identification Division, there are two approaches to combat identification—cooperative and non-cooperative.

"The more mature approach is the cooperative technology better known as Identification Friend or Foe, or just IFF. In this approach, an electronic question is signaled to an aircraft or vehicle. A transponder on the vehicle would then answer saying, in effect, 'I'm here, I'm friendly. Don't shoot.' For instance, the cooperative Mark XII IFF system has already been fielded for aircraft identification," Johnson explained.

Johnson noted that the other approach, non-cooperative, does not require equipment on the aircraft or ground vehicle to respond.

"Instead, energy emitted by the target is collected by a sensor, such as a radar, and then processed to extract specific characteristics of the target. Depending on the sensor, the received energy is modulated by the target to produce a unique signature which provides a more positive identification," said Johnson.

According to Famolari, one problem with IFF is that each time a target is interrogated, it is required to signal back and those signals can be detected by the enemy, as well as allies.

Protecting Ground Forces

"When you consider ground IFF, the guy sitting in the tank has to ask the question of any such IFF gadget. 'Does it enhance my survivability or does it endanger me? If I put something on my tank that identifies me as a friendly, I am also putting something up that lets an enemy see me and I'm making myself a more obvious target.' The trade-off is that, at the point when you are being engaged by your own smart weapon, the likelihood of your being killed is very high if you don't announce your presence," Famolari said.

Johnson added, "There was a lot of discussion in the media about the kinds of things employed in Operation Desert Storm to avoid the friendly fire casualties. CECOM participated in the early evaluation of the things we used during Operation Desert Storm, and we are continuing our testing and evaluation of those devices."

Planning Ahead

Johnson added that efforts are continuing with industry to develop cooperative types of equipment.

"Some of the concerns of cooperative systems may be overcome if we develop them smartly. For example, if we can build an interrogation mode into a laser rangefinder which is already used in the engagement process, we will probably not add to either killer or target vehicle vulnerability," said Johnson.

According to Johnson, there is a plan to evolve from a cooperative to the preferred non-cooperative approach.

"The technology has matured for air-to-air and ground-to-air roles and we're looking to build on our experience for these future developments where possible. The other key element of the friendly fire problem, good situation awareness, includes technology being developed by a number of other CECOM activities. These improvements include IFF systems, enhanced optics and the use of global positioning satellite receivers by ground forces," Johnson explained.

Johnson emphasized that the capability being developed will allow friendly forces to know where they are on the battlefield at all times.

"Being in the wrong place was a serious problem in the featureless terrain of the Gulf War battlefield," Johnson concluded.

MARK COYNE is a public affairs specialist in CECOM's Public Affairs Office. He has a B.A. degree in journalism from Temple University.

Army NCOs...

IS THE ACQUISITION COMMUNITY MISSING ITS BACKBONE?

By Arthur A. Scharein and CPT Larry S. Phillips

Most acquisition programs are managed by brigadier generals serving as program executive officers (PEO), by colonels in project manager (PM) positions, or by lieutenant colonels serving as product managers. Those programs not managed by active duty Army officers are managed by senior Department of the Army civilians. Although this management structure works reasonably well, there is one missing element which, if added, would make it even better—senior non-commissioned officers (NCOs). Why are no senior NCOs involved in managing the Army's materiel acquisition process?

The Army puts great faith, trust and responsibility in its NCO corps—except in the materiel acquisition arena. NCOs are found at all levels of command, ranging from first sergeant of a unit to sergeant major of the Army. In short, the Army values the expertise and advice of its NCOs.

Senior NCOs could play an important role in advising and assisting PMs. In addition, Training and Doctrine Command (TRADOC) system managers (TSM)—the TRADOC counterpart to a PM—could also be assisted by senior NCOs.

Why is it important that NCOs be involved in the materiel acquisition process? It is important because most of the equipment fielded by the Army is operated, maintained, and supported by NCOs and other enlisted personnel. Sure, officers are responsible for their units and equipment, but NCOs do the work. In fact, the NCO corps is often referred to as the backbone of the Army. Without their dedication, the Army would not function. The NCO is responsible for conducting training and, since the Army spends a great deal of time training, who is better qualified to provide advice on training devices and equipment?

In managing their systems, PMs must focus on cost, performance, schedule, and supportability. Commanders, much like PMs, must also focus on specific factors to maintain a high state of readiness. The difference, however, is that commanders often have the assistance of a senior NCO.

Even though a PM may be well versed in acquisition management, he may have had little exposure to troop units and troop unit assignments. Thus, his knowledge of the user's true needs relative to the equipment he is developing is limited.

The key link missing in the whole acquisition process is the conscience of the Army—the advice of a senior NCO. What qualities and attributes does a senior NCO contribute to the process? First, he normally has had extensive troop level assignments. He has 12 or more progressive years of increasing responsibility for troops, training, tactics, and equipment. He has a clear understanding of the deficiencies and training constraints new equipment is supposed to overcome. He fully comprehends the equipment maintenance and logistics impact on readiness and has kept equipment running long enough to complete a mission.

Today's NCO is increasingly well-educated—many have associate or other college degrees. Many senior

The key link missing in the whole acquisition process is the conscience of the Army— the advice of a senior NCO.

NCOs also have the technical training required to stay proficient in various Military Occupational Specialties (MOSs). Furthermore, it is less likely an NCO will lose sight of all the implied functions that must be performed to complete a unit's mission. These include "little things" such as communication; maintenance and resupply; load plans; personnel rotation; nuclear, biological, and chemical operations and other field tasks which are often ignored when focusing only on the primary piece of equipment.

As stated earlier, NCOs are in charge of conducting training. While officers plan for training time and assets, the NCO ensures that personnel in the unit can perform to standard. What individual can better define the types of training to be replicated, embedded, or simulated? In addition, the NCO knows the capabilities of the target MOS and is best able to define the "5th to 95th percentile" soldier.

Most NCOs also have an excellent understanding of what types of user tests should be conducted and how rigorous they should be. Many acquisition problems result from testing the wrong things at the wrong time and often against the wrong standard. This wastes time, dollars and personnel resources.

Since NCOs have served in a variety of geographic areas and climatic conditions, they can best advise when a particular design or function is unacceptable and what trade-offs are feasible.

Engineers and acquisition managers often cannot anticipate how equipment will perform in the field. The NCO has been there. He knows.

We propose that each PEO, PM, and TSM, as well as each laboratory and research development and engineering center, have a sergeant major assigned to provide advice and recommendations. Selected product managers could also have a sergeant major or master sergeant assigned if needed. In addition, each NCO should be required to submit input as part of the program documentation for major reviews.

NCOs would provide comments on equipment size, weight and complexity; training and training devices; human factors; and maintenance and logistics concerns. This would ensure that soldier issues are addressed during the design trade-off process.

To insure the senior NCOs have a strong voice in a program, but is not a PM's puppet, we suggest that the PM not rate the NCO on efficiency reports. He should be rated by other senior NCOs in the acquisition chain, with a senior rater in the Army acquisition executive's office, or the TRADOC commander's office, as appropriate. A similar procedure is used by Judge Advocate General (JAG) defense attorneys.

This rating process will ensure the ability of the NCO to surface important issues that PMs or contractors might otherwise gloss over in an effort to meet major milestones. A separate NCO acquisition corps is not necessary. In fact, what best qualifies an individual for his role in acquisition is extensive experience in his primary MOS. However, a four-to six-week acquisition introduction course should be required prior to being assigned to an acquisition position. This course would introduce the NCO to the vocabulary, organizations, and process of Army acquisition. The course would be based on curriculum from the Materiel Acquisition Management, Combat Development, and PM courses.

Conclusion

If NCOs are valuable in units, and we doubt anyone would argue to the contrary, then why not assign them to development programs? Since NCOs are the primary users of most of the Army's equipment, then they should be involved in all phases of the materiel acquisition process, from concepts to fielding and support. With the addition of experienced NCOs to the acquisition team, we can produce better, usable equipment to maintain the technological edge we require.

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IMPORTANT NOTICE

The Army RD&A Bulletin office has relocated to Fort Belvoir, VA. All correspondence should now be addressed to:

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Our new phone numbers are (703) 805-4215/6 or DSN 655-4215/6. Fax numbers are (703) 805-4044 or DSN 655-4044.

THE ARO IR&D DATABASE

By David Seitz

Introduction

The Army Research Office (ARO) has, over the past several years, created and maintained a database on industry's Independent Research and Development (IR&D) program in an effort to assist Army technology managers in their allocation of increasingly scarce Army RDT&E funds, leveraging those funds, and avoiding duplication of effort. The database can be run on any IBM compatible, desk-top computer utilizing dBase III Plus software, and currently contains over 6,200 individual project records from more than 250 corporate profit centers.

Independent Research and Development projects, totalling about five billion dollars, are performed each year by major Department of Defense contractors utilizing company controlled funds. Corporate IR&D programs are planned and performed independently by companies to maintain and improve technical competence or to develop new or improved products. The Army's "share" in the cost of this program is approximately $350 million and is derived from overhead charges on procurement contracts.

Overhead charges on other DOD and other government contracts, as well as corporate profits, make up the balance of the funding. Although the Army's share of the overall cost is small, its return on investment, or leverage, is very high. More than three billion dollars worth of the projects are of potential interest to the Army and are included in the ARO database.

Projects conducted under IR&D fall into four categories: Basic Research (B), Applied Research (A), Development (D) and System Studies (S) (see Figure 1). These categories cover work that would be considered 6.1–6.3b if conducted under the Army's RDT&E Program. It is this parallelism with the RDT&E program which generated the interest in creating the database and its single most important feature; namely, the taxonomy on which it is based.

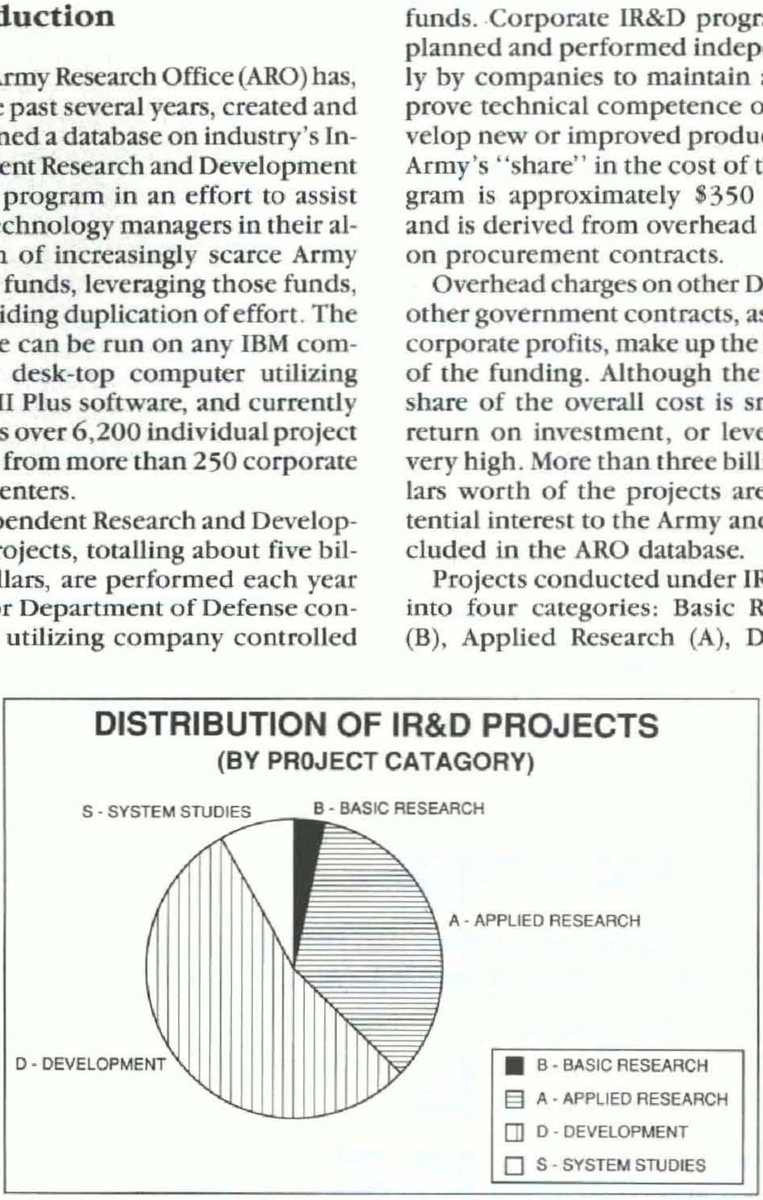


Figure 1.

Taxonomy

The taxonomy, known as the ARO Technology Base Descriptors, links the scientific and technological efforts performed under the IR&D program to the mission and function requirements of the Army in the eight following generic areas: 100 Logistics and Computer Technology; 200 Mobility; 300 Vulnerability Reduction/Survivability; 400 Nuclear, Biological, Chemical Protection; 500 Target Acquisition; 600 Lethality; 700 C^3I and ECM/ECCM; and 800 Space.

Within each of the eight areas there are as many as four levels of detail corresponding to a five digit numbering system. For example, within the 100 area (Logistics and Computer Technology), the 130 area (Materials Technology is broken down as follows:

130.00 MATERIALS TECHNOLOGY
- 131.00 Structural
  - 131.10 Composites
    - 131.11 Polymer Matrix Composites
    - 131.12 Ceramic Matrix Composites
    - 131.13 Metal Matrix Composites
    - 131.14 Carbon-Carbon Composites

131.15 Fiber Materials
131.20 Ceramics
131.30 Metals
131.40 Elastomers/Polymers
131.50 Adhesives
132.00 Structural Mechanics/ Design
133.00 Lubricants
134.00 Coatings, Preservatives, Corrosion

Thus, projects related to fiber materials for composites used in structural applications in materials technology can be located in the 131.15 area. By placing both industrial and Army projects into the same "bin," they can be compared from company to company, lab to lab, and lab to company.

Database Construction

There is a senior level technologist at ARO responsible for each of the eight generic technology areas listed above. That individual is responsible for the review of all IR&D projects falling within the area, and for the data on each project entered in the database. As the IR&D Technology Plans are received from industry, each project is sent to the appropriate technologist for review. If the project is deemed to be of interest to the Army community, the following information is entered directly from the project summary sheets into dBase III Plus records: the performing company/ division, the project title and number, the funding, and the category (B,A,D or S).

In addition to the above information, the reviewer will then supply the ARO "value added" items to the project record. The single most important step in this process is the assignment of up to three ARO Descriptors from the taxonomy to the project. This step assigns the project to as narrow an area of Army interest as possible because this is a key feature by which the database can be searched.

Other value added information provided for each record by the reviewer includes an Army relevant list of key words; the Army labs and centers which may have an interest in the project; and any of the DOD critical technologies or Army emerging technologies which the project addresses. Any of these fields may be searched, listed, summed, etc., using the dBase III software.

ARO has also utilized the same taxonomy to characterize each work package contained in the Army RDT&E database produced by AMC, and a field has been added to each of the 837 records containing the most appropriate ARO Descriptor. By utilizing the ARO Descriptors, it is now possible to search both databases and compare "apples with apples" when viewing the results.

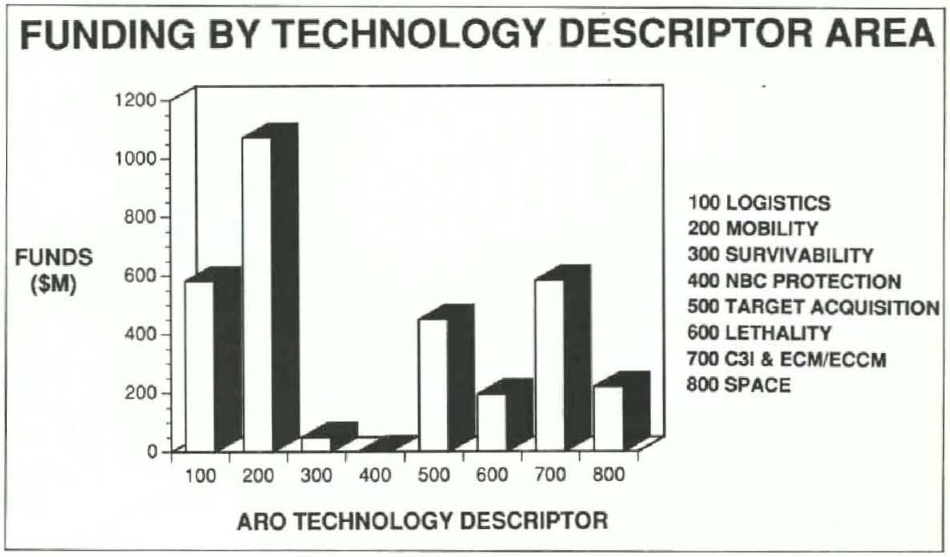


Figure 2.

Utilizing The Database

Utilization of the database requires an IBM compatible computer with a hard drive, dBase III Plus installed and approximately two megabytes of memory available. Experience in using the dBase program is desirable but not absolutely necessary; most searches can readily be performed utilizing the user-friendly, menu-driven features of dBase III Plus.

The information in the database can be searched in many different ways, but perhaps the most common is to search one or more ARO Technology Descriptor areas to review all IR&D projects within an area of interest. Keyword searches can also be performed on both the title and/or the keyword sections of the database and searches for projects addressing any of the DOD critical technologies or the Army's emerging technologies can be performed.

It is also possible to search for all projects being performed by any of the IR&D companies. In each of the examples mentioned, it would also be possible to limit the scope of the search to any combination of the four categories of IR&D projects or to sum the funds associated with the results of each search.

Figure 2 illustrates the type of information that can be derived from the database. In this graph, the total Army relevant IR&D funding is shown for each of the eight ARO descriptor areas.

Summary

In creating the IR&D database, ARO has produced a powerful tool with which Army RDT&E managers can search for leveraging opportunities with industry and avoid any unnecessary duplication of effort between the RDT&E and IR&D programs. The creation and utilization of a common taxonomy between the two is the single most important factor in providing this capability. The database has received wide distribution within both AMC and TRADOC, with an ARO staff member usually traveling to the recipient's location to install and demonstrate the database's capabilities.

For further information about the ARO IR&D Database, please contact David Seitz or Dr. Roy Roth at DSN 832-4207 or commercial (919) 549-4346.

DAVID SEITZ is a member of the Technology Integration Office at the Army Research Office. He holds bachelor's degree in chemistry from the University of Georgia and previously spent 19 years at the Army's Materials Technology Laboratory.

THE WHEEL OF QUALITY

By LTC Kenneth H. Rose

It has been said that one picture is worth a thousand words. Considering that, the intent of "The Wheel of Quality" is to capture and display the essence of Total Quality Management in a single graphic image.

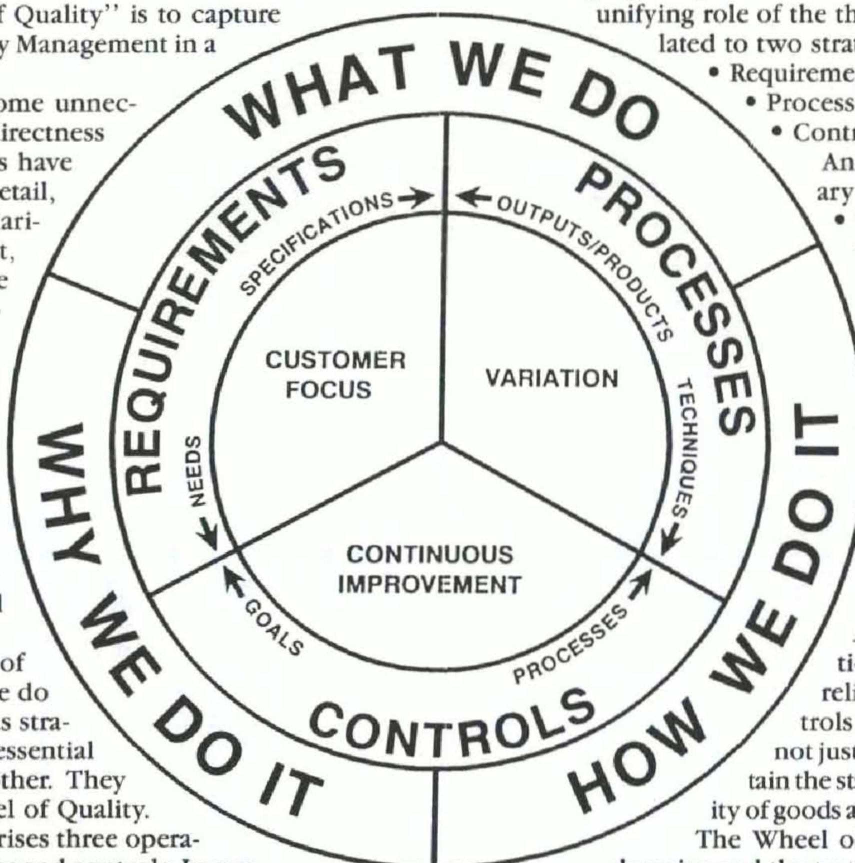
Total Quality Management has become unnecessarily complex. The simplicity and directness of Deming and other quality pioneers have been smothered in an avalanche of detail, all in the name of explanation and clarification. The danger is that, as a result, we will wind up doing exactly what we set out not to—that we will become so enamored with the means that we lose sight of the desired end. The goal is quality; everything else is just a milestone along the way.

What follows does not pretend to be "the real truth." It has been distilled from a variety of sources and abstracted into its present form. It it makes only arguable sense, it may generate some healthy discussion that will provide further illumination.

At the top level, quality is a function of what we do, how we do it and why we do it. These three issues may be viewed as strategic in nature. They are universal, essential and only indirectly related to each other. They constitute the outer ring of The Wheel of Quality.

The middle ring of the wheel comprises three operational domains: requirements, processes and controls. In contract to the strategic issues, each of these domains is directly related to the others. Each exists as a bidirectional vector whose end points are the boundary with another domain.

Requirements may range from generally stated needs to defined item specifications. Processes may be viewed with a concern ranging from the outputs and products of the process to the techniques of the process, be it manufacturing or administrative. Controls may be applied from a process level to a goal level—a micro-to-macro range.



The merging of operational domains, one with the other, reveals the unifying role of the three strategic issues. Each domain is related to two strategic issues—

- Requirements: What we do; Why we do it.
- Processes: What we do; How we do it.
- Controls: How we do it; Why we do it.

And each strategic issue spans the boundary between two domains—

- What we do: Requirements; Processes.
- How we do it: Processes; Controls.
- Why we do it: Requirements; Controls.

Finally, the inner ring of the wheel consists of three tactical building blocks of quality, one for each domain. Customer focus is the foundation for requirements. Without a solid customer focus, requirements are irrelevant except as self-justification. Variation is the central element of processes. The real world does not exist in discrete, predetermined states. Any process that does not address variation up front and always will not produce reliable results. The sole purpose of controls is to insure continuous improvement—not just to meet specifications and not to maintain the status quo, but to improve forever the quality of goods and services produced by an organization.

The Wheel of Quality. Strategic issues, operational domains and the tactical building blocks of customer focus, variations, and continuous improvement. It's just that simple.

LTC KENNETH H. ROSE is attached to the Office of the Deputy Commanding General for Research, Development and Acquisition, HQ, Army Materiel Command. He is a single-track R&D officer and a member of the Army Acquisition Corps.

TARDEC GETS ROBOT VEHICLE CONTROL SYSTEM

By George Taylor

The U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI, now has an experimental robot control system that will allow engineers to test and demonstrate new technologies for single- and multiple-vehicle control.

Referred to as the Robotic Command Center (RCC), the system was completed for TARDEC last October by FMC Corporation under terms of a contract awarded to the firm in 1987 for design and development of the system.

Before coming to TARDEC, the RCC underwent extensive contractor tests at Camp Roberts, CA, and at FMC. The system was then shipped to the Army's Aberdeen Proving Ground, MD. There it demonstrated multiple-vehicle control with robot vehicles provided by TARDEC and the U.S. Army Laboratory Command (LABCOM) as part of the first of two scheduled unmanned ground vehicle demonstrations for the Office of the Secretary of Defense (OSD).

The RCC will help TARDEC robotics engineers develop and evaluate advanced robotic concepts for use in vehicles that may someday enhance troop survivability by performing such high-risk battlefield missions as tactical and chemical reconnaissance and mine clearing. This research is part of a DOD-wide robotics program that also includes the Defense Advanced Research Projects Agency (DARPA), LABCOM, and the U.S. Army Missile Command.

The RCC will also be a major contributor to an OSD-sponsored Advanced Vehicle Technologies Program, whose aim is to find ways of reducing combat vehicle crew size.

Gerald R. Lane, who heads TARDEC's Robotics Office, said engineers will first use the RCC in performance tests with two robotized HMMWVs (High-Mobility Multipurpose Wheeled Vehicles) to measure the system's robotic capabilities. The HMMWVs use the

"The arrival of the RCC for us means the beginning of an evolutionary process leading to intelligent and autonomous mobility for both unmanned ground vehicle and advanced vehicle technology research."

same power train as their standard counterparts, but they have a computerized control system and radio and video communications equipment that allow an operator to control them and monitor their progress from a remote station.

Lane said the performance tests will take place at TARDEC and include remote operation of the robots on the facility's tank test track and in an off-road area. He added that when these tests have been completed, the RCC will then be used in a DARPA-sponsored cooperative research venture between TARDEC and the University of Michigan to evaluate existing and emerging unmanned vehicle technologies. These technologies include computer-aided remote driving (CARD), autonomous road following, a panoramic vision system, touch-panel controls, multiple vehicle route planning, and common communication protocols.

"The arrival of the RCC for us means the beginning of an evolutionary process leading to intelligent and autonomous mobility for both unmanned ground vehicle and advanced vehicle technology research," said Lane. "We will be sharing the RCC with the University of Michigan over the next three years. During that time, it will serve as an evolutionary testbed whose capability will be upgraded continually as new technology evolves. The results of this effort will be demonstrated at the Office of the Secretary of Defense Demo II, scheduled to take place at Fort Hood, TX in 1995."

The RCC consists of a module mounted on the chassis of an XM975 ROLAND vehicle. This is an M109-series howitzer chassis that was modified during the late 1970s for use as a tracked carrier for the German- and French-developed ROLAND surface-to-air missile system.

The module is 15.4 feet long, 9.6 feet wide and 6.1 feet high, and carries a three-man crew—a commander and two robot operators. An additional crew member drives the RCC.

Each station includes control panels and a yoke that enable the operator to start, stop and steer the robot vehicles. There are also three large TV monitors. The center monitor provides him with stereo vision ahead of the robots he is controlling, and the two side monitors provide peripheral vision. An additional three mini-monitors are used to monitor the performance of a second robot under supervisory autonomous control.

The RCC has onboard two-way radio communications equipment to control the robots, an intercom for the module crew and vehicle driver, and a diesel auxiliary power unit to run the module systems.

The driver's stations permit each operator to control two robots simultaneously. The commander's station has all the capabilities of the driver's stations, along with digital terrain maps and other equipment, to allow the commander to perform route planning.

According to TARDEC project engineer Bruce E. Brendle, the RCC has a high degree of flexibility that allows it to control different robotic vehicles with a minimum of modifications. "It is this flexibility," he said, "that will make it possible to continually upgrade the RCC to keep pace with advances in robotic technologies so that we can evaluate them for potential military use."

Brendle discussed some of the RCC features that give it its versatility. For one thing, he said the RCC uses a communication format referred to as Common Communication Protocols, or CCPs. The CCPs were developed by TARDEC with industry and government support, to provide a common format for communicating between robot vehicles and control stations. By using the CCPs, the RCC is able to interface with robotic vehicles developed by other agencies also using the CCPs, saving time and money.

He said the RCC has two types of robotic vehicle communication links. It currently uses a combination of microwave and VHF radio frequency links, and has provisions for adding a fiber optic link later. He said the microwave link is being used to transmit video images from cameras and sensors aboard the robot vehicles to the RCC. The VHF link carries robot command and control signals to the robot vehicles and vehicle status information from the vehicles back to the RCC.

"Each type of communication link has advantages and disadvantages," Brendle explained. "The microwave system has the capacity to transmit 20 video signals at the same time. However, due to the high operating frequencies, the transmitting antenna on a robot vehicle and the receiving antenna on the RCC must be in line of sight.

"A VHF link reduces the line-of-sight problem by using a lower operating frequency," he continued, "but is not suitable for sending multiple video images. We use this link for commands and status. A fiber-optic link would be able to handle both the video and control information, and eliminate the line-of-sight problem. But then there would be a fiber-optic cable dragging behind the robot vehicle, which can limit its mobility and survivability. And if you wanted to go a long distance, you would have to carry a lot of cable with you, which is heavy and expensive."

Brendle said that besides allowing an operator to control robot vehicles manually (referred to as teleoperation), the RCC is using CARD software developed by the Jet Propulsion Laboratory and autonomous road-following software developed by DARPA.

In CARD, stereo cameras aboard each robot vehicle produce still images of the scene ahead of the vehicle. These images are sent to the operator's display in the RCC, where they are used to construct a three-dimensional image. The operator designates where he wants a vehicle to go by moving an electronic cursor on the display to specific points in the image. The CARD software then translates this information into the appropriate control signals needed drive the vehicle to its destination.

For autonomous road-following, the images produced by the robot vehicle cameras and sensors are fed into an image processor in the RCC. The processor then analyzes the images to find the edges of the road and produces the proper driving commands needed for the vehicle to follow the road.

"These capabilities make it possible for two operators in the RCC to each put one vehicle on autonomous road-following or computer-aided remote driving while simultaneously teleoperating another," Brendle said.

Besides the DARPA-sponsored joint venture with the University of Michigan, Brendle said plans call for TARDEC to use the RCC in exercises with robot vehicles developed by other NATO countries to demonstrate interoperability.

GEORGE TAYLOR is a technical writer-editor for the U.S. Army Tank-Automotive Command. He has a bachelor's degree in journalism and a master's degree in communications from Michigan State University.

ARMY HOLDS 18TH ARMY SCIENCE CONFERENCE

"Army Key Emerging Technologies"

By Dr. Daphne Kamely
and Dr. Robert A. Fifer

Highlighting the theme "Army Key Emerging Technologies," the 18th U.S. Army Science Conference, sponsored by the assistant secretary of the Army for research, development and acquisition (ASA(RDA)), was held this past June in Kissimmee, FL. The traditional objective of this biennial conference is to provide a forum for presentation, discussion and recognition of significant accomplishments by Army scientists and engineers. This is achieved primarily through the presentation of technical papers.

This year's conference was the first to be open to the industrial and non-Army academic community, as well as foreign nationals. As a result, there were 450 registrants—roughly twice the attendance of previous Army Science Conferences. In addition, only unclassified papers were presented.

The program contained one keynote address for each of the 16 technical sessions and other special addresses by distinguished scientists, educators, and government leaders. In addition, the conference featured a major exhibition of Army technology featuring 58 booths with displays from 24 Army laboratories, centers and commands.

The conference began with a welcoming reception hosted by ASA(RDA) Stephen K. Conver. Conver noted the significance of the conference being open for the first time to the industrial and academic communities. He viewed this as an indication of the partnership that will be required to increase the efficiency of procurements during times of major decline in procurement spending. He also discussed various elements of the new acquisition strategy, such as "technology insertion" which puts new technology into existing systems rather than waiting for new systems.

Daniel Gill, director of the Army's Small and Disadvantaged Business Utilization Office, then gave a presentation highlighting progress in the Army's Historically Black Colleges and Universities/Minority Institutions (HBCU/MI) programs, and discussed the new HBCU/MI Centers of Excellence in the environment and training areas.

Dr. Edward Teller, noted physicist and director emeritus, Lawrence Livermore National Laboratory, emphasized in his keynote presentation the tremendous opportunity the DOD now has to focus on research. He highlighted the unexpectedly low cost victories achieved through high technology in Afghanistan (Stinger missiles) and the Gulf war. He proposed relatively low-cost space observation via a combination of low-flying, short lifetime satellites, and extremely light unmanned solar-powered high-flying airplanes.

Dr. George A. Keyworth of the Hudson Institute and former science advisor to President Reagan, contrasted the U.S. with the former Soviet Union, suggesting that our preoccupation with preserving versus restoring security does not promote long-term investment in new technology. He also suggested that the observation and targeting areas represent major opportunities, and proposed a system of "distributed surveillance" based on small inexpensive networked satellites.

Cherri J. Langenfield, director, Office of Technology Analysis, Department of Energy (DOE), discussed the president's "National Technical Initiative" and DOE's ideas to encourage, reward, and expedite government-industry cooperative ventures.

Dr. Donald N. Langenberg, chancellor, University of Maryland System, and former president, American Association for the Advancement of Science, discussed future revolutionary changes in the military and academic communities, and their implications for the continuing partnership between the two sectors.

Dr. Mark S. Wrighton, provost, Massachusetts Institute of Technology, emphasized the sizeable DOD investment in major research universities since World War II, and the non-military products resulting from these investments. He also outlined new DOD-related challenges for research universities.

LTG James A. Abrahamson, USAF (Ret.), executive vice-president, Hughes Aircraft Co., called for a new national technology policy to ensure defense preparedness and commercial competitiveness through government and industry support of critical dual-use technologies. He also called for new procurement and specification systems to enable the DOD to rapidly exploit low-cost technologies from the private sector.

Several presentations and discussions were devoted to the National Research Council (NRC) and the Board on Army Science and Technology (BAST) Strategic Technologies for the Army for the 21st Century (STAR-21) report. This general session was moderated by Dr. Daphne Kamely, director, research and laboratory management, Office of the ASA(RDA), who also served as chairperson and organizer of the conference.

Ninety technical papers were presented at this year's conference. They were selected from approximately 450 narrative summaries submitted for consideration by scientists and engineers from the Army Materiel Command, the Medical R&D Command, the Corps of Engineers, the Strategic Defense Command, the Army Research Institute and the U.S. Military Academy.

A select committee, called the Science Conference Review Board, chose the papers to receive awards. This review board included representatives from laboratories, RDE centers, major commands, the BAST, the Army Science Board, and the Army Research Office.

Members of the Science Conference Review Board noted that this year's selection process was difficult because of the high number of quality papers submitted for consideration.

In addition to the 90 technical papers presented, each of the 16 concurrent sessions featured a keynote address that set the tone of the session. The 16 concurrent sessions were devoted to the following topics: microelectronics, biotechnology and neurosciences, space, photonics, battlefield environment, advanced materials, protection, materials processing and manufacturing technologies, robotics and artificial intelligence, advanced signal processing and computing, modeling and simulation, biomedical sciences and nutrition, lethality, environmental sciences, advanced propulsion technology, and power and directed energy.

Presentations during these sessions included: "Femtosecond Nonlinear Optics of Semiconductors," by Dr. Eric Mazur, Harvard University; "Photonic Integration Technologies for Telecommunications," by Dr. Thomas Koch, AT&T Bell Laboratories; "Future Battlefields and Emerging Technologies," by BG Joe N. Ballard, deputy commanding general, Army Engineer Center; "Mission Kill—Metrics for Combat Damage Accounting," by David C. Hardison, Army Science Board; and "Prospects for Laser Weapons in Army Combat," by Dr. Walter R. Sooy, Lawrence Livermore National Laboratory.

Of the 90 technical papers presented during the 16 concurrent sessions, 18 were cited for special recognition.

The awards were presented by Secretary of the Army Michael P.W. Stone, Secretary of the Army, during the awards banquet. Stone described some of the many Army programs that have not received attention, such as the Army Career Alumni Program (ACAP) currently being exported to Russia, and the Corps of Engineers' work in alleviating the recent flood in Chicago. Following these remarks, Stone, assisted by George T. Singley III, deputy assistant secretary of the Army for research and technology, presented one silver medallion, two bronze medallions, and 15 honorable mention awards.

A team of outstanding scientists from the U.S. Army Ballistic Research Laboratory (BRL), Aberdeen Proving Ground (APG), MD, was the recipient of the first prize, the Paul A. Siple Memorial (silver medallion) Award. The team will share a $2,500 award. Drs. Rosario C. Sausa, George W. Lemire, Josef B. Simeonsson, and Andrzej W. Miziolek co-authored the winning entry, which was titled "Laser-Based Sensitive Detection of Trace Atmospheric Vapors of Military Interest." The paper describes a new detection technique in which a single laser photofragments the target molecule, and detects a characteristic resulting fragment by resonant-enhanced multiphoton ionization. The technique was demonstrated by detection of explosives, RDX and TNT, in the parts-per-billion range, and by detection of a nerve agent simulant in the parts-per-million range. For the explosives at least, an increase in sensitivity to the 1–100 parts-per-trillion range is projected using higher laser powers. Potential applications of this new laser-based technique include environmental-related detection in the areas of pollution prevention and compliance.

Two additional papers were selected for outstanding achievement. The authors received certificates of achievement and bronze medallions, and shared a $1,000 cash award.

Dr. Steven P. Harvey and Dr. Joseph J. DeFrank, of the U.S. Army Chemical Research, Development and Engineering Center, APG, MD, were recognized for their work on the paper titled, "Biodegradation of Chemical Warfare Agents: Demilitarization Applications."

CPT Harry E. Cartland and MAJ David W. Veney, from the U.S. Military Academy, West Point, NY, along with Dr. Scott L. Nickolaisen and Professor Curt Wittig of the University of Southern California at Los Angeles, were honored for their work described in the paper titled, "Time-Resolved Infrared Diode Laser Spectroscopy: A State Specific Probe of Atom-Molecule Reaction Dynamics."

In addition, 15 other papers were selected for honorable mention. The authors of these papers received certificates of achievement and shared a $500 cash award.

Dr. John H. Beatty and Dr. Morris Azrin, both from the U.S. Army Materials Technology Laboratory, Watertown, MA, were honored for their efforts on the paper titled "Correlation of Ballistic Performance to Shear Instability Studies in High Strength Steel."

Dr. George F. McLane, Melanie W. Cole, Dr. Howard S. Lee, Dr. Allen Lepore, Donald W. Eckart and Dr. Richard T.

Lareau, all from the all from the U.S. Army Electronics Technology and Devices Laboratory (ETDL), Fort Monmouth, NJ, with Dr. Meyya Meyyappan from Scientific Research Associates, Inc., Glastonbury, CT, and Mark Namaroff and Dr. Jay Sasserath from Materials Research Corporation, Orangeburg, NY, were cited for their accomplishments on the paper titled "Magnetron Ion Etching for GaAs Device Processing."

Dr. Michael E. Chenshaw, Dr. Michael Scalora and Dr. Charles M. Bowden, of the U.S. Army Missile Research, Development and Engineering Center, Redstone Arsenal, AL, were recognized for their research efforts described in the paper titled "New Optical Switch Stemming from Dipole-Dipole Interactions in Dense Media."

Dr. Mitra Dutta, Dr. Hongen Shen, Dr. Jagadeesh Pamulapati, Peter G. Newman and Wayne H. Chang, all of the U.S. Army ETDL, were cited for their work on the paper titled "A Novel High Contrast Optical Modulator in a GaAs-ATAs Structure."

LTC Wendell C. King, U.S. Military Academy, West Point, NY, Dr. Alan J. Witten of Oak Ridge National Laboratory, Oak Ridge, TN, and James R. Ursic from the U.S. Environmental Protection Agency, Chicago, IL, were honored for research described in "High Resolution Image Processing of Geophysical Data with Diffraction Tomography."

Paul Weinacht and Dr. Walter B. Sturek of the U.S. Army BRL, and Dr. Lewis B. Schiff of NASA Ames Research Center, Moffett Field, CA, were cited for authoring the paper entitled "Navier-Stokes Predictions of Pitch Damping for Axisymmetric Shell Using Steady Coning Motion."

Dr. Kwong K. Choi, Monica Taysing-Lara, and Wayne H. Chang, U.S. Army ETDL, were recognized for their paper entitled "High Sensitivity Infrared Hot-Electron Transistors."

Dr. James F. Harvey, Dr. Hongen Shen, Dr. Robert A. Lux, Dr. Weimin Zhou, Dr. David C. Morton, Melanie W. Cole, Dr. Mittra Dutta, Dr. Madan Dubey, Richard C. Peikarz, Richard T. Lareau, Armand M. Balekdjian, Dr. Jagadeesh Pamulapati, and Dr. Clarence G. Thornton, all of the U.S. Army EDTL, along with Dr. Charles M. Bowden of the U.S. Army Missile RD&E Center and Dr. Raphael Tsu, University of North Carolina, Charlotte, NC, were cited for their work described in "Physics and Device Applications of Silicon Microclusters."

Dr. LTC(P) Steven R. Hursh, at the Walter Reed Army Institute of Research (WRAIR), Washington, DC and Dr. Richard E. McNally, Science Applications International Corp., Joppa, MD, were honored for authoring the paper titled "Modeling Human Performance to Predict Unit Effectiveness."

COL Jerald C. Sadoff, WRAIR, along with Dr. Hermona Soreq of The Hebrew University, Jerusalem, Israel, and Drs. Joel Sussman and Israel Silman of the Weizmann Institute, Rehovot, Israel, and Dr. Avigdor Shafferman of the Israel Institute for Biological Research, Ness-Ziona, Israel, were cited for their accomplishments described in the paper entitled "Cloning, Expression, Production and X-Ray Crystallographic Structure of Acetylcholinesterase."

Dr. Suryanarayana Bulusu of the U.S. Army Armament Research, Development and Engineering Center (ARDEC), Picatinny Arsenal, NJ, and Dr. Richard Behrens Jr. of Sandia National Laboratories, Livermore, CA, were recognized for their research described in the paper titled "Thermal Decomposition of RDX and HMX in the Condensed Phase: Isotope Scrambling and Deuterium Isotope Effect Studies."

Dr. Robert J. Lieb of the U.S. Army BRL and Dr. Samuel F. Trevino of the U.S. Army ARDEC, were cited for their research described in the paper titled "A Small Angle Neutron and X-Ray Scattering Study of the Onset and Nature of Fracture of Uniaxially Compressed Gun Propellants."

Dr. Arpad Juhasz of the U.S. Army BRL, Stan Smith of the U.S. Army Strategic Defense Command (SDC), Huntsville, AL, along with Dr. Zwi Kaplan, Dr. David Melnik, and Dr. David Saphier, and LTC Maxi Blum of the Ministry of Defense, Israel, were honored for "Solid Propellant Electrothermal Gun Propulsion."

Dr. Reginald A. Willingham, Dr. John H. Cornell, David M. Alabran, John W. Cullen, Dr. Frank H. Bissett, Dr. Masato Nakashima, Dr. David E. Remy, and Joseph F. Roach, all of the U.S. Army Natick Research, Development and Engineering Center (NRDEC), Natick, MA were cited for their research reported in "Synthesis of Metallo-Tetrabenzporphyrins Possessing High Third-Order Optical Nonlinearity for Military Laser Eye Protection."

Dr. Donald W. Hoock Jr., of the U.S. Army Atmospheric Sciences Laboratory (ASL), White Sands Missile Range, NM, was recognized for research leading to the paper titled "An Approach to Mitigating Atmospheric Effects on Image-Based Pattern Recognition by Neural Networks."

This year's Army Science Conference also included an R&D Achievement Awards Dinner, during which George Singley announced the winner of the 1992 Research and Development Organization of the Year Award, which was presented to the Corps of Engineers' Waterways Experiment Station. Also announced were three Awards for Excellence, which were presented to the Armament Research, Development and Engineering Center, the Communication and Electronics Command's Research, Development and Engineering Center, and the Medical Research Institute of Chemical Defense.

Singley also presented plaques to the winners of the 1991 R&D Achievement Awards, who were previously announced in the January–February 1992 issue of *Army RD&A Bulletin*. A total of 46 contributors were honored for their contributions to 22 successful R&D programs.

Proceedings of the 18th Army Science Conference will be published by the ARO in October 1992. For additional information concerning this publication, contact Don Rollins at (703)549-4282 or DSN 832-4282.

DR. DAPHNE KAMELY is the director, research and laboratory management in the Office of the Deputy Assistant Secretary for Research and Technology, Office of the ASA(RDA). She received her undergraduate degrees in physics and mathematics from Goethe University in Frankfurt, Germany, and holds a doctorate degree in biophysics and molecular genetics from Harvard University.

DR. ROBERT A. FIFER is the leader of the Chemical Characterization Team at the U.S. Army Ballistic Research Laboratory at Aberdeen Proving Ground, MD. He co-authored this article as part of a recently completed temporary assignment to the Office of the Director of Research and Laboratory Management at the Pentagon. Fifer holds a B.S. in chemistry from Gordon College in Wenham, MA, and a Ph.D. in Physical Chemistry from Temple University.

Officer Record Brief Modified

Army Acquisition Corps (AAC) officers may have recently noticed a change in their Officer Record Briefs (ORB). Effective in July 1992, the number of months of acquisition experience was included in Section X—Remarks, of the ORB. Acquisition experience will be coded by "P"—number of months in a systems organization, such as Army Materiel Command, Information Systems Command, Strategic Defense Command, program management office, Defense Plant Represenative Office, etc.), "E"—number of months of education (by law, no more than 12 months), "O"—number of months of experience not categorized as "P" or "E" (such as Training with Industry, etc.), and "T"—number of total months of acquisition experience. Officers will now be able to ascertain their career level in accordance with DOD 500.52-M.

IMA Assignments Available at MICOM

COL David Bautista, commander of the 183d Individual Mobilization Augmentee (IMA) Detachment (RD&A), Kingsport, TN, has announced that his unit is conducting a staff study and survey for the U.S. Army Missile Command (MICOM) regarding use of IMA's to fill logistical assistant representative (LAR) positions at MICOM, headquartered at Redstone Arsenal, Huntsville, AL. The primary population, the subject of the survey, is comprised of Individual Ready Reservists.

Needed to fill the requirement are officers who hold or have held MOS 91A (Ordnance, General) and 91C (Missile Materiel Management). Warrant Officers who hold or have held the following MOS (former MOS shown in parenthesis) are also included in survey:

151A (160A) Avn. Mtn. Tech., 140A (225B) Comd. and Cont. Sys. Tech. and 91A (271A) Land Combat Msl. Sys. Tech. Officers and Warrants with the following civilian occupational codes may also be considered: 019 (Logistics Spec. & Reliability Engr.) and 621 (Aircraft Mtn. Supvr.), 012 (Indus. Engr.), 189 (Mgr. Indus., Prog. Mgr. and project Dir.).

Individuals selected will be trained by MICOM Personnel in the Readiness Directorate to perform specific LAR missions. The LAR will serve as central staff officer and provide logistical interface between MICOM and reserve component units utilizing the following weapon system: Land Combat (TOW, DRAGON, SHILLELAGH, LANCE, MLRS, HELLFIRE); Air Defense, (HAWK, PATROIT, CHAPPARAL, REDEYE, STINGER, VULCAN, AND FAAR).

Selected officers will receive training in the first year for an overview of the missile and logistic system. The second year will include an in-depth study of the logistics system. The third year will include hands-on training at a Corps or Division Logistics Assistance Office (LAO). Subsequent years will find the LAR providing direct logistical interface between MICOM and the supported user units to insure that supported units achieve and maintain combat readiness. Training described above will serve as the individual's annual training and will be for periods of approximately two weeks.

Interested officers are requested to send their qualifications, along with a brief history of assignments, to: Commanding Officer, 183d IMA Detachment (R&D), P.O. Box 1305, Kingsport, TN 37662. Additional information may be obtained by calling Mr. Cress, (615)245-9114.

Army War College Corresponding Studies Course

Congratulations to the officers listed below who have been selected for the Army War College Corresponding Studies Course Class of 1994 (Annual Years 1992-1994). Selection for the course this year was extremely competitive. Over 400 applications were received to fill 211 available seats.

Name	Grade	FA/BR
ARMBRUSTER, Robert E.	LTC	51/35
BARNES, John W.	LTC(P)	51/25
BARNES, Thomas R.	LTC(P)	97
BOREL, John E.	LTC(P)	51/25
CANTLEY, Samuel E.	LTC(P)	51/91
COWDEN, Sammy J.	LTC(P)	51/35
DANDRIES, Michael I.	LTC	51/15
EHLINGER, Thomas M.	LTC(P)	97
GIRLANDO, Joseph G.	LTC(P)	51/14
GUTA, Charles J.	LTC	97/88
HAMILTON, Albert J.	LTC	51/14
HERINGER, Wayne L.	LTC	51/35
HOBBS, Quincy C.	LTC(P)	97/92
HOWELL, Michael I.	LTC	51/14
IVEY, Larry E.	LTC	51/91
JOLLY, Michael G.	LTC	53/92
KAFKALAS, Peter N.	LTC	97
KORTZ, James S.	LTC	97
LEVISTER, Joseph W.	LTC	53/25
MCGAUGH, Dennis A.	LTC	51/35
MEYER, Henry W.	LTC	97/92
OKEEFFE, Edward C.	LTC(P)	53
OLER, Roy P.	LTC	51/15
PERRY, John H.	LTC	51/91
PINKERTON, Paul V.	LTC	51
PIPLANI, Lalit K.	LTC	51/25
REYNOLDS, James C.	LTC	51/15
SCHEUER, Henry H.	LTC	51/15
SNIDER, James R.	LTC(P)	51/15
THEIMER, David B.	LTC(P)	97
THOMAS, James A.	LTC(P)	51/13
UNTERSEHER, James E.	LTC(P)	51/13
WESTRIP, Charles W.	LTC	97
YOUNG, Sammie G.	LTC(P)	51/25

Commissioned Officer Development and Career Management

DA Pam 600-3, *Commissioned Officer Development and Career Management* is being revised under the guidance of the U.S. Army Training and Doctrine Command. Special emphasis is being placed on this revision to provide the opportunity to shape the future officer corps and to provide a roadmap to guide the Army and its officers through these pivotal years of change.

There are four chapters in DA Pam 600-3 that provide career development guidance for officers in the Army Acquisition Corps (AAC): Chapter 45—Systems Automation; Chapter 47—Army Acquisition Corps; Chapter 48—Research, Development and Acquisition (FA 51); and Chapter 49—Contracting and Industrial Management (FA 97). Each chapter presents a life cycle model which provides a career map for the AAC officer in his or her functional area; and developmental patterns specifying standards by which officers will be measured and certified at each rank, to include institutional training and education, acquisition experience requirements, and assignments.

Upon completion of the revision process, each AAC officer will be provided with a copy of his or her pertinent functional area chapter, as well as the chapter on the AAC. Any questions on either the revision of DA Pam 600-3 or on career development in general should be directed to the Army Acquisition Corps Proponency Officer MAJ Steve Cox at DSN 224-5920/5921 or commercial (703)614-5920/5921.

Program Management Course Attendees Announced

The following is a list of members of the Army Acquisition Corps selected to attend the Program Management Course at the Defense Systems Management College, July 27–Dec. 11, 1992.

Civilians

BODENSTEIN, Patricia
BRADSHAW, Richard
BRAY, James
BREEDEN, Robert L.
BROCK, Donna L.
BROTHERS, James R.
BYERS, John E.
CARPENTER, Rosemary M.
CEBULA, Charles
CONNOR, Jerome
CORNETT, Edwin
DENTON, Joan
DOTO, Robert
DUVALL, Lawrence C.
EATON, Richard E.
FIALA, Ronald A.
FISHMAN, Judith
FRENCH, Stephan
GATENBEE, Robert J.
GLASS, Richard L.
GRIFFIS, Ronald W.
HAUG, John
JONES, Denise E.
KRETZLER, Garret A.
LYNCH, Manfred
LAING, Andrew
MARTIN, Gary
MARTIN, Steven
MCGEE, Michael
MILLER, Theresa
NELSON, James H.
OGRAYENSEK, Donald F.
OXENBERG, Paul
PATTON, Kay I.
POTTS, Joe T.
QUALLS, James R.
RAMME, Richard
ROWAN, James D.
SCHANNEN, Joseph
SCHNEIDER, Susan L.
SIIRILA, Arthur D.
SIMPSON, Michael J.
SMITH, Charles M.
SPINNER, Charles R.
STULL, Susan
SURAVLAS, Stamatios
SUTTON, James C.
THOMAS, John C.
VAN KIRK, Jack M.
WRIGHT, Harold E.

Military

Name	*Rank*	*Name*	*Rank*
ADAMS, John C.	MAJ	KIRKS, David	MAJ
ALEXANDER, Steven M.	MAJ	KUMMERER, John N.	MAJ
ASADA, Michael K.	MAJ	LANGHORST, Richard H.	MAJ
BARTON, Christine M.	MAJ	LEONARD, Alvin J.	MAJ
BENKUFSKI, Steven J.	MAJ	LUSTIG, Michael	LTC
BOREL, John E.	COL	MANGANIELLO, Anthony	MAJ
BRINDLE, Gary L.	LTC	MCGEE, Michael R.	MAJ
BRYANT, Bradford J.	MAJ	MCGROADY, James J.	MAJ
BUCKSTED, Robert	MAJ	MCKEE, Jona W.	MAJ
COCHRANE, Dennis	COL	MCCLEOD, Hugh	COL
CONTI, Michael S.	MAJ	MCNIEME, Dixie L.	MAJ
COX, Michael	MAJ	MEADE, Kevin J.	MAJ
CURLEY, Mark	MAJ	MANYHERT, Carl F.	MAJ
DANIELS, Rickie	MAJ	MONRAD, Glenn	MAJ
DAVIS, Michael P.	MAJ	MOORE, Stephen C.	MAJ
DEFRIES, Danny L.	MAJ	NEWBERRY, Tommie E.	MAJ
DYKSTRA, Robert L.	MAJ	O'HARA, Michael J.	MAJ
FAHLSING, George A.	MAJ	PARSONS, Billie G.	MAJ
FONG, Terence	MAJ	PONTING, Kurt P.	MAJ
FOSMAY, William	MAJ	QUACKENBUSH, John E.	MAJ
FRIEDLI, John L.	MAJ	ROBINSON, James O.	MAJ
GARCIA, Alberto	MAJ	ROUSE, John E.	MAJ
GINDER, Lawrence	MAJ	RYLES, Richard R.	MAJ
GRIGSON, Allan E.	LTC	SCHUSTER, David W.	MAJ
GROSS, John L.	MAJ	SHIFLETT, James E.	COL
HANSEN, James S.	MAJ	SIDWELL, Mike	LTC
HINTZE, Charles J.	LTC	SIMS, Calvin R.	MAJ
HORNEY, Jay	MAJ	SMITH, Brian D.	LTC
HOSTETTLER, Daniel G.	MAJ	STEVENS, Charles R.	MAJ
HUDSON, James C.	MAJ	THOMAS, Daniel R.	MAJ
KAMSTRA, Mark R.	MAJ	TOLLIFFE, Brian	MAJ
KELLY, Thomas P.	MAJ	WHITTAKER, David F.	MAJ
KEPPLER, Susan A.	LTC	WOLCOFF, Edward	MAJ
KESSINGER, Stephen H.	MAJ		

Training With Industry

Thirty-one officers are currently participating in the Training With Industry (TWI) Program, Annual Year 92–93. TWI was initiated in the 1970s, in response to the Army's critical need for officers with state-of-the-art skills in industrial practices and procedures not available through military or civilian education programs.

Officers participating in TWI spend a year learning how private industry conducts business, and training in higher level managerial techniques. After a year with industry, the officer brings this knowledge and information back to the Army to improve its ability to conduct business with industry. Listed alphabetically, the 31 current participants and their functional areas and training locations are as follows:

OFFICER	FA	TWI LOCATION
CPT Elijah ANDERSON	97	General Electric
MAJ Damian BIANCA	51	Westinghouse
MAJ Stephen BIANCO	51	Raytheon Corporation
MAJ Harry BREEDEN	97	Boeing Aerospace
MAJ Ross BURTON	97	DPRO Ratheon
MAJ Alfred COPPOLA	51	Alliant Techsystems
MAJ Diana DAVIS	97	General Motors
MAJ Robert GROLLER	51	Martin Marietta
CPT Eric HANSON	97	Motorola Government Electronics Group
MAJ Ralph HERNANDEZ	97	DYNCORP
CPT Jay HILLIARD	51	LTV
MAJ Donald HUFF	51	Hughes Aircraft
CPT A.R. INCORVATI	97	Hercules Engine
MAJ Jeffrey JANCEK	97	Hercules Engine
CPT David JEROME	97	Hughes Aircraft
MAJ Joseph JOHNSON	97	Textron Lycoming
MAJ Pamela JOHNSON	97	Textron Lycoming
MAJ Wayne JOHNSON	97	Honeywell
MAJ William LAKE	97	Bell Helicopter
MAJ John LAWLESS	97	Textron Lycoming
MAJ Bruce LEGRAND	97	Hughes Aircraft
CPT Robert LEONARD	97	FMC
MAJ John LEWIS	97	McDonnell Douglas
MAJ David LUDWIG	97	General Electric
MAJ August MANCUSO	51	LTV
CPT Paul McQUAIN	97	Martin Marietta
MAJ Mark MEADERS	97	Oshkosh Truck Corp.
CPT Daniel POWERS	97	General Dynamics
CPT Toby REESE	97	Martin Marietta
MAJ Luis SANS	97	Rockwell International
MAJ William STEELE	97	McDonnell Douglas

Selectees for AAC Civilian Training Programs

The following is a list of selectees for Army Acquisition Corps Civilian Training Programs.

Long-Term Training
University of Texas, Austin, TX, (began Aug. 26)

Michael Cobb, Longhorn, AAP

Senior Service College Fellowship Program
University of Texas, Austin, TX, (began Aug. 2)

Dr. Ashok Patil, Belvoir RD&E Center
Bobby Bowles, MICOM

Tuition Reimbursment
for Degree Completion at Local Universities

Elizabeth Flaharty, HQ AMC
Jeffrey Herman, CECOM
Janet Farrow, OASA
Thomas Zemke, TACOM
Linda Gentle, MICOM
George Behnen, AVSCOM
Barbara Hoskins, OSARDA

Part-Time Training, Executive Masters
of Science in Engineering
University of Pennsylvania (began Sept. 6)

Paul Laster, CECOM
Joseph Cartelli, CRDEC
John Burneskis, ISSAA

OPM Executive Development Seminar
Denver, CO (was held July 6–17)

Gail E. Stenger, PEO, Comm Sys
Wayne A. Wesson, HQ, AMC

OPM Managerial Competencies
Oakridge, TN (was held July 6–17)

Monica L. Godbey, ISSA
Earl D. Scott, DOD PM, MEP

Harvard Executive Management Program
(Sept. 20–Nov. 20)

Primaries	Alternates
Sandra Benson, MICOM	Deborah Frank, CECOM
Carol Lowery, PMSBA	Linda Gentle, MICOM
Daniel Maksymowicz, TACOM	
Carlos Piad, HQ, AMC	

The Brookings Institution
Emerging Technologies in Public Management
(Sept. 14–18)

Primaries	Alternate
Cary Fishman, CECOM	Manfred Lynch, HQ, AMC
James Kirkwood, AVSCOM	

The Brookings Institution
Boston, MA (Sept. 20–25)

Primaries	Alternate
David Keetley, CECOM	Eric Stern, CECOM
Donald Barker, MICOM	
Allan Madnick, CECOM	
Dr. James Edgar, OSARDA	

Executive Supervisory Functions
Austin, TX (held Aug. 2–7)

Olga Lawrence, CECOM
Marlu Vance, OSARDA
Emmanuel Nidhiry, HQ, AMC
Michael Kien, HQ, AMC
Edmund Marcinkiewicz, CECOM
Daniel Haugan, AVSCOM
Thomas Tekotte, AVSCOM
Betty Wyskida, MICOM
Noel Donlin, MICOM
Glenda Jones, HQ, AMC
Jack Coogan, CECOM
Tommy Cheng, CECOM
Laverne Jones, OSARDA
Leo Emery, PEO Comm Sys
Loretta Starkey, MICOM

Western Executive Seminar Environmental Policy Issues
Denver, CO (held Aug. 17–28)

Thomas McWilliams, PEO, Armaments
Maryann Dominiak, HQ, AMC

SPEAKING OUT

What Impact Will the DOD's Emphasis on Low-Rate Production Have on the U.S. Defense Industrial Base?

Donald J. Atwood
Deputy Secretary of Defense

The Department of Defense has changed its approach to weapons procurement as a result of the end of the Cold War. For 40 years, U.S. procurement was driven by the need to modernize in order to maintain a technological edge in the face of a massive Soviet effort to field advanced technology weapons. Today, that requirement is significantly lessened. We do not need to produce new weapon systems at the pace or in the quantity that we did in the past.

As a result, the rate of weapons' production in the years ahead will be well below the current production capacity of the defense industry. In addition, given existing inventories of high-technology weapons relative to the proposed smaller armed forces, there may well be a gap in the production requirements for some weapon systems.

Yet it remains essential that we maintain our technological advantage over potential adversaries. To do so with reduced resources, we have refocused our acquisition strategy. This new approach places increased reliance on research and technology development to maintain our advantage. We will also make greater use of technology demonstrations and prototypes in the development of new weapons. Not all new technologies will automatically go into production. When we develop a promising technology, we will evaluate it carefully to determine its use. For example, we may incorporate it in an existing system to improve reliability or performance, or we may use it in a new system. Full-scale production of a new weapon system will occur only when there is a definitive need because of obsolescence or aging of an existing system and when it is proven to be cost-effective.

Despite the dramatic nature of the changes in our approach to acquisition, and the increased emphasis on research and technology development, production will not disappear. We will still spend over $50 billion on procurement in Fiscal Year 1993 and more than $300 billion in the next five years. That's 22 percent of the Department's budget. During that same period, we'll spend $190 billion on research and development—14 percent of the defense budget.

Nonetheless, the new defense environment and our acquisition strategy will definitely have an impact on the defense industry. Because there will be excess production capacity, there undoubtedly will be a rationalization of industry. Firms that are efficient and have a high-technology capability will survive and prosper. Others may not. Teaming, joint ventures, and mergers among companies may be desirable to take advantage of individual companies' strengths and to spread risk and cost.

In addition, the Department of Defense has already begun to implement a sweeping series of reforms and initiatives to support a healthy industrial base. In order to make research and development attractive and give industry an equitable return on its investment, we are also eliminating fixed price contracts for R&D work where there is significant risk. Furthermore, we are encouraging industry to pursue the dual use of technologies developed for defense when such technologies may have commercial applications.

We are also working to identify critical manufacturing processes with their associated technologies and worker skills which must be maintained even during gaps in production. Not only will it be necessary to fund these critical technologies and worker skills, but it may also be necessary in some cases to fund limited production even though there is no immediate requirement.

Finally, we are working to reduce military-unique specifications so we can increase off-the-shelf procurement of commercial items.

We all share the concerns for the industrial base — and for the technical and engineering skills sustained within it. We must and will take sensible measures to protect it, but production capacity that we do not need cannot be saved at the expense of our basic military capabilities. The new acquisition strategy will allow us to sustain a healthy, although smaller, defense industry while ensuring that we maintain the technological advantages that proved so important to our dramatic victory in the Gulf War.

Gerald A. Johnston
President
McDonnell Douglas Corporation
St. Louis, MO

We all know that the changed security threat in the world has removed the urgency for the U.S. to produce and deploy new systems. But the new U.S. approach to defense acquisition could have a profound impact on the future defense industrial base.

And that, to put it bluntly, could place America's future in the balance. Global economic warfare already threatens to erode out export capabilities, cut into the muscle of our manufacturing power and ultimately jeopardize the economic well-being of our nation.

What we stand to lose is our technology lead in defense. The writing is on the wall: Aerospace and defense products, along with pharmaceuticals and chemicals, represent the only major high technology positive export balance left in American hands. And that could change very quickly as the international aerospace field becomes more crowded and economic blocs and countries consolidate their efforts to win a bigger portion of the business.

The emerging U.S. defense acquisition policy includes a heavy emphasis on government-supported R&D, more reliance on technology demonstration prototypes, limited production to validate production processes, advancement to full-scale production on fewer systems, and more reliance on product upgrades rather than new systems.

McDonnell Douglas has learned from its concurrent engineering experience that the transition to production is essential if we want to deliver an affordable product. A *succession* of technology demonstrator prototypes does not address the complex transition from development to production and does not preserve critical core competencies or capacity required to make the transition in the future.

In the new global environment there are going to be fewer programs, but that doesn't mean we should rely totally on prototypes.

That's a little like paying admission to hear an opera singer who spends the performance clearing her throat.

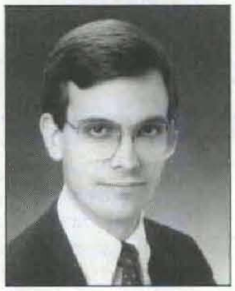
One partial solution would be for our government and other governments to encourage cooperation on new programs that would go the full distance from conception, through development, production and deployment. And we should develop them for multi-national markets, not just for individual countries.

Through a cooperative approach our nations can achieve needed defense modernization at least cost.

Cooperation got us through Desert Storm in superior fashion. Let's see if it will take us through the 21st century.

SPEAKING OUT

Dan C. Heinemeier
Vice President, Government Division
Electronic Industries Association



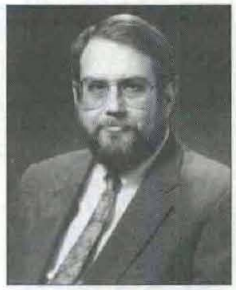
The immediate impact on industry of DOD's announced prototyping/low-rate production strategy has been to raise concerns about whether there will be a concurrent change in R&D acquisition policies. In the absence of production options, the new approach must contemplate adequate profitability on instant contracts to ensure reasonable return on investment of industry's limited research and proposal funds.

Industry also is concerned about whether the new acquisition strategy will ensure a solid basis for continued technology development across the range of defense-critical mission areas. Technology development by competitor nations will continue to proceed, without regard to the budget pressures now driving our defense funding decisions. Prototyping and low-rate production alone may not ensure our troops have the technological edge that saves lives in "come-as-you-are" conflicts like Desert Storm.

In implementing the new acquisition strategy, how will DOD carry out its decision-making on limited production funding vs. mere prototyping? These program specific decisions will determine corporate survivors and future capabilities at all tiers of the defense industrial base. Accurate, sector-by-sector analyses will be essential in determining the areas in which commercial capacity may be a viable alternative to current defense-unique production.

As DOD seeks to rely increasingly on the commercial market place, government buying practices will continue to represent the biggest roadblock to a more commercially-oriented industrial base. These practices are largely in the control of OSD and the Services to the extent that most are not statutorily based. Taken together, however, they represent an ingrained way of doing business that has frustrated a host of reform efforts in the past.

Absent a sustained, senior-level effort to implement more commercially-oriented buying practices throughout DOD, premier commercial technologies will not be offered to the government despite their ready availability to commercial buyers. The result may be that soldiers in the field again will resort to personal credit cards to acquire high-tech commercial items which their procurement system is unable to supply. As an alternative, we in industry stand ready to recommend reforms and support the Army and other Services in implementing procurement policies which promote participation of commercial suppliers in the defense base.



John M. Shelley
Chief, Industrial Base Division
Army Acquisition Executive Support Agency

The U.S. defense industrial base is entering a new and challenging era. While overall DOD acquisition investments will remain fairly robust ($50 billion a year from FY 93 to 97), some sectors, such as combat vehicles, will experience a virtual cessation of production. In many cases, acquisition programs will spend a longer time in development before reaching production. For some, several iterations of Advanced Technology Demonstrators will be built to demonstrate the feasibility of technologies being considered for incorporation in the system. This emphasis on low-rate production will put a premium on efficient, cost effective producers. Those producers which can pare overhead and design flexible production processes which allow efficient low-rate production will be the core components of the industrial base. Rather than new production, a great deal of future "production" will be upgrade and technology insertion. This may cause us to look at the roles we have traditionally assigned to portions of the industrial base. For example, in order to maintain an industrial base which has all the services needed to develop, produce, field and maintain a weapon system, teaming arrangements could be developed where the depot restores equipment to "like new" condition and the Original Equipment Manufacturer (OEM) performs upgrade and technology insertion. These and other innovative approaches will be needed to maintain industrial base capabilities. Due to the reduced opportunity for a number of firms to profit from defense work, the industrial base will contract. This will especially impact the subtier vendor base where in many cases firms do not have sufficient financial resources to hang on till the next contract or the capabilities to compete in the civilian marketplace. It is imperative that the Army closely monitor this downsizing to identify critical capabilities that are in danger of being lost. If no other feasible solution exists, we may, as a last resort, have to intervene in the marketplace to preserve that capability.

LETTERS

Dear Sir:

Concerning a book review by CPT Eric S. Parker on the book titled, *Fundamentals of Computer Integrated Manufacturing*, published in the July–August 1992 issue of *Army RD&A Bulletin*, our general comments are as follows:

CPT Parker's book review appears to be in-depth and thorough, however, unfairly critical of a valuable and useful document. It is well known that Computer-Integrated Manufacturing (CIM) technology will change every two to three years due to changes in electronics/microelectronics, software, tooling, machine design, and robotics. Books written about CIM technology will almost be obsolete before they get published. This book is no exception.

Still, one must consider the strengths of the book and the value of this information to the reader. CPT Parker indicates that the strength of the book lies in three areas: the description of the manufacturing process; support and commitment to the CIM system; and implementation of the CIM system. These areas appear to be well enough in detail to allow someone who is unfamiliar with computer systems and manufacturing processes to understand and do a good job in obtaining CIM support for an organization.

In our estimation, if the book has met these objectives, it has achieved it's goal as a teaching document. We would not only recommend this for purchase but we would buy it ourselves as a reference document.

Ken Gibson
Quality Assurance Specialist
Implementation Division
Office, Deputy Chief of Staff for Research, Development and Engineering
HQ, U.S. Army Materiel Command

Ed Nader
General Engineer
Implementation Division
Office, Deputy Chief of Staff for Research, Development and Engineering
HQ, U.S. Army Materiel Command

Technology Transfer Through Cooperative R&D Agreements

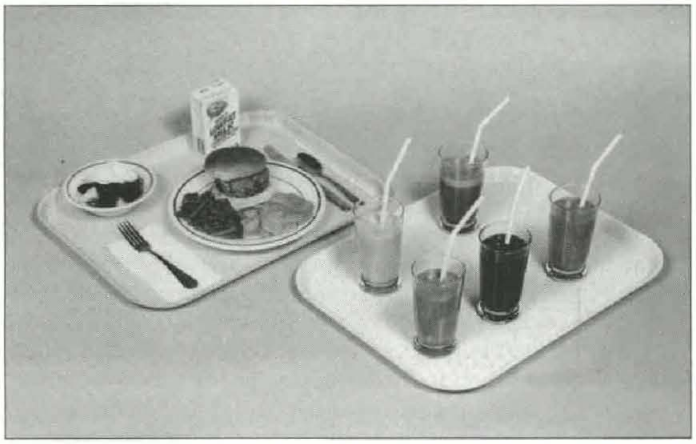
The U.S. Army Natick Research, Development and Engineering (RDE) Center's primary mission is to maximize survivability, sustainability and supportability of the individual soldier in all environments. This mission is achieved through research, development and engineering in the areas of food, clothing, shelters, and airdrop, and individual and organizational equipment. As a supplement to its in-house RDE programs, Natick has participated, nationally and internationally, with industry and academia in several types of agreements using methods under the Technology Transfer Program.

An article in the November-December 1991 issue of *Army RD&A Bulletin* described the Federal Technology Transfer Act of 1986 and the ways in which federal R&D can and should be transferred to the private sector to enhance the United States' global competitiveness. A few ways Natick is transferring R&D include publishing technical reports, responding to technical requests from industry and academia, inviting industry to participate in symposia and in Advanced Planning Briefings for Industry (APBIs) at Natick, and cosponsoring Technology Transfer Forums with New England federal laboratories and state economic development offices.

Natick's R&D transfer efforts provide industry the opportunity to observe research performed at federal laboratories, make contacts with laboratory personnel, and get the insight necessary to become familiar with the future needs of the Army.

One effort familiar to industrial liaison offices—the Independent Research and Development Program—is not extensively used at Natick because the participating companies are mostly involved in aerospace, electronics and aircraft manufacture. Therefore, very little of the R&D is directly applicable to Natick's technology or commodity areas.

One successful technology transfer vehicle at Natick is the cooperative research and development agreement (CRDA).



Normal meal components with their dental liquid ration counterparts.

Natick currently has five CRDA's in place, four of which have been approved in the last year: the first is in the biodegradable polymer area to help the Navy eliminate dumping of plastic waste at sea; the second is for the scaling up of spider silk production to explore alternative approaches to ballistic protective materials; the third is for the development of microwave sterilization of flexible packaged food products; and the fourth is for the irradiation preservation of foods. Natick's first CRDA, in place since June 1990, is between Natick and Procor Technologies Inc., a subsidiary of Land O'Lakes Inc., in the area of dental liquid rations. This CRDA is expected to continue with Advanced Food Sciences Inc.—another subsidiary of Land O'Lakes Inc.

Dental liquid rations are designed for soldiers or civilians who cannot eat solid foods due to broken jaws, facial injuries, dental disorders, or infirmity. Currently, dental liquid ration preparation requires blending, using electricity, which is not always possible in a combat environment. The new rations will consist of dehydrated powders that, when reconstituted with water (the "instantization" process), are sipped through a straw and taste like normal components of a meal. Fifty-six products make up a five-day menu cycle, from recipes provided by Natick; the instantization process technology is being supplied by Procor Technologies Inc.

Through this CRDA with Procor Technologies Inc., the Army will be gaining expertise in the instantization process of menu items, thereby alleviating the need for a blender. This new process will save time and money and will be easy to use. In addition to Army and private sector applications, the ration will be used by the Navy, Air Force, and the Department of Veteran's Affairs.

One important criterion of a CRDA is that federally developed R&D be transferred to the private sector. In this case, the company will be receiving technology in the form of a database consisting of many recipes developed by Natick. The company will then have the ability to commercialize dental liquid rations which in turn will provide a production base for both military and civilian purchasing.

One of the newer methods of collaborating with industry is the possibility of transitioning from the Small Business Innovation Research (SBIR) Program to a CRDA. In this manner, the Phase III portion of the SBIR Program—the commercialization of the SBIR effort—could transition to other government programs. During this phase, a CRDA under the Technology Transfer Program could possibly be signed with the company to further develop the product.

There are many facets of technology transfer, all of which serve to propel R&D forward. Also, the teamwork between government, industry, and academia provides an improved product more quickly with widespread application. True to the spirit of Technology Transfer, the CRDA is just one way Natick is sharing its expertise with the private sector while simultaneously meeting its military goals faster and more cost-effectively.

The preceding article was written by Robert Rosenkrans, technology transfer coordinator, Advanced Systems Directorate, Natick RDE Center, and Michael J. Statkus, writer-editor, Advanced Systems Directorate, Natick RDE Center.

Army Establishes Petroleum Excellence Center

The Army has announced the establishment, in New Cumberland, PA, of it's newest Center for Technical Excellence, the Army Petroleum Center (APC). The purpose is to provide an improved focal point for all petroleum issues and to ensure responsive support to its soldiers throughout the world.

The move, prompted in part by a Defense Management Directive calling for the consolidation of inventory control points, results in disestablishment of the U.S. Army's Troop Support Command's General Materiel and Petroleum Activity (GMPA), and the transfer of some of its missions (cataloging and redistribution) to other Army and DOD agencies, while retaining the petroleum related functions under the new APC.

MG Thomas Prather, commander of the U.S. Army Troop Support Command, believes this is a major step in the right direction. According to Prather, "The APC will streamline management and improve responsiveness and visibility of fuels and lubricant field conditions with fewer resources." The APC's newly assigned missions include:

- Execution of the Army's technical assistance and quality surveillance and testing programs to assure the quality of petroleum products used by the Army and other DOD elements.
- Directing the petroleum, oil, and lubricants qualification and standardization programs and the certification of petroleum testing labs.
- Operating an active technical assistance and inspection program for the Army.
- Directing research and development for current and future petroleum products, and
- Serving as the DOD executive agent for ground fuels and lubricants.

COL Richard Holley of the Army Energy Office said, "Establishment of the APC was a cooperative effort between the Army Materiel Command and the Office of the Deputy Chief of Staff for Logistics. Regardless of the size we end up drawing the Army down to, petroleum support will remain a critical logistics function. The APC provides us with a small but effective organization to provide technical assistance, maintain quality, coordinate requirements and address environmental impacts of petroleum throughout the Army."

COL Gary Solander, the last commander of GMPA and the first commander of the new APC states, "This will be the only activity in the Army that will routinely go into every installation, every activity, every TO&E, every TDA organization and look not only at personnel, but equipment and facilities, fuel quality, and operational training of people, whether military or civilian; performing the petroleum mission."

According to Solander, for the APC to be successful, it will operate under the tenets of total quality management. "The APC will be a responsive organization which will provide service to its customers—soldiers and Army civilians everywhere," he adds. "APC means that if I am at any post, camp or station, I will have only one number in the Army to call.

"Secondly, if I am out at a depot or newly assigned to an installation and want to find out what my petroleum program condition is, I can check the APC and they can pull the profile of my installation or activity and tell me what my program should be to maintain or improve operational efficiency," Solander claims.

The APC will also link the TRADOC community to that same database that now tells them equipment condition and needs in the field from a first-hand viewpoint. The data base will be used to serve the Defense Fuel Supply Center and Defense General Supply Center in terms of contract supplier performance in the areas of service and quality of product.

"Our database will also allow the R&D community to begin to look deeper into the program of petroleum specifications," he adds. "Do we over spec because we didn't have the database to measure in the past? Are we under specing? The database will also be significant in that arena," Solander concludes. "Sometimes it will be just as useful to prove our specs are right."

The APC assumes control of testing procedures currently being performed in a myriad of manners and locations. "By getting in control of the testing picture we should be able to efficiently allocate those testing resources and more efficiently determine the need for them. We simply have to look at better ways of doing business," adds Solander.

According to Solander, the need to keep the Army in compliance with environmental laws will continue to provide the APC with a major workload.

Via a recently signed memorandum of understanding between the APC and the Army Corps of Engineers, all facility designs will, by regulation, be coordinated with APC for petroleum operational safety and environmental concerns. Secondly, in the environmental area, the "control" of the R&D focus by the APC of Army petroleum will ensure that the Army stays in close step with all environmental requirements while ensuring that the service's focus on combat operations is also met.

Voice Mail and Electronic Mail at PERSCOM

The U.S. Army Personnel Command's (PERSCOM) Military Acquisition Management Branch has voice mail and electronic mail systems targeted at serving the officers "in the field" more effectively. The PERSCOM telephone system was recently upgraded with voice mail enhancement. If your assignment officer is on the phone with another officer or away from the desk, the voice mail capability will allow you to leave as long a message as you like including the specifics of your question, your name, and autovon and commercial telephone numbers. It is often easier for the assignment officer to return your call using a commercial phone number, especially if you are OCONUS.

The new capability has been very effective in improving the assignments officers' ability to respond to the needs of the field. "I don't know how we got along without voice mail," said CPT Dave Carroll, FA97 Captains Assignments. "I suppose most people trying to get through to us in the past just got a busy signal." It is especially helpful when officers include the specifics of their question so the answer can be researched before the call is returned, added Carroll.

If you prefer to write rather than call, you may send a note to your assignment officer using electronic mail. The Military Acquisition Management Branch telephone numbers and electronic mail addresses are listed below. These services are designed to help us serve you more effectively.

POC	DSN	CML
Advanced Civil Schooling	221-2763	(703)325-2763
Separations	221-3095	(703)325-3095
Chief, Military Acq Mgt	221-3131	(703)325-3131
FA51 LTC Assignments	221-3129	(703)325-3129
FA51 MAJ Assignments	221-3128	(703)325-3128
FA51 CPT Assignments	221-2800	(703)325-2800
Military Personnel Specialist	221-3127	(703)325-3127
FA53 LTC/MAJ Assignments	221-3114	(703)325-3114
FA53 CPT Assignments	221-2759	(703)325-2759
FA97 LTC/MAJ Asssignments	221-3124	(703)325-3124
FA97 CPT Assignments	221-2801	(703)325-2801
AAC Computer Engineer	221-3130	(703)325-3130
AAC Strength Management	221-2760	(703)325-2760

DDN E-MAIL Addresses

Functional Area 51: TAPCOP51@HOFFMAN-EMH1.ARMY.MIL
Functional Area 53: TAPCOP53@HOFFMAN-EMH1.ARMY.MIL
Functional Area 97: TAPCOP97@HOFFMAN-EMH1.ARMY.MIL

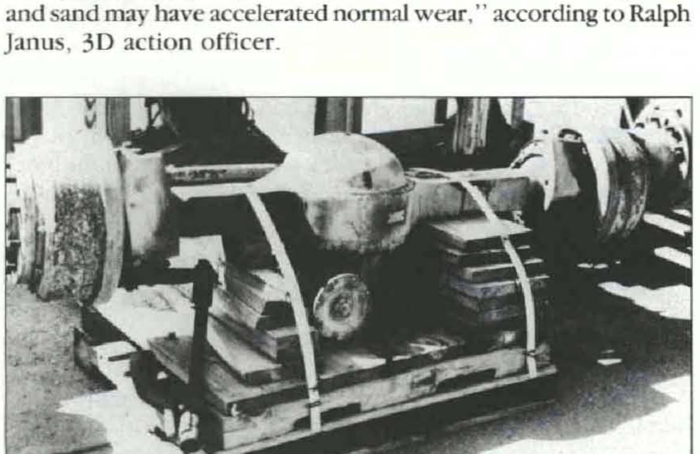
TACOM Begins Delayed Desert Damage Program

The U.S. Army Tank-Automotive Command (TACOM) has begun an important new program to identify and assess hidden damage to Army equipment resulting from harsh environmental extremes during the Gulf conflict.

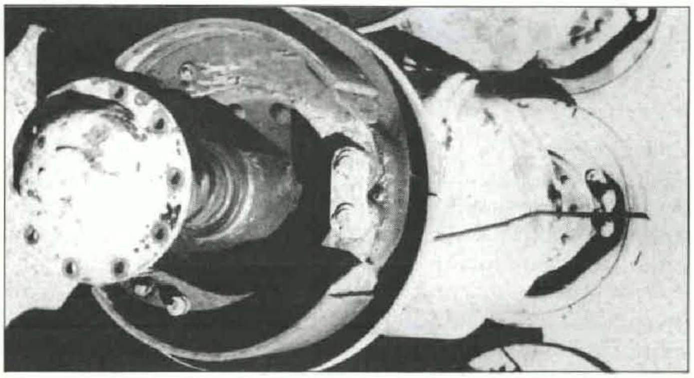
Called Delayed Desert Damage, or 3D, the program is designed to assess the extent of the damage and use the information as a base for engineering analysis, to revise short-and long-term maintenance policies and determine funding needs. The Maintenance Directorate at TACOM has the responsibility for 3D.

"By learning how our equipment performed in the relentless heat and blowing sand, we can improve Army readiness," said LTC Al Lopez, maintenance director at TACOM.

"TACOM equipment was tested for this type of environment and performed exceptionally well, but the unrelenting heat and sand may have accelerated normal wear," according to Ralph Janus, 3D action officer.



A build-up of sand causes premature brake wear in these 5-ton truck axle assemblies.



In some cases, sand breached the seals and contaminated the oil and grease, causing abrasion damage.

As a result of Operations Desert Shield and Storm, TACOM has found evidence of unique and premature wear caused by sand ingestion and other environmentally-induced factors on equipment returned to units and depots, says Janus. The extent of latent or hidden damage and long-term effects is being evaluated by using field experts and through a complete inspection and disassembly process of examining numerous vehicle systems.

Major systems being assessed in the 3D program include the M1A1 Abrams Tank, M2A1 Bradley Fighting Vehicle, High Mobility Multipurpose Wheeled Vehicle, Heavy Equipment Transport, M939 Five-Ton Cargo Truck, and Heavy Expanded Mobility Tactical Truck.

The results should lead to a high-tech version of the old Army program known as FITCALS. The FITCALS acronym stands for: Feel, Inspect, Tighten, Clean, Adjust, Lube, and Smell, LTC Lopez explained.

The 3D program has already produced enough information to use in revising Defense Business Operating Fund projections and to publish new maintenance procedures and advisories. The final result will enhance equipment life with a balanced Army-wide maintenance program.

TACOM will publish a special technical bulletin outlining maintenance procedures which will help units sustain equipment.

"The 3D program actually goes beyond the systems mentioned. And though we are only one-third of the way through, we've already seen high dividends from our work," Lopez continued.

The combined input of field data and special depot inspections at Anniston, AL, Red River, TX, and Tooele, UT, is being evaluated by a matrix team of engineers, technicians, specialists and other major subordinate command representatives. So far, the data has provided enough information for the team to make certain insightful assumptions.

"For example, 3D analysis of tactical vehicles showed that sand and other environment-induced factors caused premature wear of brake drums, steering knuckles and internal gears. Sand penetration of the seals was the most significant cause of premature wear. Brake shoes exhibited scoring and cuts caused by sand," Janus noted.

"We found evidence that sand entered many of the seals and caused abnormal wear. Internal gears also showed signs of heat stress and unusual wear," Janus added.

TARDEC Gets New Track-Pad Tester

Researchers at the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI, expect to achieve significant R&D cost savings, thanks to a new computer-controlled machine that can test combat-vehicle track pads in the laboratory under closely simulated field conditions.

Currently, the machine is undergoing shakedown testing in preparation for a field validation test using the M1-series tank T158 track system.

The machine is the result of a program that the U.S. Army Materials Technology Laboratory initiated and that the U.S. Army Laboratory Command funded. MTS Systems Corporation was contracted to build for TARDEC a generic test system for combat tank track pads. The system can accommodate track systems up to 28 inches wide and currently supports fixturing to test track pads used on M1-and M60-series tanks, as well as M2 and M3 Bradley vehicles.

In their quest to extend track life, engineers field test track pads made from numerous types of rubber compounds in an effort to identify more wear-resistant materials. But field testing, which involves driving combat vehicles over various courses at Aberdeen Proving Ground and other Army test sites, is expensive and time-consuming.

The new machine will not eliminate field testing. But, according to TARDEC's Michael Saxon, who is in charge of its operation, it will play an important supplemental role. "Laboratory testing is much less costly than field testing," he explained. "Therefore, the long-range goal is to develop a test that will enable us to evaluate compounds in the laboratory so that we can isolate good and bad ones. Then we can limit field testing to those compounds that demonstrate a high potential for improving field performance and durability."

The machine is designed to simulate the time a track pad spends on a road or ground surface and the load induced by the vehicle's road wheels running over the track as well as the return time spent off the ground at speeds from 5 to 40 mph.

The machine consists of a platform called a load cell that supports the track during testing, three hydraulic actuators that simulate vehicle-induced vertical and horizontal track loads and motions, and a computer.

To conduct a test, a slab of concrete, granite or other representative material is fastened to the load cell and serves as a simulated road surface. A complete track link is clamped to a fixture located above the load cell. The operator then programs the computer with test instructions—for example, the type of vehicle to be simulated, the speeds at which it is to travel and the duration of the test. The computer then executes the test.

When the test begins, two vertical actuators lower the track pad onto the load cell test surface with sufficient downward force to simulate the weight of the vehicle. The actuators are programed to lower the rear of the pad down prior to the front to create the effect of a track link approaching and contacting the road. The track link and pad assembly is compressed and rocked to simulate the vehicle weight distribution by the road wheels passing over the top of the link.

During this portion of the cycle, the third actuator, which is mounted horizontally, draws the track link rearward slightly to simulate "walking." This is the tendency of a track link to slide on the terrain every time a road wheel runs over the pad. Each time the link walks, small amounts of material are sheared off the pad, contributing to the pad wear.

The actuators then lift the track assembly off the terrain surface to simulate the time needed for the track link to complete its travel over the sprocket, support rollers and idler. It is then returned to its starting point, and the cycle repeats. Throughout the test, sensors in the load cell, hydraulic actuators and the track system itself measure rubber characteristics and other track pad performance data, feeding them into the computer, which records them into a file for later evaluation.

Saxon indicated that in addition to reducing test costs, engineers hope to reduce the test time from days to hours by compressing the time a track link normally spends off the ground, increasing the track load and lengthening its walking distance. "Right now," he said, "we are studying different road surfaces and how they induce different failure modes into the pad. Once we develop a test that duplicates the wear we get in the field, our goal will be to find the right amount of shearing force and movement that will induce accelerated wear but still retain the wear characteristics of a field tested pad."

The preceding article was written by George Taylor, a technical writer-editor for the U.S. Army Tank-Automotive Command. He has a bachelor's degree in journalism and a master's degree in communications from Michigan State University.

YPG Tests Japanese Projectile

Only the project engineer's countdown can be heard at the gun position on this cold December morning. Suddenly, the desert calm is shattered by the deafening blast from the Japanese FH70 Howitzer, as a 96-pound Japanese Basebleed (JBB) Projectile is sent on its way to its target. More than 1.5 minutes will elapse before the projectile reaches its destination, some 19 miles away. Seconds after the projectile leaves the muzzle, the gun crew leaves the armored bombproof shelter and gets ready to load another round.

This was a typical scene on the Kofa Firing Range at Yuma Proving Ground (YPG) during firing operations for the engineering test of the JBB. More than 800 JBB projectiles were tested from mid-October through mid-December of 1991. The test included a range and accuracy phase which examined the projectile under a prescribed set of firing conditions; a temperature sensitivity phase, which tested the effects of high and low temperatures on the basebleed unit performance; and a worn tube phase, which demonstrated the changes in projectile performance when fired from worn tubes.

The 155mm JBB, which is being developed by the Technical Research and Development Institute of the Japanese Defense Agency (JDA), will eventually replace U.S.-produced rocket-assisted projectiles in Japanese 155mm Howitzer batteries. The basebleed concept, which extends a projectile's range, is not unique to the JBB. It is utilized in several projectiles around the world, including one U.S. 155mm projectile. The concept involves burning propellant at the base of the projectile during flight. The resulting "jet" increases the pressure at the base of the projectile, reducing the drag force and allowing the projectile to fly further.

The Japanese Basebleed.

YPG was selected as the test site because the maximum range available on Japanese proving grounds is 18 kilometers (approximately 11 miles), a range easily exceeded by the JBB. Another reason for YPG's selection is that for four successive years (beginning in 1988), JDA customers have been very satisfied with other artillery testing performed at YPG.

Future YPG testing of the JBB will include an operational test, which will evaluate the interface between the projectile, howitzer and non-test artillery troops (using JDA troops), and a firing tables test, which will generate data from which firing tables for this projectile will be produced. All YPG testing, which involves approximately 2,200 projectiles, should be completed by December 1992.

The preceding article was written by Julio Dominguez, branch chief, Munitions and Weapons Division, Yuma Proving Ground.

Howitzer and FAASV Get Improved Engine

A joint program involving the U.S. Army Tank-Automotive Research, Development and Engineering Center (TARDEC), Warren, MI, the Armament Research, Development and Engineering Center, and Detroit Diesel Corporation has led to the development of an improved engine for the Army's new M109A6 Paladin howitzer and M992A1 Field Artillery Ammunition Supply Vehicle, an M109 derivative.

The engine is a modified version of the Detroit Diesel-built eight-cylinder, 405-horsepower 8V71-T diesel used in earlier M109-series howitzers and M992-series FAASVs. The Army's decision to adopt the engine came after it repeatedly demonstrated good performance in laboratory and field tests.

The new engine offers several improvements. It is inherently easier to cool, is more fuel-efficient, develops more power and starts rapidly in cold weather.

In laboratory tests, the engine rejected about 10 percent less heat to the radiator than its standard counterpart, thus significantly reducing the radiator's cooling load. Moreover, it demonstrated a fuel-economy improvement ranging from 6 to 25 percent, depending on operating conditions. This improvement came despite an increase in the engine's horsepower output from 405 to 440. The engine also started quickly at temperatures down to minus 25 degrees F.

Additionally, the engine completed a 400-hour NATO endurance test last March. This is a mandatory standard laboratory test designed to determine the suitability of engines for NATO country and U.S. military ground vehicle use.

Dubbed the 8V71T-LHR (low-heat-rejection engine), it looks essentially the same as the original howitzer engine and is designed as a "drop-in" replacement power plant that requires no major vehicle modification. But there are significant differences inside the engine.

According to Dennis Palazzolo, chief of the Self-Propelled Artillery Branch in TARDEC's Systems Engineering Directorate, one change is that the cylinder heads have been redesigned to reduce heat transfer from exhaust gas to the engine coolant during engine operation. He said the new heads feature exhaust ports which have been modified to include stainless steel internal sleeves that serve as heat shields. As exhaust gas passes inside the sleeves, air gaps between the sleeves and the exhaust-port walls insulate the surrounding head material from the 1,000-degree Fahrenheit exhaust heat. This allows the exhaust heat to pass through the sleeves and leave the engine through the exhaust instead of transferring heat to the coolant in the cylinder heads and leaving through the cooling system.

Palazzolo said another feature helping the engine to run cooler is special high-temperature insulation that covers the exterior surfaces of the engine's exhaust manifolds. The material keeps the temperature of the engine compartment down by preventing the heating of the engine compartment air, thus further reducing the temperature of the air entering the vehicle radiator.

Normally this would not significantly affect engine cooling, since the radiators in most vehicles receive cool outside air directly through a grill. But Palazzolo explained that in howitzers, the incoming air first travels around the engine where it picks up exhaust-manifold heat before reaching the radiator, thereby making the radiator's job of cooling the engine more difficult.

"Though the low-heat-rejection engine has more power than the old engine, which would normally cause poorer vehicle cooling, it has been shown in our tests that the M109 has much better cooling with the LHR engine," Palazzolo said.

According to TARDEC project engineer John Swigart, the new cylinder head design and manifold insulation have combined to produce another important benefit—improved fuel economy. "By stopping the heat loss from the exhaust while it is in the cylinder head," Swigart explained, "more heat energy is available to the turbo charger for conversion into additional mechanical power. So we were able to make the low-heat-rejection engine more fuel efficient by redesigning the engine air intake system to use this increased energy."

Swigart added that this improvement, coupled with changes to the engine's fuel-injection system, enabled engineers to achieve the 35-horsepower increase without increasing the fuel consumption.

Also featured in the new engine are glow plugs, small electric heating elements that make cold-starting easier by providing hot spots in the cylinders to ignite the fuel. The original M109 engine, like many Army diesels, uses a diesel-fuel-fired heater to preheat the incoming air during cold starting. But such heaters require much maintenance and skill to use in extremely cold temperatures.

Swigart said the glow plugs used in the low-heat-rejection engine have proved to be highly effective in saving battery power formerly necessary to start the engine and reducing electrical system maintenance, particularly in below-zero weather. According to Palazzolo, the M109A6 Paladin and M992A1 FAASV are scheduled for introduction to troops during the fourth quarter of FY93. He said current plans call for the Army to buy 824 Paladins and 660 FAASVs over the next several years. He added that 664 FAASVs will also be retrofitted.

The preceding article was written by George Taylor, a technical writer-editor for the U.S. Army Tank-Automotive Command. He has a bachelor's degree in journalism and a master's degree in communications from Michigan State University.

JSSAP Office Concludes M-16 'Can't Be Beat'

After eight years of research, design and testing the latest in rifle technology, the Joint Service Small Arms Program (JSSAP) Office at Picatinny Arsenal, NJ concludes that the U.S. military's M-16 standard issue still can't be beat.

None of the M-16's competitors could significantly outperform the weapon, which has been improved several times since it was first fielded during the Vietnam War in the late 1960s. In fact, none did any better overall than the M-16.

Four firms produced acceptable weapons systems, all based on new concepts.

• Heckler & Koch, GmbH of Oberndorf am Neckar, Germany, designed a semi-automatic three-round burst or fully automatic weapon that fired caseless 4.92mm ammunition. Of all the candidate systems, it was the most innovative. A unique hydraulic buffer delayed the recoil of the weapon until the third round burst left the muzzle. Because the German Army was already developing the system for its G-11, the research was co-funded by the U.S. and Germany.

• AAI Corp., of Hunt Valley, MD, produced a flechette-firing 5.56mm modified version of the previously developed Serial Bullet Rifle, which has two modes of fire: semi-automatic and three-round salvo burst.

• Colt of Hartford, CT, produced a modified M-16A2 capable of firing a "duplex" 5.56mm round, which contains two bullets, nose to tail, in the same cartridge case. Another innovation was a muzzle compensator, which decreased recoil by about 40 percent.

• Steyr-Mannlicher of Austria produced a rifle using plastic-cased lightweight flechette ammunition, and had the simplest weapon, the simplest round and the most cost effective approach of any of its competitors. Poor round-to-round dispersion, as with the AAI model, was its greatest deficiency.

The tested M-16 was the standard issue A2 model which fires 5.56mm rounds in the semi-automatic or three-round burst modes.

Ares Corp. of Port Clinton, OH, and McDonnell Douglas Helicopter Company, Mesa, AZ, also had systems being considered under this program but they were not taken to the field experiment because their designs lacked technical maturity.

Vernon Shisler, head of the ACR program, said that the results produced significant advances in weapon design, especially in lightweight caseless and plastic-cased systems, which could reduce both a soldier's basic load and the logistics needed to keep him resupplied. "Our effort," Shisler said, "was to investigate how we could improve the hit performance of soldiers in a stressed environment where multiple targets appear quickly and for short amounts of time."

Other goals of the program were to advance the state-of-the-art in rifle design by investigating new and emerging technologies and to develop a performance data base for the M-16 rifle. Both of these goals were met, Shisler said.

To double the M-16's hit probability—the program's benchmark—the ACR weapons were designed to fire more than one projectile with each trigger pull. Dispersion of these multiple launch bursts was controlled to compensate for expected large aiming errors.

"Using the M-16A2 rifle as a base to measure the other weapons against, we physically and mentally stressed the soldiers through exercising, competition, time constraints and target behavior to replicate the large aiming errors experienced in combat. Despite all this stress, the soldiers did significantly better than expected.

"This means that the size of the controlled bursts from the ACR weapons was too large for the aiming errors that were actually experienced. From a functional point of view, however, all weapons performed extremely well.

"We have concluded that soldier performance has been underestimated because of the less sensitive instrumentation of previous ranges. This usually meant we did not always record all target hits. With the range that we used, we had several methods to determine target hits and bullet location," Shisler said.

The computer-driven range, located at Fort Benning, GA, was specially constructed to measure the dispersion patterns of the multi-burst salvos. To record these patterns, electronic devices were constructed at certain targets on the range to determine exactly where the projectiles—flechettes or bullets—penetrated those targets or the air space around them.

Although none of the concepts will be pursued into the development stage, Shisler says the data base on soldier rifle performance will help in future development.

Army Consolidates AVSCOM and TROSCOM

The U.S. Army Aviation Systems Command (AVSCOM) and the U.S. Army Troop Support Command (TROSCOM) are being consolidated into a new command—the U.S. Army Aviation and Troop Command (ATCOM). The consolidation will take place by Oct. 1, 1992.

ATCOM, with headquarters in St. Louis, MO, will have about 4,500 military and civilian personnel drawn from similar positions currently with AVSCOM and TROSCOM. The new command will be a major subordinate of the Headquarters, U.S. Army Materiel Command in Alexandria, VA.

The consolidation results from a Defense Base Closure and Realignment Commission recommendation which is estimated to save about $22.5 million annually. The savings will result from a reduction of about 500 positions by Mar. 31, 1993. AVSCOM and TROSCOM are expected to have achieved a reduction of about 450 of these positions by Oct. 1, 1992 through normal attrition. AVSCOM and TROSCOM employees involved in the consolidation will be reassigned locally to ATCOM with no involuntary separations, no reductions to lower grades and no retirements resulting from this action.

RD&A NEWS BRIEFS

YPG Conducts Tire Tread Tests

Civilian support of Yuma Proving Ground's testing is a key factor in getting the job done. Both civil service and contractor personnel are involved in the overall series of tire tread tests being conducted at Yuma Proving Ground (YPG) in Arizona. Since YPG is the desert environmental test center for the U.S. Army, many types of vehicles are tested routinely on its infamous desert mobility test courses.

As a result of overall poor wheeled vehicle mobility in Southwest Asia during Operation Desert Shield/Storm, the U.S. Army Test and Evaluation Command (TECOM) was tasked by the U.S. Army Tank-Automotive Command (TACOM) to conduct a series of tests. These tests were aimed at improving the desert mobility of the Army's tactical wheeled vehicle fleet. YPG was chosen to support this effort because of its climate which is very much similar to Southwest Asia.

According to Andy Kowalsky, one of YPG's test team members, the directives were received from TACOM as to what to test and how to test it. Testing began in November, 1990.

Kowalsky added that the main thrust of this effort is to evaluate the mobility, performance and durability of tires for the CUCV series of vehicles, the 2½- and 5-ton series of vehicles and the HMMWV vehicles. Five different baseline tires will be compared to a number of radial and retread tires. All tires, including the baseline, will undergo thermal profile testing, sand mobility performance testing and endurance testing so that TACOM can determine which are the best types for future procurement.

To date, four of the baseline tires and five radial tire candidates have been tested to determine the thermal profile and sand mobility. A thermal profile is the envelope of temperature, pressure and speed that a tire can operate within. YPG is awaiting an optimum tire pressure recommendation based upon the above test results so that endurance testing may begin.

Several other tests, which have been initiated to date, include:

- An evaluation of commercial radial tires is being conducted for the M747 semi-trailer payloaded with an M1A1 tank. Three radial tires have undergone limited endurance testing ranging from 1,000 to 4,000 miles. The tests were performed to determine form, fit, and function of the tires on the M747.
- An evaluation of a single wheel application on the rear axles of a 2½-ton truck has been performed. More than 13,200 durability miles were accumulated on vehicles configured in this manner.
- Two standard CUCV's were modified to increase overall desert mobility and improve ride and handling during off road operation.
- Testing was conducted on the Mack Truck/Tractor, with the tractor towing an M747 loaded with a Bradley Fighting Vehicle.

CONFERENCES

- The 41st Defense Working Group of Nondestructive Testing (NDT) will be held Nov. 16–20 at the Holiday Inn, Tucson, AZ. It is sponsored by the U.S. Air Force, Headquarters, Aerospace Maintenance and Regeneration Center, Davis-Monthan Air Force Base. It is an annual meeting of all Department of Defense and other government activities who have NDT responsibilities. Additional information may be obtained by writing Headquarters, Aerospace Maintenance and Regeneration Center, Nondestructive Inspection Supervisor, ATTN: Paul Machado, Davis-Monthan AFB, AZ 85707-6201 or by calling commercial (602) 750-3670 or DSN 361-3670.
- The International Symposium on Spectral Sensing Research will be held Nov. 16–20 at the Stouffer Waiohai Hotel, Kauai, HI. This symposium is co-sponsored by government (U.S. Army, U.S. Navy, NASA, Department of Energy, National Oceanic and Atmospheric Administration, U.S. Geological Survey, and the Environmental Protection Agency) and professional organizations.

  The theme of this unclassified meeting is High Resolution Sensing of the Environment with special emphasis on advances in fundamental hyperspectral research. The symposium will have tutorial presentations by international experts, technical sessions and workshops. Additional information is available from Judy Cole, (804) 865-7604.
- The Second International Seminar on Double Layer Capacitors will be held at the Ocean Resort Hotel and Conference Center, Deerfield Beach, FL, Dec. 7–9, 1992. This seminar will continue the discussion of double layer capacitors and similar high capacity energy storage devices initiated at the first meeting. An update on the current status and future promise of these high energy storage devices will be provided. Exhibit space will be available. For additional information concerning this seminar, write Dr. S.P. Wolsky, 1900 Cocoanut Road, Boca Raton, FL 33432, or call (407) 391-3544.
- The Army Aviation Association of America's Aircraft Survivability Equipment Symposium will be held Nov. 4–5 in Marietta, Georgia. For more information, contact Bill Harris, (203) 226-8184.

Concepts Analysis Agency Sponsors 31st Operations Research Symposium

The 31st U.S. Army Operations Research Symposium, sponsored by the U.S. Army Concepts Analysis Agency, will be held at the U.S. Army Logistics Management College, Fort Lee, VA, Nov. 16–18, 1992.

The theme of this year's symposium is "Analysis in Support of a Rapidly Changing Strategic Environment." The symposium will address the new analytic challenges brought about by rapid political and economic changes both at home and abroad, including the prospects of joint or coalition warfare; the increased emphasis on non-European contingency operations, the end of the Cold War, downsizing of the Army and other services, and the impact of reduced defense budgets on force modernization.

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

Inquiries pertaining to the symposium should be directed to: Director, U.S. Army Concepts Analysis Agency, ATTN: CSCA-SP, 8120 Woodmont Avenue, Bethesda, MD 20814-2797. Phone inquiries should be directed to COL Joseph E. Stull, Coordinator; LTC Ralph Hagemann, LTC Jeffrey Paulus, or Ms. Rosie H. Brown at DSN 295-1580, Commercial (301) 295-1580.

BOOK REVIEWS

The Corporation of the 1990s: Information Technology and Organizational Transformation

Edited by Michael S. Scott Morton, Oxford University Press, New York, New York, 1991

Reviewed by MAJ Patricia Pippin, a member of the Army Acquisition Corps currently attending the Materiel Acquisition Management Course, Army Logistics Management College.

The Corporation of the 1990s: Information Technology and Organizational Transformation presents the "final report" of the Management in the 1990s Research Program. This program, created in 1984 to examine the impact on organizations of information technology (IT), was a close collaboration between the Massachusetts Institute of Technology (MIT) Sloan School of Management and experts from major corporations. Corporate sponsors contributed funding, time, and effort, participating both in the research and synopsis processes. As a result, the material is a welcome mix of theory and practical information.

Surprisingly readable for a collection of individually written research reports, the book represents a valuable resource to managers who must solve information technology issues in the real world. Both of the program's basic premises are true for the military climate: a turbulent business environment, likely to remain so; and continued rapid evolution of IT over the next decade. Based on these premises, the research program looked to organizational change to enable corporations to remain viable. For businesses, viability translates to profit; for the U.S. Army (one of the corporate sponsors) this must mean maintaining mission capabilities while under steadily decreasing resources.

To do this, a military manager must not only understand the impact of IT on the organization, but seize the advantage it offers. Part I of the book explains the tools with which to identify and quantify the IT impact; part II focuses on identifying and designing strategic options for sweeping change; part III completes the model with a tactical focus on accomplishing detailed changes. The research reports outline three stages of IT impact and implementation together with processes to move an organization from one stage to the next. Applying the change model used by the authors (Value Process Model, found in Appendix D), depends on accurately identifying the current and subsequent organizational IT stage.

Until recently, U.S. Army automation assets were used mainly to speed up processes that remained essentially unchanged. This stage, *automate*, is supposed to achieve savings through reduced production cost (fewer workers). However, in actuality, during the 1980s, the growth of personnel exceeded that of productivity, weakening the economic justification for implementing only this stage. The defense establishment is struggling to achieve the next stage, *informate*. In this stage, new IT tools and ways of thinking may be required in the production workforce; IT supported processes are intrinsically different from the manually supported ones they supplant. If successfully implemented, the new IT tools generate new information as a by-product of the basic task that, if properly identified and utilized, increases organizational opportunities. The goal of effective IT implementation is to pass through the third stage, *transformation*. In this stage, the changing nature of work started in the informate stage expands to affect the entire organization. As a result, the fundamental features of the organization are transformed to incorporate the opportunities presented by IT, creating structures flexible enough to survive and prosper in the challenging years ahead.

This book will be especially valuable to middle-and senior-level managers working to select organizational change routes with decreasing resources. Until recently, IT issues were left to a subject matter expert. Now, IT contains both the problem and the solution and any successful change philosophy must incorporate it from the outset.

Army Publishes ILS Lessons Learned Report

The 18th edition of the Integrated Logistic Support (ILS) Lessons Learned Report was published this year.

The ILS Lessons Learned Program was established in 1980 to allow those involved in the ILS process to collect, validate and disseminate knowledge gained from previous ILS programs. The Army Materiel Command Materiel Readiness Support Activity, Lexington, KY, manages the program and distributes the report.

Topics covered in the 1992 edition of the report include TMDE testing, battery usage during Desert Shield/Desert Storm, tiedown provisions for the M1 Tank, total package fielding, provisioning, and cost and pricing data from subcontractors.

Tailored lessons learned reports are available upon request. These reports provide a collective set of lessons learned in a specific problem area within the ILS elements. Reports are also available which address topical areas such as manpower and personnel integration, contractual requirements, ILS testing, ILS management, and materiel fielding.

For additional information, contact Langston Thomas, DSN 745-3393 or commercial (606) 293-3393.

Government Printing Office Releases Publications

The following publications are available from the U.S. Government Printing Office:

Scenes from an Unfinished War: Law-Intensity Conflict in Korea, 1966#1969 Leavenworth Papers Number 19, By MAJ Daniel P. Bolger

Edition: 1991

Stock Number: 008-020-01252-1

Can Americans fight a successful counterguerrilla war? Thirty years ago most American soldiers would have answered "yes."

BOOK REVIEWS

The more historically minded might have justified that assertion by pointing to decades of U.S. Indian fighting, years in the Philippines battling Moros and Huks, several Marine Corps "Banana Wars" in Latin America, and the successful anticommunist struggle in post-1945 Greece. "Any good soldier can handle guerrillas," Army Chief of Staff General George H. Decker told President John F. Kennedy. Kennedy and his brain trust decided to test Decker's claim in a place called Vietnam.

The German Northern Theater of Operations 1940–1945
Edition: 1989, Reprint 1991
Stock Number: 008-029-00194-2

This volume describes two campaigns that the Germans conducted in their Northern Theater of Operations. The first was launched on April 9, 1940, against Denmark and Norway. The second they conducted out of Finland in partnership with the Finns against the Soviet Union. The latter campaign began on June 22, 1941, and ended in the winter of 1944–45, after the Finnish Government had sued for peace.

Joint Warfare of the U.S. Armed Forces
Edition: 1991
Stock Number: 008-020-01269-6

The nature of modern warfare demands that we fight as a team. This does not mean that all forces will be equally represented in each operation. Joint force commanders choose the capabilities they need from the air, land, sea, space, and special operations forces at their disposal. The resulting team provides joint force commanders the ability to apply overwhelming force from different dimensions and directions to shock, disrupt, and defeat opponents. Effectively integrated joint forces expose no weak points or seams to enemy action, while they rapidly and efficiently find and attack enemy weak points.

Individuals who would like more information on any of these books can contact Mr. Thompson, U.S. Government Printing Office, Dept: SSMC, Washington, D.C. 20401; Telephone (202) 512-2413.

BOOK REVIEWS

If you have read a book which you feel may be of special interest to the RD&A community, please contact us. The editorial staff welcomes your literary recommendations. Book reviews should be no longer than two double-spaced typed pages. In addition, please note the complete title of the book, the author's name, address, and commercial and DSN phone numbers. Submit book reviews to the address below:

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Building 201, Stop 889
Fort Belvoir, VA 22060-5889
Phone: (703) 805-4215/6 DSN: 655-4215/6
FAX: (703) 805-4044 DSN FAX: 655-4044

AWARDS

NTC/Fort Irwin Receive Conservation Award

The Los Serranos Group of the Sierra Club has presented its 1992 Conservation Award to the National Training Center (NTC) and Fort Irwin. The NTC earned the award for its geothermal research and development program.

Geothermal R&D began at Fort Irwin two years ago, which is an ideal location for tapping into geothermal energy because of the many secondary geological faults located on the post. "These faults are conduits for underground water, as well as natural seams where heat from the center of the earth can escape to the surface, said Rene Quiones, Fort Irwin's project manager for the geothermal program.

Working with NASA, Fort Irwin used satellite photography to identify these faults and the most likely spots to harness geothermal energy, according to Quiones.

Geothermal energy uses hot water in the earth to create electricty. A geothermal plant would take this super-heated water from within the earth's crust, bring it to the surface, and then turn it into steam to turn turbines to produce electricity.

Award Recipients Named

Listed by agency, the following Army Acquisition Corps personnel recent recipients of key awards.

Army Acquistion Executive Support Agency: MAJ Michael D. Gayle, Meritorious Service Medal (MSM); LTC Wayne D. Killian, MSM; MSG Larry P. Landon, MSM; LTC Chester L. Rees Jr., Legion of Merit (LOM); SFC George A. Williams, MSM; MAJ Edmund A. Dowlin, MSM; LTC William R. Hertel, LOM; CPT Campbell D. Allison, MSM; CPT Stephen M. Corcoran, MSM; COL Lawrence W. Day, LOM; LTC Stephen P. Ansley, MSM; MAJ Douglas P. Anson, MSM; MAJ Charles M. Barnett, MSM; COL John M. Harnisch, LOM; MAJ Robert D. Buckstad, MSM; LTC Glenn J. Harrold, MSM; MAJ Samuel A. Holloway, MSM; CPT(P) Russell J. Hrdy, MSM; MAJ Thomas J. Moriarty, MSM; MAJ Robert A. Otlowski, MSM; MAJ James P. Sanders, LOM; MSG Michael R. Womer, LOM; and LTC Thomas D. Hardy, MSM.

Strategic Defense Command: LTC Joe D. Seay, LOM; LTC Joe R. Elmore, LOM; MAJ Michael Bibby, MSM; COL Thomas Kunhart, LOM; MAJ Michael Hunter, LOM; LTC Andrew Green, MSM; COL Thomas Smalls, LOM; CPT Terrance Bauer, MSM; MAJ John F. Owens, MSM; and LTC Stephen D. Rice, LOM.

IMPORTANT NOTICE

The Army RD&A Bulletin office has relocated to Fort Belvoir, VA. All correspondence should now be addressed to:

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Fort Belvoir, VA 22060-5889.

Our new phone numbers are (703) 805-4215/6 or DSN 655-4215/6. Fax numbers are (703) 805-4044 or DSN 655-4044.

FROM THE ARMY ACQUISITION EXECUTIVE

A healthy defense industrial base is essential to meet the Army's needs for affordable and high-quality weapon systems, for supporting contingency operations, for surging production of consumable items in times of crises, and for developing advanced technologies to upgrade current and produce future systems. We are increasingly concerned about the industrial capabilities that will be needed to design, develop, produce and sustain our weapons systems of the future.

As the dollars available for modernization shrink in the face of reduced world threats, the defense industrial base will inevitably contract. In previous articles, I have discussed the Army's strategy of continuous modernization, our resource allocation strategy, and the Department of Defense's (DOD) revised approach to acquisition. Each has an impact on the industrial base and, as in the past, it will adjust itself to conform to these strategies and specific requirements by DOD. Indeed, defense companies have responded already with consolidations, diversifications, and other major moves in order to focus on market niches that may fare well in the new acquisition environment.

These changes bring uncertainty. There is no explicit market mechanism which assures that defense companies will always act in a manner that best protects our national security interests. Likewise, there is no guarantee that, without careful planning, the aggregate of the winners of individual source selection decisions over time will constitute an adequate industrial base that will be able to meet our future needs. We must strive for an integrated industrial base that is comprised of original equipment manufacturers, government depots, build-to-print companies, and small and disadvantaged businesses. Our challenge is to ensure that the mix of these types of manufacturers is appropriate for the new defense environment, and that the government's role in shaping the defense industrial base is carefully thought out.

As we in the military services and in DOD make day-to-day decisions on strategies and requirements, we are indirectly shaping the size and composition of the future industrial base. We can directly influence the downsizing of the base by individual source selection decisions, by allocation of workload among various types of suppliers, and by other means that we may want to pursue. The remaining issue then becomes: To what extent should DOD intervene directly to shape the future defense industrial base?

To the extent permitted by law, regulation, and fairness, I think we should act to ensure that the minimum essential core capability will be available to satisfy our future modernization requirements and to provide the base for future reconstitution of that industry. By this, I do not mean that DOD should buy equipment that is not needed for warfighting just to protect the industrial base. I do not mean that DOD should protect jobs for the sake of avoiding unemployment. I do not mean that DOD should protect specific companies. However, it is important that we preserve certain skills in the workforce and protect certain industry capabilities when such actions are less costly than would be full shutdown and restart.

The industrial base is a key component in the Army's ability to equip its future force. There are other steps that we need to consider to help ensure a responsive, innovative, and financially sound industrial base.

We will necessarily have to reexamine our traditional approach to competition. In the mid-1980s, when defense budgets were rising dramatically, we found that more competition was needed to ensure best value to the government. The high volume procurement of that time made it desirable to establish multiple sources for the procurement of many items. In the current environment, we may have no new production of certain equipment, and we certainly will not have sufficient production to sustain multiple producers for most items. We might find ourselves with only a single supplier in some areas and we will have to adapt accordingly. To ensure the delivery of high-quality equipment at fair prices, we may have to resort to means other than competition. This will demand strong management skills throughout the Army acquisition community.

Likewise, with low volume production, we will need to reexamine our attitudes toward the breakout of spare parts and components to smaller producers, because the low procurement quantities may not warrant the up-front costs associated with preparing technical data packages and drawings and for qualifying new sources.

The significant decline in defense spending should cause us to examine carefully the infrastructure associated with defense acquisition. We have a bureaucracy that has grown to accommodate acquisition budgets that were, in some cases, double their present levels. As these budgets decline, and the defense industry that executes those budgets "downsizes" appropriately, we should reduce significantly—if not proportionately—the government component of acquisition infrastructure and cost. We need to attack these costs with the same vigor that we apply to reducing contractor overhead.

Finally, our new acquisition environment should dictate that we take a fresh look at the way we deal with program risk. Clearly, without a specific compelling threat, we will get away from the high levels of concurrency that characterized some programs in the mid-1980s. At the same time, we need to recognize that trying to achieve minimum risk, as opposed to optimum risk, is counterproductive. Even if it were achievable, a "zero risk program" would be prohibitively expensive and our technology would be obsolete before it was fielded. Clearly what is needed here is a common sense approach that avoids highly concurrent and/or high risk programs while not losing sight of the importance of fielding our technology in some reasonable time.

In summary, it is important that we work with industry to manage programs and limited resources as wisely as possible. My next article will focus on methods that we can and should use to protect core industrial capabilities.

Stephen K. Conver

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