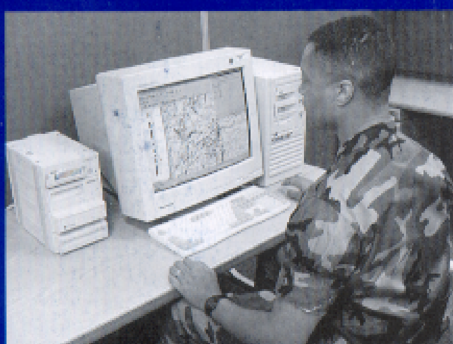
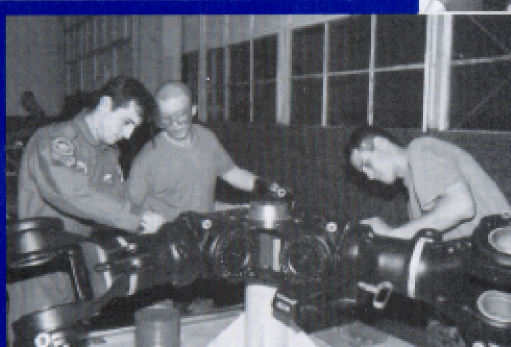
ARMY LOGISTICIAN

MARCH-APRIL 2000





Readiness and Reliability

The Assistant Secretary of the Army for Acquisition, Logistics, and Technology shares his thoughts on readiness. *See page 28.*

PB 700-00-2 Headquarters, Department of the Army

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ARTICLES

DEPARTMENTS

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Submissions: Articles and information on all facets of logistics operations and functions are solicited. Direct communication is authorized and should be addressed to: EDITOR ARMY LOGISTICIAN/ALMC/2401 QUARTERS RD/FT LEE VA 23801-1705. Phone numbers are: (804) 765-4761 or DSN 539-4761; Fax (804) 765-4463 or DSN 539-4463; e-mail alog@lee.army.mil. Articles may be reprinted with credit to ***Army Logistician*** and the author(s), except when copyright is indicated.

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COVER

An increase in the Army's responsiveness will require a corresponding increase in the reliability of weapons and equipment. This issue contains several articles that address various aspects of the readiness-reliability connection. The photos on the cover demonstrate the wide spectrum of Army systems and activities that will benefit from increased reliability.

This medium is approved for the official dissemination of material designed to keep individuals within the Army knowledgeable of current and emerging developments within their areas of expertise for the purpose of enhancing their professional development.

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

Official:

Joel B. Hudson

JOEL B. HUDSON
Administrative Assistant
to the Secretary of the Army
9935003

Coming in Future Issues—

- Integrating Active and Reserve Component Training
- Ensuring Food Safety
- Hydrogen As an Alternative Fuel
- Determining War Reserves: A Better Way
- Improving Reserve Support to Power Projection Platforms
- Prairie Warrior Logistics Challenge
- Capitalizing on Digital Logistics at CGSC
- Logistics After Initiative: Theater Support Command
- Force XXI in Action
- Templating Data Base Management
- Cold War Ship Carries NATO Weight
- Alternatives to the Soldier Canteen
- Joint Total Asset Visibility

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ALOG NEWS

ARMY'S GOAL IS TO BALANCE RESPONSIVENESS WITH CAPABILITY

The Army's goal, under the vision for the future presented by the Chief of Staff, General Eric Shinseki, is responsiveness balanced with capability. That was the observation of the commander of the Army Training and Doctrine Command, General John Abrams, in a recent appearance at an Association of the United States Army forum. The Army wants to be able to put a brigade on the ground anywhere in the world in 96 hours, while remaining "the indisputable leader of land warfare."

To achieve that goal, the Army is studying the strengths and weaknesses of two brigades at Fort Lewis, Washington—one from the 2d Infantry Division and one from the 25th Infantry Division (Light). According to General Abrams, " . . . inside the two initial brigades, there are some very strategic areas that are going to inform the rest of the Army on how we can balance responsiveness with capability."

However, any new approaches "cannot just appeal to the sensibilities, they've got to survive the test of our practitioners—our great young noncommissioned officers and junior enlisted soldiers." So Army planners are not only redesigning combat systems, they also are analyzing the human aspects of a force that must be ready for combat anywhere, anytime. "How do you maintain the training readiness of an organization that's on this kind of footing; how do you keep this razor's edge of readiness and reconcile unit spirit when this is a life's career?" General Abrams noted that these questions are just as important to planners as developing technology and will remain a challenge as the vision is implemented.

PORTABLE DOCUMENT VIEWER DEVELOPED

Soldiers soon will be able to carry a computer display unit as part of their personal equipment. The Military E-Book, as it is called, acts as a document viewer and a terminal that receives data and graphics such as orders, maps, and troop movements. The E-Book can interface with a computer worn on a soldier's body. It gives soldiers the ability to compute and store data and to communicate with one another directly.

The small (approximately 5 by 7 inches), lightweight, ultra-low-power, wireless device can be carried on a belt, in a cargo pocket, or on load-bearing equipment. It can store an image indefinitely, even without power. The viewer screen is visible in bright sunlight and emits no light at night. Special goggles enable the soldier to read the display at night.

The Army Soldier Systems Center, the Defense Advanced Research Projects Agency, and two private industry partners—Honeywell and Kent Displays, Inc.—are the product developers. Military police units will conduct the first test of the device.

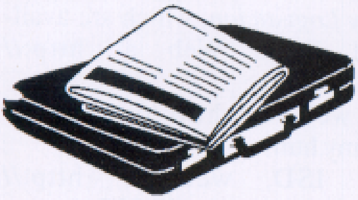
ARMY CREATES FIRST SPACE BATTALION

The Army's use of space to support the battlefield took a significant step forward last December with the activation of the 1st Space Battalion at Peterson Air Force Base, Colorado. The new unit will consolidate under the operational control of one commander several elements that provide space support.

Previously, these elements—four space support teams and five joint tactical ground stations—worked under the G3 of the Army Space Command. Space support teams provide units with space-generated intelligence, planning, and operational products. Joint tactical ground stations are forward-deployed activities that provide theater commanders in chief with the only in-theater tactical ballistic missile warning capability on the battlefield.

According to Lieutenant General John Costello, the commander of the Army Space and Missile Defense Command (the parent organization of the Army Space Command), "The 1st Space Battalion helps institutionalize space within the Army by giving our soldiers a familiar structure to work with . . . This unit is an example of the type of organization that will enable the smaller, lighter, more agile fighting forces recently envisioned by General Eric Shinseki, the Army Chief of Staff."

(News continued on page 58)



NEWS

(News continued from page 1)

FORT HAMILTON CONTRACT SETS MODEL FOR UTILITY PRIVATIZATION

Fort Hamilton, New York, is the first Army installation to transfer responsibility for all of its utility systems to a private firm under one contract . Under the 10-year contract, Enron Energy Services of Houston, Texas, will gain ownership of Fort Hamilton's utility infrastructure and will operate, maintain, and upgrade all post utilities, including electric, gas, water, wastewater, and storm water systems. At the end of the 10 years, the Army will either negotiate a new contract with Enron or, if an agreement cannot be reached, negotiate to repurchase the utilities.

The Fort Hamilton contract is the latest development in the Army's ongoing utility privatization program. Under a Defense Reform Initiative directive, the Army has until the end of this fiscal year to decide on whether or not it should privatize all of its 1,104 utility systems. The Army then will have another year to begin the contracting process for all systems selected for privatization. According to Army officials, the primary purpose of privatization is not to save money but rather "to provide reliable systems" in the face of appropriations that are not sufficient to keep post utility systems from deteriorating.

The Fort Hamilton contract brings the number of privatized utility systems to 150. More than 200 systems are in the contract negotiation stage. Another 144 will not be privatized: 15 because transfer to the private sector was considered "uneconomical," 56 because no private firm was interested in them, and 73 because the Army judged that privatizing them could create security problems.

The Army expects the consolidated Fort Hamilton contract to set a precedent. The Military District of Washington is already using the Fort Hamilton strategy by soliciting bids on one contract for privatizing 13 utility systems at 5 installations in the National Capital Region.

GUARDSMEN GAIN PEACEKEEPING MISSION

For the first time since American soldiers went to Bosnia in late 1995, an Army National Guard unit is serving as the command and control headquarters for the peacekeeping mission there. Previous rotations have been performed by Active Army units, reinforced by small Army National Guard and Army Reserve detachments.

A task force from the 49th Armored Division, headquartered in Austin, Texas, departed in February for an 8-month tour of duty in Bosnia. "We feel like this is a model," said Colonel Garry Patterson, chief of staff of the 49th Armored Division. "This . . . may be the blueprint for the success [of] . . . full integration of both active component and reserve component units."

The Army National Guard soldiers comprising the task force are from units in Abilene, Austin, Dallas, San Antonio, and other Texas cities. Active Army soldiers participating in the mission are from Fort Carson, Colorado; Fort Huachuca, Arizona; and Fort Sill, Oklahoma. The first shipment of task force equipment left Corpus Christi, Texas, on 16 January. A second shipment followed on 4 February. Together, they included 447 vehicles, helicopters, and shipping containers. Equipment loading was directed by soldiers and civilians of the 596th Transportation Group, Beaumont, Texas, a unit of the Military Traffic Management Command Deployment Support Command.

☐ Members of the 596th Transportation Group load equipment headed for Bosnia with the 49th Armored Division task force.

TELEMAINTENANCE SYSTEM WILL LINK DEPOT TECHNICIANS TO EQUIPMENT IN THE FIELD

Tobyhanna Army Depot, Pennsylvania, successfully demonstrated a prototype telemaintenance system that someday will allow logistics assistance representatives (LAR's) to communicate with each other and with Tobyhanna. The system will allow technicians at the depot to see communications and electronics components in the field.

Designers intend for telemaintenance to make coordination easier among Tobyhanna technicians, LAR's, and soldiers in the field and to lessen the time it takes to troubleshoot and repair systems. Enabling the technician to see the equipment in place will reduce the number of pieces of serviceable equipment that are sent to Tobyhanna for repair, and it will allow the technician to give guidance for on-site repairs. LAR's conduct repairs on site, but a LAR's specialty may not pertain to the system he is trying to repair. This communication system will enable a LAR to seek assistance from another LAR who has specialized knowledge of the system under repair. If they cannot solve the problem, a technician at Tobyhanna will be contacted.

The telemaintenance system is composed of personal computers and belt computers (computers designed to be worn like a belt) that are linked through the Internet by a wireless local area network. Each belt computer will have a small multimeter and an oscilloscope to help diagnose problems and a digital camera to relay images of the component being repaired.

The prototype telemaintenance computer has been installed in three areas of the depot. The systems will be installed in four other Tobyhanna areas by October. Once completed, the system will have a computer chat room, an electronic drawing board, access to data schematics and other features to make it more versatile, and its communications route will be connected to the Internet by a dedicated local area network.

Fielding of the system to ASM–146, 147, 189, and 190 communications-electronics shelters will begin in 2002. The telemaintenance system should be available throughout the Army by 2010.

GOVERNMENT AND PRIVATE SECTOR SPLIT FIRST DLA DEPOT COMPETITIONS

The Defense Logistics Agency (DLA) has announced the results of the first public-private competitions for operating its distribution depots. The Government will continue to operate Defense Distribution Depot Columbus, Ohio, but it will contract out operation of Defense Distribution Depot Barstow, California. The Barstow depot will be managed by EG&G Logistics of Manassas, Virginia.

DLA announced in March 1998 that it would conduct public-private competitions for operation and management of 16 of its distribution depots. The competitions are conducted under the guidelines of Office of Management and Budget Circular A–76, "Performance of Commercial Activities." All competitions should be completed by mid-2003.

WARRANT OFFICER CORPS LOOKING FOR QUALIFIED NCO'S

The Army Recruiting Command is seeking noncommissioned officers (NCO's) who have the experience, ambition, and desire to become officers, leaders, or technicians in today's Warrant Officer Corps.
To be eligible for the Warrant Officer Accession Program, soldiers must—

- Have a general technical score of 110 or higher.
- Possess a high school diploma or a general equivalency diploma.
- Be a U.S. citizen.
- Have an interim security clearance of SECRET or higher.
- Achieve a passing score on all three elements of the standard Army physical fitness test.
- Meet height and weight standards.

Each warrant officer military occupational specialty (MOS) has specific prerequisites as established by the warrant officer proponent, but applicants can request a waiver for the prerequisites if they have compensating experience.

Applicants selected for the Warrant Officer Accession Program can expect to report to the Warrant Officer Candidate School at Fort Rucker, Alabama, 4 to 6 months after selection and will receive a conditional appointment to Warrant Officer 1 upon completion of the 6-week, 4-day course.

To find out more about the Warrant Officer Accession Program, visit the Army Recruiting Command Warrant Officer Recruiting Team's website at http://www.usarec.army.mil/warrant. This website contains eligibility requirements and prerequisites for all warrant officer MOS's. Also included are a sample application and a guide that can be viewed or downloaded and other useful information. Prospective applicants can e-mail the recruiting team at wo-team@usarec.army.mil or contact a warrant officer recruiter at (502) 626–0716/1860 or DSN 536–0716/1860. Applicants also may contact the team toll free at 1–800–223–3735, extension 60716 or 61860.

ALMC TO TEACH CSSAMO COURSES

The Army Logistics Management College (ALMC) at Fort Lee, Virginia, has been tasked by the Army Combined Arms Support Command to develop and provide Army-wide training on maintaining and troubleshooting the hardware and software that support the Global Combat Support System-Army (GCSS-Army) for personnel assigned to combat service support automation management offices (CSSAMO's). The training is scheduled to start in fiscal year 2002. Training on maintaining legacy Standard Army Management Information Systems will continue at the Army National Guard Professional Education Center in Little Rock, Arkansas.

ALMC will develop a family of 11 courses to ensure an adequate level of training for a projected 850 students per year from the Active Army, Army National Guard, and Army Reserve. The courses will be divided into three modules: modules 1 and 2 will be taught by distance learning, and module 3 will be conducted on site. Distance learning will be used as a means of reducing costs while maintaining the level of training and will permit a flexible, modular approach to the development of the courses.

For more information, call (804) 765–4469 or send an e-mail to roskowskir@lee.army.mil.

USE OF ONE CONTRACTOR TO TRANSPORT POV'S IS A SUCCESS

The Military Traffic Management Command's (MTMC's) use of one contractor to ship the privately owned vehicles (POV's) of Department of Defense service members is proving a success. Ninety-nine percent of the service members who have shipped their vehicles since the global POV contract began were satisfied with the service they received. Delivery times have improved, and there have been fewer damages to vehicles.

MTMC awarded a 2-year global POV contract to American Auto Logistics, Inc., of Woodcliff, New Jersey, in November 1998. Under the old system, multiple contractors often handled the vehicles. A vehicle could change hands up to nine times during a single move. Advantages of the new contract include convenient drop-off points near major airports, 1-hour vehicle processing, on-site claims settlements for minor damage, and customer tracking of vehicles via the Internet or by calling a toll-free number.

NEW BODY ARMOR REPELS 7.62-MM HITS

An Army and Marine Corps team has developed body armor that provides better protection to the wearer while weighing about 9 pounds less than its predecessor.

The new Interceptor Body Armor system weighs about 16 pounds and can be tailored to fit the mission. Worn alone, the Kevlar outer tactical vests (NSN 8470–01–465–1863) repel 9-millimeter (mm) rounds while offering antipersonnel fragmentation protection. If the mission is more dangerous, the soldiers can add ceramic plates (NSN 8470–01–465–1181) to their vests. When the plates are added, the vests will stop multiple hits from 7.62-mm ball rounds.

The plates come in five sizes and fit into the front and back of the vest. The vest has a quick-release feature that allows the front plates to be dropped with one tug. It has additional throat and groin protection attach-ments and can be worn with all current load-carrying equipment. It was developed concurrently with new load-bearing equipment, so it is compatible with that equipment also.

Point Blank Armor of Oakland Park, Florida, is manufacturing the new vests, and Specialty Defense Systems of Dunmore, Pennsylvania, is manufacturing the accompanying ceramic plates.

RESERVE COMPONENT CSS CONFERENCE SET

The Combined Arms Support Command (CASCOM) will host the sixth annual meeting of Reserve Component Combat Service Support (CSS) soldiers 13 to 15 March 2000 at the Quartermaster Noncommissioned Officers Academy at Fort Lee, Virginia. The Chief of the Army Reserve and the Director of the Army National Guard will provide the keynote addresses.

This year's conference will focus on challenges facing the Reserve Components as the Army restructures and reengineers its logistics business processes. The goal is to provide specific information and points of contact for doctrine changes, new equipment, new systems, training opportunities, enablers, and changing concepts.

For more information, visit the conference website at http://www.cascom.army.mil/USAR_CSS_Conference/conference.htm, call (804) 734–2465 (DSN 687–2465), or send an e-mail to bechelyj@lee.army.mil.

FUNDING ASSISTANCE AVAILABLE FOR LOGISTICS DEVELOPMENTAL PROGRAM

The Army is offering funding assistance to selected supply and maintenance careerists in grades GS–12 through GS–14 to attend a 12-month graduate-level education program in logistics at Pennsylvania State University beginning in August. (Exceptional GS–11's may apply also.) One applicant each will be selected from career programs 13 (Supply Management) and 17 (Materiel Maintenance Management). For more information, send an e-mail to YoungL1@lee.army.mil or visit the Army Civilian Personnel Online home page at http://www.cpol.army.mil (click on Training, then on FY 2000 ACTEDS [Army Civilian Training, Education, and Development System] Training Catalog; select the applicable career program from the Table of Contents; and scroll down to the Penn State Program listed in Chapter 3). Application forms must be received by 1 April and are available by scrolling down to "Click Here for Application Package."

MTMC RESHAPES FOR EFFICIENCY

The Military Traffic Management Command (MTMC) is reorganizing to more closely resemble the private enterprise transportation organizations it uses to move Department of Defense passengers and cargoes worldwide.

"The future organization will be smaller, faster, and more efficient in its work," said Major General Kenneth L. Privratsky, MTMC commander. "The economies of operation should provide reduced freight rates for MTMC's Department of Defense customers. We need change."

The reshaping will involve centralizing some headquarters work processes and standardizing staff in the command's 25 worldwide port units. Some work processes may shift to the Deployment Support Command (DSC), MTMC's operations element. Resource management and personnel and logistics functions that currently are performed at MTMC's subordinate headquarters and ports will be centralized under the Falls Church, Virginia, headquarters. In addition, an evaluation group led by Lieutenant Colonel Kathleen Pedersen of the 835th Transportation Battalion in Naha, Okinawa, is developing a common staffing structure for MTMC's battalions.

Although some changes will not be implemented until fiscal year 2001, others already have taken place. Many MTMC headquarters functions have been consolidated and streamlined. The work of 11 personal property positions at DSC has been moved to headquarters, and all DSC battalions now report directly to DSC headquarters at Fort Eustis, Virginia. The DSC's 596th Transportation Group, Beaumont, Texas, and the 597th Transportation Group, Southport, North Carolina, no longer have battalions reporting to them.

Automation and commercial software is being used to centralize some work processes and to streamline or eliminate others. The changes are expected to create work force reductions in the command's 2,800 employee authorizations. Voluntary moves, voluntary separations, and retraining will be offered to affected employees wherever possible, according to Colonel Clark Hall, Chief of Staff, who is charged with developing the reorganization plan. "Bottom line, we will do everything possible to assist anyone who is adversely impacted by these actions," he said.

The Logistics Management Institute, of McLean, Virginia, is assisting MTMC with the reorganization.

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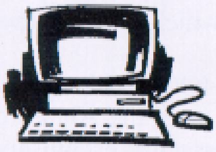

SYSTEMS

The information presented in Army Logistician's Systems *is compiled, coordinated, and produced by the Army Combined Arms Support Command (CASCOM) Information Systems Directorate (ISD). Readers may direct questions, comments, or information requests to Lieutenant Colonel Thet-Shay Nyunt by e-mail at nyuntt@lee.army.mil or phone (804) 734–1207 or DSN 687–1207.*

GCSS-ARMY FIELDING PLANS DESCRIBED

The Global Combat Support System-Army (GCSS-Army) is the Army component of the GCSS joint system. This article continues the series of GCSS-Army reports designed to keep system users informed of actions and decisions that ultimately will affect them and their units' missions. It will attempt to explain the planned procedures for fielding of GCSS-Army and provide users a framework for understanding what is going to happen in their units when fielding begins later this year.

Fielding any new piece of equipment, training soldiers to use it, and employing it doctrinally are complex tasks. Now imagine fielding, training, and employing a new piece of equipment for every unit in the Army and in active and reserve components, and doing it in 2½ years. Imagine further that this fielding and training of over 40,000 major end items could be done with no loss of productivity during the transition from old equipment to new. Such a mission would be one of the largest and most ambitious equipment fielding projects ever attempted in the history of the Army.

This essentially is the task assigned to GCSS-Army developers. They will replace the current family of logistics Standard Army Management Information Systems (STAMIS) with GCSS-Army. Stated another way, their mission is to deploy the new system Army-wide in both garrison and deployed environments in approximately 2½ years with minimal disruption to logistics business processes. The term "deployment" is used in the GCSS-Army community because it more accurately describes an activity that requires work not only from the deployment teams but also from equipment recipients. Deployment indicates that the system will be put into use upon receipt.

GCSS-Army deployment is a combination of activities: pre-deployment actions, new equipment training, computer hardware issue, and establishment of a system support network.

Pre-deployment actions. Most major Army commands (MACOM's), as well as the Army National Guard and Army Reserve, have established GCSS-Army process action teams (PAT's). Pre-deployment action begins with coordinating requirements for GCSS-Army by these PAT's. In conjunction with the Project Manager, GCSS-Army, each PAT will orchestrate the activities of its subordinate units before, during, and after GCSS-Army deployment. During pre-deployment, the PAT's identify specific table of distribution and allowances (TDA) requirements and ensure that user communities are kept abreast of GCSS-Army developments. Each PAT coordinates allocation of seats for new equipment training at designated training locations in its region. This regional coordination ensures that training is scheduled and slots are allocated equitably according to unit readiness and deployment criteria. This training allocation then will trigger pre-positioning of hardware at regional distribution sites and dissemination of information to the units on preparing logistics STAMIS data for conversion to the GCSS-Army data base.

New-equipment training (NET). NET is a two-pronged set of actions that simultaneously address institutional training and the training of units in the field. Army schoolhouses now training STAMIS will take on the additional task of training GCSS-Army. Schoolhouses will teach courses on both systems, because current systems must be maintained during the 2½ years it will take to deploy GCSS-Army worldwide. The plan will require close coordination with the Total Army Personnel Command (and its reserve component equivalents) to identify the training requirements of advanced individual training (AIT) soldiers who will be trained on the systems they will use in their new units. Systems training for noncommissioned officers, warrant officers, and commissioned officers will be conducted similarly. It also will be a challenge to identify the appropriate regional schools for the Total Army School System (TASS) battalions as the battalions extend institutional training into their regions.

NET in the field will be conducted on a regional basis for all components using active component installations, regional training sites (RTS's), and other locations as appropriate. The table at right lists RTS's that will conduct NET. The plan continues to evolve under the direction of the GCSS-Army Council of Colonels and the Program Manager, GCSS-Army. *ALOG Systems* will keep you posted.

NET in the field will consist of an 8-day training period at an RTS as coordinated by a regional coordinating committee formed from the PAT's. The training will consist of data conversion from current STAMIS's to GCSS-Army, general computer knowledge, MS Windows familiarity, and training on the functionality of a particular module (Supply/Property, Maintenance, Supply Support Activity, Integrated Management, Management and Ammunition). The first module scheduled for deployment is the Supply Property module. The RTS's will train operators on each module as it becomes available for deployment. Systems training will be accomplished by a combination of embedded training (ET), traditional instructor-based platform training, and over-the-shoulder coaching as required. ET is built into the GCSS-Army software and will continue to assist operators at their home stations. ET will provide users with a set of interactive performance enhancement tools such as help, coaches, demonstrations, tours, and cue cards.

Computer hardware issue. After users have completed NET training, they will be certified to pick up computer hardware from regional distribution sites. The regional distribution sites will issue hardware to all certified units, regardless of component, as designated by the regional coordination committees. When users return to their home stations, their combat service support automation management office (CSSAMO) will help them put their systems hardware together, load converted data, and use their new software.

Regional Training Site	Location	Component
Fort Hood	Killeen, TX	USAR
Salina	Salina, KS	ARNG
Camp Robinson	North Little Rock, AR	ARNG
Camp Shelby	Hattiesburg, MS	ARNG
Fort Stewart	Savannah, GA	ARNG
Camp Blanding	Blanding, FL	ARNG
Fort Bragg	Fort Bragg, NC	ARNG
Fort Indiantown Gap	Jonestown, PA	USAR
Tobyhanna Army Depot	Mt. Pocono, PA	USAR
Fort Dix	Wrightstown, NJ	ARNG
Fort McCoy	Sparta, WI	USAR
Fort Devens	Leominster, MA	USAR
Camp Custer	Grayling, MI	ARNG
Camp Ripley	Brainerd, MN	ARNG
Fort Dodge	Des Moines, IA	ARNG
Gowen Field	Boise, ID	ARNG
Sacramento Army Depot	Sacramento, CA	USAR
Camp Roberts	San Miguel, CA	ARNG

Support system establishment. The post-deployment support system being established by the Project Manager, GCSS-Army, will support users through the CSSAMO or its equivalent and a regional support network. The system will provide reliable support worldwide through the establishment of regional area support centers (RASC's). The RASC's will operate in the same time zone as their customers and will staff help desks 24 hours a day, 7 days a week. The RASC's will operate in much the same way as commercial software help desks and will provide automated troubleshooting, on-line system information, and World Wide Web support to lead users and CSSAMO's through troubleshooting guides.

GCSS-Army is an enabler for the Revolution in Military Logistics and will affect every unit in the Army. This system, coupled with the logistics modernization efforts of the Army Materiel Command, will change the way the Army does business in the 21st century.

More information on GCSS-Army is contained in—

- Back issues of *Army Logistician*, which are available on the World Wide Web at http://www.almc.army.mil/alog.
- The GCSS-Army web-site, http://www.gcss-army.army.mil/GCSS-Army.htm.
- The CASCOM ISD website, http://www.cascom.lee.army.mil/automation/GCSS-Army_Global_Combat_Support_System-Army/index.htm#gcss.

ANTICIPATORY LOGISTICS EXPERIMENT SET

The Army Combined Arms Support Command (CASCOM) soon will begin development of anticipatory logistics systems that can transfer data remotely from diagnostic and prognostic sensors on weapons platforms directly to automated maintenance systems without human intervention. Once the system processes these data, it will predict mechanical faults and speed parts requisition and maintenance flows, thereby improving readiness. Experiments conducted earlier on the M1A1 Abrams tank at Aberdeen Proving Ground, Maryland, and at Fort Hood, Texas, using an on-board turbine engine diagnostic system laid the groundwork for this new series of combat development activities.

The anticipatory logistics experiment is sponsored by the Training and Doctrine Command (TRADOC) and will be managed by the Directorates of Ordnance and Information Systems at CASCOM. The project is an effort to bring together a number of related initiatives under one roof. The systems slated for inclusion in the experiment are the Predictive/Anticipatory Maintenance Capability System (formerly known as the Failure Analysis and Maintenance System), the Movement Tracking System, the Electronic Technical Manual-Interface, the Forward Battle Command Brigade and Below System, and the Global Combat Support System-Army (GCSS-Army). The project bridges the efforts of the Program Manager Test, Maintenance, and Diagnostic Equipment (PM TMDE) and the Program Manager GCSS-Army to produce a module that can analyze and predict equipment failure for selected weapons platforms and manage their repair. Development of hardware, software, and interfaces will start in the third quarter of fiscal year 2000. The experiment at the PM TMDE test bed at Fort Riley, Kansas, will take place between March and October 2001.

Readiness: Year 2000 and Beyond

by Thomas J. Edwards and Richard W. Price

"The Army intends to begin immediately to develop a force that is deployable, agile, versatile, lethal, survivable, sustainable, and dominant at every point along the spectrum of operations." So begins the Army news release on the Army's vision for the future, which was announced by Secretary of the Army Louis Caldera and Chief of Staff of the Army General Eric K. Shinseki at the annual meeting of the Association of the United States Army (AUSA) in October 1999. The vision calls for creating a "more strategically responsive U. S. Army," and it describes the Army's initiative to develop prototype brigade-sized forces to attain that objective. The means of creating those forces will include leveraging technology, employing off-the-shelf systems, and developing new concepts of employment and support.

Dramatically reducing the logistics footprint of our deploying forces is paramount to achieving a responsive Army. General Shinseki stated in his AUSA speech that, ". . . in general, our logistical footprints for deployed forces are unacceptably large . . . We will aggressively reduce our logistics footprint and replenishment demand . . . We will prioritize solutions which optimize smaller, lighter, more lethal, yet more reliable, fuel efficient, and more survivable options."

The focus on achieving and sustaining adequate readiness through increased reliability is a multifaceted contributing factor to achieving the Army's vision. Increased reliability of weapons platforms contributes directly to greater combat effectiveness; the most lethal weapon is useless if a single mission-critical component malfunctions and causes that weapon to be unavailable. From a sustainability standpoint, the fewer times a system fails, the fewer maintenance resources are needed to keep operational the number of systems required to meet mission requirements. Numerous second-order effects also result from improved reliability. Fewer maintainers require fewer additional support personnel, such as cooks, medics and legal and financial support personnel. Fewer equipment failures mean reduced demand for repair parts, which means fewer stocks are needed to maintain readiness and fewer personnel are needed to manage those stocks. In other words, improved reliability not only decreases direct support requirements, but it also, in a multiplying effect, reduces "support to support" requirements.

Readiness remains a key focus as the Army reshapes itself for the future. Three crucial elements of readiness are dependable, supportable weapons and equipment; proper manning; and realistic and adequate training.

The cumulative effect of improved reliability is that the logistics footprint can be decreased, in both personnel and hardware. Reducing the logistics footprint of the force to be deployed directly enhances the deployability, and ultimately the strategic responsiveness, of the Army.

Deployability for New Conditions

The Army's role in the years ahead is not a singular one, as it was in the Cold War era. We must continue to be ready to fight and win our Nation's wars. However, other world demands of the 21st century call for us to be ready to respond effectively to an array of situations. Stability and support operations, humanitarian efforts, and peace-promoting operations likely will be foremost in our efforts within the next 10 to 15 years. We have experienced an increasing number of such operations since Desert Storm, and we expect this trend to continue into the foreseeable future.

These operations call for capabilities different from those required for a major theater war. A key difference is in responsiveness and supportability. Today's force-projection Army does not enjoy the luxury of prepositioned units and equipment as in years past. To be sufficiently responsive, our Army must be agile, flexible, and highly mobile. Quick deployability, coupled with winning firepower, are imperative. These will be achieved by reshaping the force to be smaller and lighter. Fewer weapons platforms and a much smaller support structure are essential, particularly in the initially deployed force.

Equipment Readiness Factors

These constraints call for us to reconsider the parameters that affect readiness, especially those impacting equipment readiness. Four factors affecting the readiness of weapon systems and equipment are the operating tempo (OPTEMPO) of an operation, logistics responsiveness, reliability, and maintainability.

OPTEMPO is established by the unique demands of each operation and will, by its nature, vary from one operation to another. In an unconstrained support environment, logistics responsiveness can be adjusted to make up for shortfalls in equipment readiness. However, this approach will offer no solution in the constrained support environments expected to characterize the small-scale contingencies the Army will face in the next 10 to 15 years. Support in terms of maintenance and repair parts will be extremely limited for the initially deploying force. Warfighters may be required to carry out their missions with limited support for extended periods.

In the period 2015 to 2025 and beyond, the Army After Next (AAN) will emerge and face more demanding challenges. However, one striking similarity will be the challenge of constrained support—particularly support organic to the fighting force. Unlike the small-scale contingencies that we are prepared for in the next 15 years, AAN battlefields are projected to be very large. OPTEMPO will be extremely high. The dispersed, lethal, agile, and nonlinear characteristics of AAN operations, compounded by very limited organic battleforce support, will pose tremendous challenges to sustaining readiness.

Reliability

Reliability and maintainability, as inherent characteristics of a weapon system or a single piece of equipment, offer the best potential to meet these challenges. Compared to today's systems, AAN systems must operate at higher OPTEMPO for significantly longer periods of time before experiencing mission-affecting failures. This will require much higher reliability than that offered by today's systems. One of the six pillars comprising the AAN support concept is ultrareliability. This pillar conveys the importance of developing and fielding AAN systems with very, very high reliability. The remoteness of the AAN battleforce and its lack of significant organic support will demand ultrareliable weapons and equipment. As the Army develops platforms for the AAN, emphasis must be placed on designing in and building in ultrareliability. The goal is to have systems that rarely, if ever, fail.

Systems that are very, very, reliable are not a far-off dream of the 21st century. Today, we as consumers enjoy many products that are already highly reliable. This is particularly true when we compare those same products to their predecessors of 20 to 30 years ago. Not only do these items last for longer periods before needing repair, but many have much longer useful lives before we discard them as worn out. This attribute, referred to as durability, is a special case of reliability. Passenger car tires today are more durable and are much more resistant to disabling flats. Consumer electronics are another good example, particularly televisions. Many consumers today own televisions that never have had even a minor annoying failure throughout a 20-year life, much less a completely disabling failure. Today's automobiles, which operate for 100,000 miles before needing their first tune-up, are still another example.

Between now and the year 2025, the Army will purchase interim platforms and equipment to bridge the gap between current systems and those that will be developed for the AAN. Choosing those that are the most reliable is imperative to sustain adequate readiness across the spectrum of operations. Many of these interim platforms will not be developed from the ground up; reliance on existing platforms is likely. Reliability characteristics already are fixed in their designs. While none of these weapons and equipment will approach the reliability levels we need for the AAN, reliability nonetheless must be a key source-selection criterion to contribute to equipment readiness needed over the next 15 years.

Maintainability

Maintainability is no less important. It is the inherent equipment characteristic that represents the quickness and ease with which a failed system can be restored. As we move farther into the 21st century, the Army must seize every opportunity to build very high on-system maintainability into its combat platforms and equipment. This includes embracing enabling technologies such as advanced diagnostics and prognostics, along with making optimal use of modularity in design-for-replacement activities. While essential for AAN, high maintainability is a readiness booster for units deployed to perform in small-scale contingencies. In buying interim platforms over the next 10 years, opportunities to select candidates with high maintainability must be exercised. This will enhance the equipment readiness of brigades deployed to carry out small-scale operations.

Evidence of very high maintainability in today's consumer products is not as apparent as reliability improvements. Advances in the design and construction of many products have made it economically imprudent to repair them. These products contribute to the notion of a throwaway society. However, there are exceptions. Relatively expensive electronic items frequently are designed for quick and easy on-system repair. Often this is accomplished through modular design so that a technician can replace circuit cards, boards, or subassemblies. Sometimes, even an owner with limited skills can make the needed replacement.

Lower reliability and maintainability of legacy and interim systems also cause us to consider sparing as a means of achieving and sustaining equipment readiness. A lean support structure, particularly in terms of organic mechanics, may cause the Army to rely on pushing spare replacement systems forward in exchange for failed ones. While solving readiness shortfalls, this approach has its own set of obvious problems and costs. However, the alternatives for maintaining needed equipment readiness are limited. With reliability and maintainability fixed, OPTEMPO dictated by the operation at hand, and logistics responsiveness severely constrained by a very limited support structure, sparing becomes the best remaining alternative for sustaining readiness.

Manning and Training

Equipment readiness is only one facet of unit readiness, which encompasses other critically important areas such as manning and training. An adequately manned unit not only must have the proper number of persons assigned, but it also must have the proper mix of special skills. The Chief of Staff of the Army recently announced that manning of operational units will be a priority issue as we move into the new millennium.

Once adequately manned, our units must be adequately trained. This includes sufficient time in training, both individually and collectively, to amass and hone the needed operational skills. Simulated training is not new to the Army, and its use will increase as we struggle to contain costs. Realistic training is essential. This is not just the major-theater-of-war training with which all are familiar. To be effective, survivable, sustainable, and dominant at every point across the spectrum of potential operations, we must train in realistic environments that represent that entire spectrum.

Adequate manning and training translate into prepared, highly capable soldiers. Ultrareliable systems translate into much less demand for maintainers and repair and replacement parts. Very high equipment maintainability translates into quick, easy, on-system repair and fast return to fully mission-capable equipment status. All offer the high readiness payoffs we need as our Army turns the corner into the next century. **ALOG**

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Advanced Technology for Wheeled and Tracked Vehicles

by Captain Mark A. Yoder

The author examines developments, applications, and demonstrated achievements for incorporating hybrid electric technology into the Army's fleet of wheeled and tracked vehicles.

The Army is facing the fact that operating and support costs for its ever-aging vehicle fleet are depleting the dollars available for training and sustaining the force. To reduce operating and support costs, the Army must integrate emerging technologies into its current fleet. To cut costs and still be a ready, viable, and technologically superior force, it is crucial for the Army to have the best mix of new procurements and current-system modernizations.

In current combat systems, the direct power output of the internal combustion engine drives the propulsion system and generates the electricity used for electronic subsystems. But as emerging technologies are integrated into combat systems, the demand for electric power within those systems is increasing. With this increase, new power systems are needed that will integrate power production, energy storage, and power distribution. To develop these new power systems, the Defense Advanced Research Projects Agency (DARPA) oversees the Electric Vehicle and Hybrid Electric Vehicle Technology Program. DARPA's work with hybrid electric vehicles is important for the Army. As the operating and support costs rise for the Army's aging vehicle fleet, the need for new and modernized vehicles that incorporate emerging technologies becomes imperative.

The National Automotive Center (NAC) serves as the Army's focal point for the development of dual-needs and dual-use automotive technologies and their application to military ground vehicles. NAC, which is a subordinate agency to the U.S. Army Tank-automotive and Armaments Command (TACOM), identifies the needs of the Department of Defense (DOD), automotive industry, and academia for the purpose of collaborative research and development. It also focuses on projects related to the development and implementation of innovative automotive technologies for both Defense and commercial needs. The NAC accelerates the use of these technologies by fostering relationships and forming cost-shared programs that link government, industry, and academia.

A brief survey of hybrid electric and vehicle reliability systems—both commercially available and under development—and their applications in Army wheeled and tracked vehicles can show us what the future may hold.

DARPA works directly with seven regional consortia—

- Mid-Atlantic Regional Consortium for Advanced Vehicles.
- Southern Coalition for Advanced Transportation.
- Hawaii Electric Vehicle Demonstration Project.
- Sacramento Electric Transportation Consortium.
- ElectriCore.
- Northeast Alternative Vehicle Consortium.
- CALSTART, a California-based advanced transportation technologies consortium.

These groups provide at least half of the funding while working cooperatively with the Department of Defense to overcome the challenges of developing electric and hybrid vehicle technologies. Likewise, NAC maintains agreements with a variety of industry partners such as Ford, General Motors (GM), DaimlerChrysler, Volvo, John Deere, and Cummins; academic partners such as Georgetown University, University of Iowa, University of California at Riverside, and University of Michigan; and various research institutes. These partnerships foster technology development and sharing that benefit both industry and DOD.

Using commercial research and development funds allows this program to meet military needs with only a small Federal funding outlay. Both the military and the commercial sector benefit from the dual use and technology sharing inherent in the program.

Some popular examples of this technology transfer benefit are GM's "OnStar" system, Cadillac's "Night Vision," and antilock braking systems. The "OnStar" satellite tracking capability is derived from DOD's use of navigational satellite technology in the global positioning system to determine precise location. "Night Vision" is a direct commercial application enhancement of technology developed for the military's infrared and thermal imaging needs. Conversely, the antilock braking system that now is being applied to some military trucks is a direct technology transfer from the commercial sector to defense applications. According to Michael J. Gage, president and chief executive officer of CALSTART, "These cooperative projects between industry and [DOD] continue to showcase the incredible technological prowess of companies . . . while strengthening [the Nation's] financial base for the future. By helping create, launch, and manage these projects, we speed the pace of change in cleaner, advanced transportation."

The next generation of military vehicles and weapon systems will rely heavily on improved technological advances in electric systems for propulsion, armor, and armament. Tomorrow's weapons also will need enhanced stealth ability: they will need to operate almost silently, have extremely low thermal signatures, and require low radar cross-sections in their shapes and construction materials. For effectiveness and control, they will make use of enhanced electronic command, control, communications, and intelligence. For enhanced survivability, Army systems, such as the high-mobility, multipurpose, wheeled vehicle (HMMWV), the M2/3 Bradley fighting vehicle, and the M113 troop carrier, will employ electronic countermeasures in their tactics and maneuvers. Even the projectiles they fire may be powered by electricity, allowing them to be twice as lethal as today's munitions.

Technology Development

The technology transfer initiative for the hybrid electric vehicle is focused on five major areas.

High specific power engine/generator sets. These are multifuel-capable, highly efficient, low-emission turbines and fuel cells. TPL, Inc., of Albuquerque, New Mexico, is developing a new membrane material for fuel cells that will eliminate one of their current disadvantages in transportation applications—the need for gaseous hydrogen fuel. At this time, hydrogen is available only rarely and is extremely dangerous to handle. Using a hydrogen-rich liquid fuel such as methanol would make marketing fuel-cell-powered vehicles easier. Currently, such liquid fuels must be changed in a specialized processor that extracts hydrogen for use in the fuel cell. New fuel cell membrane materials will allow the use of liquid methanol directly in the cell and make the refueling process similar to that of current gasoline-powered vehicles. The benefits of simplified refueling and fuel transportation are safety and convenience. Without a safe method of use and refueling, both commercial and military use of hydrogen as a fuel are impractical.

Power-control devices. These include high-performance power semiconductors, cooling systems, controllers and control algorithms, and circuit integration and packaging. Glacier Bay, Inc., of San Mateo, California, in a joint venture with IBM Corporation, is developing a simpler, lighter, and less costly controller for brushless direct-current motors. This new unit will improve greatly upon the reliability of controllers now available. It also will decrease significantly the size of complete power system packages used in a variety of applications, including power-assisted steering, brakes, coolant circulation, and fuel-cell air-compression motors for electric and hybrid electric vehicles.

Energy storage devices. These include advanced batteries, rapid-recharging batteries, flywheels, and capacitors. Electrosource, Inc., of San Marcos, Texas, has developed the co-extruded composite matrix (C2M), a lead-coated glass fiber woven in a grid design. This allows batteries to be made in the different shapes and sizes—perhaps long and skinny, or round and fat—needed to place the battery in or on the vehicle chassis where it will consume the least possible space or distribute weight in the most advantageous area. The C2M materials also offer enhanced performance. The C2M batteries in the first hybrid HMMWV improved its stealth characteristics when operating in an all-electric (stealth) mode. Even with the best infrared thermal imaging sensors available, the HMMWV's thermal signature was virtually undetectable. Additionally, the Horizon® C2M battery does not need the recharging equipment that other batteries need. Because of the battery's advanced absorptive glass fiber design, the diesel generator easily and quickly recharges it during operation.

As part of the hybrid electric vehicle program, research and development are underway to better understand flywheel failure indicators and to develop new materials that will reduce flywheel internal weight by nearly 30 percent and thus permit higher speed operation. Stored energy will increase by 50 percent, yielding a surge capacity of 750 kilowatts (kW) for 3 to 5 seconds. The increased efficiency and the ability to predict internal component failures may lead to the commercial availability of safe systems with light or nonexistent containment structures (which house the flywheels) in the future. Reducing or eliminating containment requirements will facilitate further reduction in vehicle weight, which then provides for additional payload capacity without exceeding the maximum gross weight of the vehicle.

Electromechanical conversion. This project conducts research on alternating current, direct current, regenerative braking, and linear motors. Unique Mobility, Inc., of Golden, Colorado, developed the four traction-drive linear motors and the auxiliary power unit generator for the first hybrid electric (HE) HMMWV (described below under "Technology Applications"). With more than 100 horsepower per wheel, these motors enable the vehicle to have much higher acceleration and efficiency than a conventional vehicle.

Unique's Power Phase system incorporates a brushless, permanent magnet motor with a microprocessor-controlled inverter with phase advance, which eliminates conventional gear change requirements. With these motors (each wheel on a HE–HMMWV has its own), the vehicle is able to accelerate without changing gears.

Regenerative braking is the process of converting the energy wasted in conventional braking through friction and heat loss to kinetic energy, storing that energy, and reusing it to provide electric power to the system. When decelerating, the electric motors that normally are used to accelerate the vehicle become generators. The motors produce electric energy that is sent back to the batteries, thereby recovering energy otherwise dispersed as heat in a normal brake system.

Lightweight, high-strength materials. These include active suspension systems, space frames, and composites. Rod Millen Special Vehicles of Huntington Beach, California, is developing a semi-active suspension system to improve off-road handling of hybrid electric military vehicles. With these new efforts in improving off-road suspension systems, the hybrid electric power systems will withstand better the constant abuse and rugged treatment of tactical and combat vehicles.

Technology Applications

In applying developing technologies, DARPA and NAC, in conjunction with industry, have made the cooperative funding of the HE–HMMWV and the family of medium tactical vehicles possible. DARPA also continues to fund the development of hybrid electric versions of the Bradley fighting vehicle and the M113 troop carrier and a potential all-electric combat vehicle. Potential applications of the all-electric combat vehicle may be incorporated into the future scout vehicle being co-developed by the United States and the United Kingdom. A closer look into each of these applications will provide additional information and system-specific enhancements and objectives.

Hybrid electric high-mobility multipurpose wheeled vehicle (HE-HMMWV). The HE–HMMWV is a conversion of a conventional internal-combustion-engine-powered HMMWV to a vehicle powered by electricity. The converted vehicle will be required to meet or exceed many of the performance standards of the current HMMWV.

The HE–HMMWV is being developed for TACOM and DARPA through a cost-share program. Under the development contract, PEI Electronics, Inc., of Huntsville, Alabama, is acting as prime contractor and team leader for the consortium that is integrating advanced electric drive systems and components into a standard HMMWV chassis. PEI provides all system design, systems integration, and electronic components for the

Current Performance	Units	Stock HMMWV	Hybrid electric HMMWV
Range	miles	300	350
Speed on 0% grade	mph	70	80
Speed on 60% grade	mph	6.8	17
0 to 50 acceleration	seconds	14	7
Payload	pounds	2240	1700
Gross vehicular weight	pounds	9100	9100
Stored energy	kW-hours	0.72	24.5

☐This table compares the performance of the stock HMMWV to that of the hybrid electric HMMWV.

power train, along with producing and testing the complete vehicle. McKee Engineering of Lake Zurich, Illinois, supplies the modified AM General HMMWV chassis; Unique Mobility provides the main drive motors and controllers; Electrosource, Inc., supplies the advanced lead-acid batteries; and Southwest Research Institute of San Antonio, Texas, provides the diesel-fueled-motor generator system. The University of Alabama at Huntsville provided extensive analysis and modeling of the vehicle.

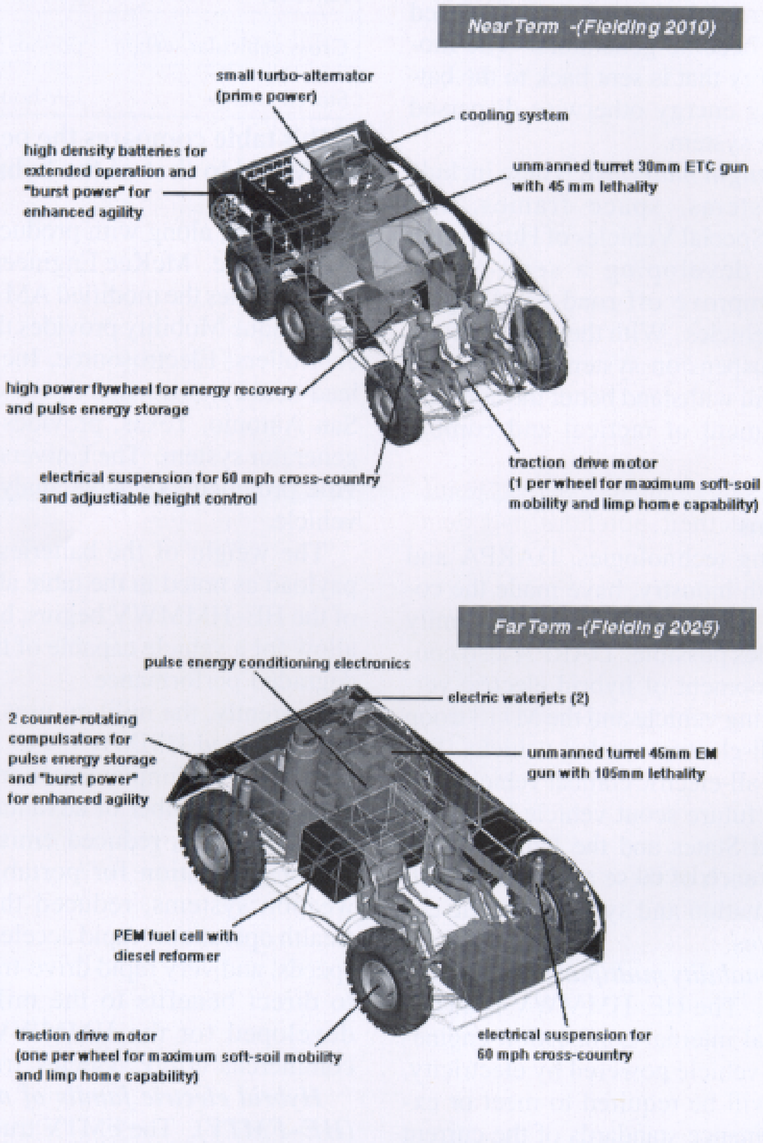
The weight of the batteries decreases the potential payload as noted in the table above. Before production of the HE–HMMWV begins, battery technology should allow for a vehicle capable of the same payload without degraded performance.

Currently, the military uses internal-combustion-engine-powered HMMWV's to fulfill a variety of transport roles. The implementation of hybrid electric power will offer a number of advantages, including improved fuel efficiency, reduced emissions, on-board electric power generation for portable communications and weapon systems, reduced thermal signature during stealth operations, rapid acceleration, high torque at low speeds, and very rapid drive-train response. In addition to direct benefits to the military, the technologies developed for the HMMWV will be applicable to commercial utility vehicles, trucks, and buses.

Hybrid electric family of medium tactical vehicles (HE–FMTV). The FMTV truck manufacturer, Stewart & Stevenson of San Antonio, Texas; Lockheed-Martin Control Systems of Johnson City, New York; and NAC have joined to develop a hybrid power train for the 5-ton series trucks used in the FMTV. The primary goals of this program are to reduce fuel consumption, improve performance, reduce emissions, and provide an on-board, integrated mobile power source.

The principles behind the HE–FMTV are nearly identical to those of the HE–HMMWV but they are applied on a slightly larger scale. The HE–FMTV incorporates the same power generation method of replacing the standard diesel engine and transmission with a smaller, more efficient diesel generator and computerized high-power control system that manages the electric output to two electric motors. The HE–FMTV differs from the HE–HMMWV in that the engine's primary purpose is to provide the immediate electrical power needed to propel the vehicle. In light to medium throttle conditions (cruising speeds), the power control system then directs additional electric energy to the battery storage system to provide burst energy for more pronounced acceleration needs. The engine is kept at a more constant speed, which optimizes fuel economy and emissions. To save more energy, regenerative braking is used in this vehicle also.

Current plans for the HE–FMTV are to add a mobile multiple rocket system to the chassis as a technology insertion program for the High Mobility Artillery Rocket System. The excess electrical energy of the hybrid power train can be used to provide power for missile-system launch electronics, communications, and fire-control systems. Challenges the demonstrator model faces include reducing the weight of the battery pack on the center chassis rail, preventing battery cases from breaking over rough terrain, and reducing "over-axle" weight.



☐**Conceptual drawings (provided by the Mid Atlantic Regional Consortium for Advanced Vehicles) of the all-electric combat vehicle for near-term (2010) and long-term (2025) fieldings.**

Hybrid electric Bradley fighting vehicle (HE–BFV). Unlike the HE–HMMWV, the HE–BFV has not moved into the conversion phase. The HE–BFV remains in the concept demonstration phase, with the goal of designing and installing a high-performance hybrid electric propulsion system. The aim is to show the automotive and operational advantages of a hybrid electric drive for tracked combat vehicles and to develop high-power density electric drive components for heavy-duty applications.

For obvious weight and operational reasons, the BFV demands a much more capable hybrid electric power system than either the HMMWV or the FMTV. Design concepts for the BFV hybrid electric system include an induction-motor-based sprocket drive system, a 275-kW auxiliary power unit, a nickel metal hydride battery-based energy-storage system, and a network-based power-management controller. The projected benefits of this development include greater design flexibility, faster acceleration, greater fuel economy, reduced noise and thermal signatures, and improved vehicle diagnostics and prognostics.

Hybrid electric M113 troop carrier. This is slightly more advanced in development than the BFV simply because of an existing electric drive transmission that previously was installed into the M113. The goal is to improve performance and space efficiency. Similar to the BFV, this vehicle also requires a substantially more robust power system than the HMMWV or FMTV. Included in the design of the hybrid electric M113 are a 55-kW auxiliary power unit, a distributed network-based vehicle power management system, an advanced lead-acid-battery-based energy storage system, and a low-noise band track in the existing electric drive. This vehicle will have the same characteristics as the HE–BFV, but at a decreased magnitude.

All-electric combat vehicle. The ultimate objective of today's research and development is an all-electric combat vehicle. This effort is rooted in the need to look into and beyond the Army After Next for alternatives to conventional combat systems. The goals of the all-electric combat vehicle program are—

- Developing optimum structural designs for an all-electric combat vehicle system.
- Defining system and subsystem requirements for a future scout vehicle.
- Assessing critical technology areas for an Integrated Hybrid Electric Power System (IHEPS).
- Developing all-electric combat vehicle and IHEPS concepts.
- Developing IHEPS critical component descriptions and development plans.

This study is charged with examining both near-term (fielding by 2010) and long-term (fielding by 2025) concepts.

Demonstrated Technology Benefits

These technologies are important to incorporate into Army systems because of their potential and demonstrated value. Each technology reduces system costs. However, based on commercial experiences with hybrid systems, incorporating these technologies can result in operating and support cost savings of 25 to 50 percent. Moreover, as these technologies spread, commercial demand will increase production, drive prices even lower, and create increased savings for purchasing commercial, off-the-shelf repair and replacement parts.

By examining these advances and applying them to current and future systems, the Army can expect to see increased performance and reduced operating and support costs due to the following improvements.

Improved fuel economy. By operating smaller engines under optimum conditions, fuel economy is increased greatly. In the HE–HMMWV, the "engine" is simply a generator that replenishes electrical power to the battery storage system rather than actually powering the vehicle's drive train system as in the standard internal-combustion-engine HMMWV. In testing at Aberdeen Proving Ground, Maryland, the current HE–HMMWV achieved 18 miles per gallon compared to the standard HMMWV history of only 9 miles per gallon.

Increased acceleration and maneuverability. The HE–HMMWV doubled the acceleration performance of the conventional model, powering it from 0 to 50 miles per hour (mph) in 7 seconds compared to 14 seconds in the standard model. In performance tests, the hybrid system scaled a 60-percent grade at 17 mph (nearly three times faster than the standard HMMWV), ran 10 mph faster on flat surfaces (80 mph versus 70 mph), and had nearly twice the rated horsepower output at 320 horsepower.

Reduced armor-protected volume. A reduction in the size of the engine and power train reduces the volume of system protection needed. The majority of the electrical storage system is located near the soldier compartment, thus allowing the same armor that protects the soldiers to protect the power storage system.

Increased overall power density. This is achieved by combining power generation for weapons, sensors, survivability subsystems, active suspension, and propulsion into one system. A 300-percent increase in power density in a flywheel battery over the current lead-acid battery is the result of advances in flywheel technology. Using improved semiconducting materials in an electrochemical capacitor resulted in a 400-percent increase in energy density over current technology. Total recharge time for a full vehicle lead-acid battery pack is now 9 minutes, instead of 8 hours, and there is no need to recharge from an external source.

Reduced vehicle thermal and acoustic signatures. While operating solely with on-board energy storage, the thermal signature was virtually undetectable to the best infrared thermal-imaging sensors available.

Operating and support costs for the Army's ever-aging vehicle fleet are depleting the dollars available for training and sustaining our force. The Army must manage the fleet to achieve the best mix of new procurements and modernization of current systems to achieve the lowest operating and support costs without harming our ability to remain a ready, viable, and technologically superior force. Electric and hybrid vehicle technologies, while still immature, provide a tremendous vision of how the Army can increase capabilities and reduce costs of future systems. Taking into consideration the benefits in both vehicle system performance and projected operating and support savings, it is prudent and necessary for the welfare of the services to develop, acquire, and modernize future wheeled and tracked vehicle systems using these technologies. **ALOG**

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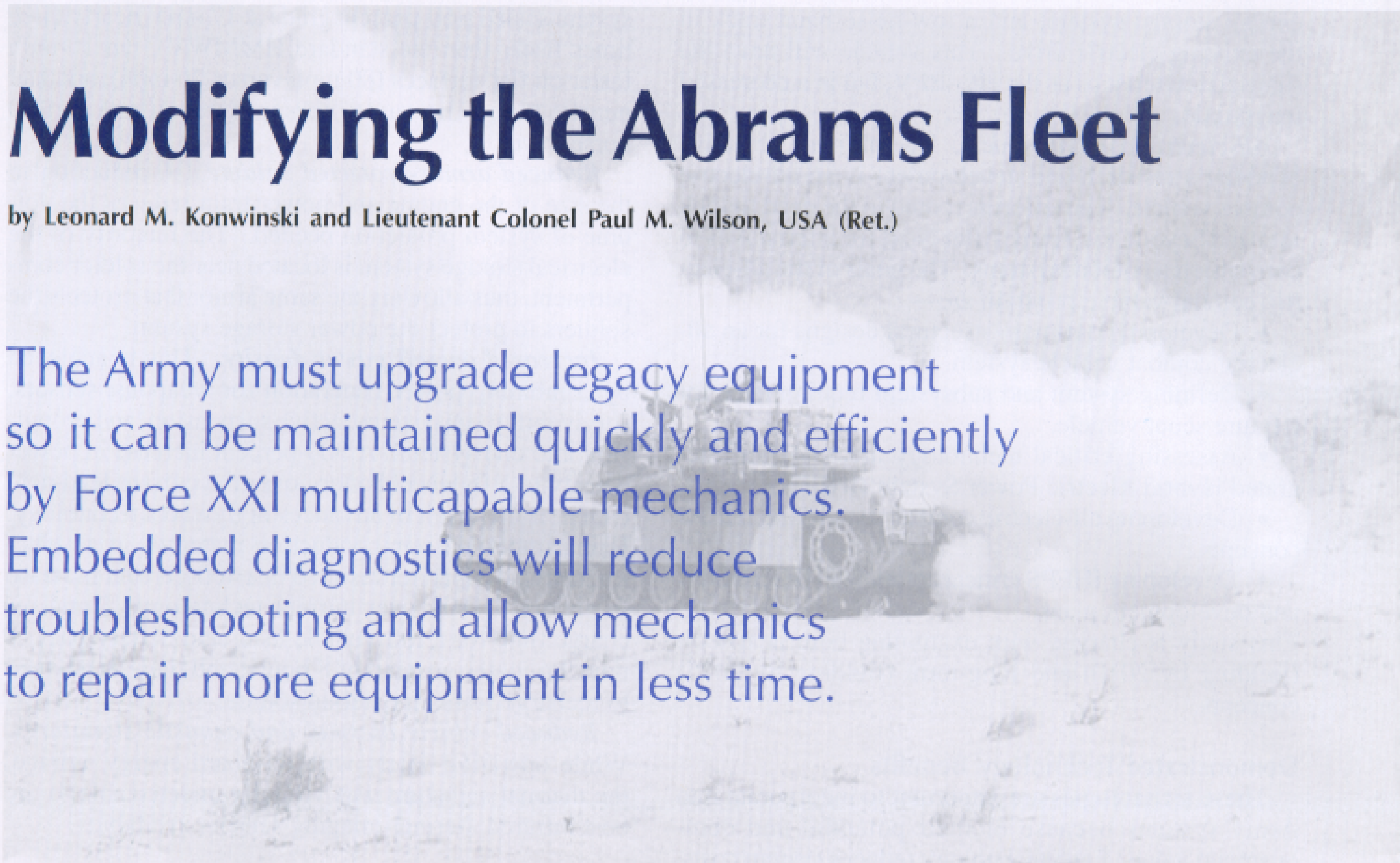
Modifying the Abrams Fleet

by Leonard M. Konwinski and Lieutenant Colonel Paul M. Wilson, USA (Ret.)



The Army must upgrade legacy equipment so it can be maintained quickly and efficiently by Force XXI multicapable mechanics. Embedded diagnostics will reduce troubleshooting and allow mechanics to repair more equipment in less time.

During the past year or so, the Project Manager for the Abrams Tank System (PM Abrams) has explored ways to extend the life of the current M1A1 tank fleet to the year 2025. At that time, M1A1's will comprise 80 percent of the Army's tank fleet. However, the costs of converting the total M1A1 fleet to M1A2's and M1A2 System Enhancement Program (SEP) tanks are prohibitive. The Army's challenge is to find a cost-effective approach to improve the supportability of M1A1 tanks. At the same time, the Army plans to combine the current mission requirements of organizational and direct support mechanics by assigning them additional maintenance tasks. To make the mechanics more effective (multicapable), the Army must provide them with the means to improve diagnostic efficiency. In line with this need, plans for maintaining the Abrams tank fleet in the future identify a need to incorporate built-in-test (BIT) and fault-isolation test (FIT) capabilities in the Army's aging tank fleet.

To reduce the operating and support costs of the M1A1 fleet, PM Abrams proposed a recapitalization plan that includes—

- Improving the engine.
- Installing second-generation, forward-looking infrared for the gunner's primary sight.
- Upgrading the armor package.
- Adding the Vehicle Integrated Defense System.
- Upgrading obsolete electronics, including inserting embedded diagnostics.

This article addresses the last point of the plan.

Electronics Obsolescence

The Abrams tank fleet is experiencing the same problems with electronics obsolescence as are other weapon systems. In 1986, a weapon system with military specification (MIL–SPEC) components could expect to undergo one modernization during its 30-year life. Today, for MIL–SPEC components, two modernizations can be expected during the 30-year life of a weapon system. This assumes the Government is willing to pay a premium price for outdated technology. Because of the expense of MIL–SPEC components, the Government is sure to purchase more and more commercial devices. Seven modernizations can be expected during the projected 30-year life of a weapon system that has commercial components.

The ever-accelerating pace of technology development is causing these changes to come faster and faster. Before 1990, complementary metal oxide semiconductor (CMOS) devices operated on 5 volts of electricity. (A

CMOS is used when storing permanent instructions in a computer. It usually controls a repetitive action, such as startup.) By 2005, it is projected that the 5-volt devices will have disappeared from the commercial marketplace. Civilian applications are transitioning to 3-volt CMOS devices, and development of 1.5-volt devices is sure to follow. This means that all weapon system technology that uses 5-volt devices will become military unique and obsolete. Even in state-of-the-art programs, such as the M1A2 SEP, individual components have become obsolete. Either the manufacturer no longer builds a particular device, or the device is available only until current stock is exhausted. For legacy systems, such as the M1A1, the problem is much more difficult, because the electronics technology in the tank is over 20 years old.

PM Abrams approaches this problem in two ways: piece-part level (short term [reactive]) and circuit card assembly level (longer term [proactive]). The piece-part approach provides needed components, including "last-chance buys," qualified replacement parts, and third-party manufactured and recycled parts generated from upgrade programs. The short-term objective is to ensure the availability of spare parts.

The circuit card assembly approach begins with a feasibility study of a particular circuit card assembly to determine if redesign is more cost effective than solving component problems one by one. The intent is to extend the life of the circuit card assembly 2 to 5 years beyond what replacement of individual parts could achieve. The long-term goal is to maintain a producible technical data package for the next production contract. Based on this approach, PM Abrams is redesigning the M1A1 turret and hull network boxes (TNB's and HNB's). The design effort for the TNB is nearing completion, with the HNB to follow. This redesign effort will insert a BIT capability in the M1A1 turret and hull that will identify faulty line replaceable units (LRU's).

Abrams On-Board Diagnostics

M1A1 and earlier Abrams tanks have very little onboard diagnostics. The only subsystem with a true BIT that can identify a faulty LRU is the Thermal Imaging System. However, the turret does have an auto self-test that is initiated each time the turret power is turned on. The self-test shows if a component is responding incorrectly or if a cable is disconnected. It alerts the crew by turning on the fire control malfunction light on the tank commander's control panel and displaying an "F" symbol (for fault) to the right of the range symbology in the gunner's primary sight. It does not identify the component or cable that caused the malfunction, which is similar to the way an "idiot" light in an automobile works.

The gunner can run a manually initiated computer self-test of selected parameters. Based on a pre-programmed set of parameters, the computer self-test checks the laser rangefinder, cant (angle), crosswind, super-elevation, and lead. Should any of the checked items fail, a corresponding code number appears in the display window on the computer control panel. The crew can perform limited troubleshooting procedures, such as checking to ensure that the crosswind sensor is clean. However, to identify failed components, mechanics use either the simplified test equipment M1/fighting vehicle system (STE–M1/FVS) or a breakout box and multimeter. The STE–M1/FVS is hard to use, takes excessive time to set up, and is physically bulky. Using the breakout box with a multimeter requires an intimate knowledge of the electrical wiring harnesses, wiring diagrams, and functional logic.

The M1A2 and later tanks are equipped with self-test, BIT, and FIT. The crew can troubleshoot the system with BIT and report the system fault. The mechanic reruns the BIT to confirm the fault and uses FIT to isolate the actual fault in the LRU. The diagnostics set-up time is reduced to zero.

Upgrading M1A1 Diagnostics

Two approaches to upgrading the M1A1 fleet are being considered. The first is to replace the current analog LRU's with digital LRU's, link them together with a data bus architecture, and develop BIT and FIT software to test the new LRU's. Essentially, this is an upgrade program similar to the M1A2 program, and it is inherently expensive.

The second approach keeps the existing analog LRU's, upgrades the TNB'S and HNB's by adding a general-purpose processor card with diagnostic software to each, and connects the TNB'S and HNB's to LRU test jacks with cables. Initial estimates are that this approach will be about 75 percent less expensive than the redesign approach.

Reducing Operating and Support Costs

The challenge is to upgrade legacy equipment designed in the 1980's so it can be supported by Force XXI multicapable mechanics. Since the Army will have fewer mechanics, they will have to be more efficient. No-evidence-of-failure (NEOF) rates (for example, faults reported in engines that actually are in running condition and should not have been sent for repair), time involved in managing the parts inventory, diagnostic time, and maintenance man-hours drive operating and support costs. By far, the greatest cost drivers are the repair parts. Some individual LRU's cost more than $160,000.

Lowering NEOF Rates

By providing the mechanic with more efficient diagnostics, we potentially can lower LRU NEOF rates by identifying the faults on a vehicle under the original conditions of failure.

There has been a lot of debate recently about what

□ **Soldiers and airmen guide an M1A1 Abrams main battle tank onto a C–17A Globemaster III for transport.**

contributes to NEOF's, how bad NEOF rates are, and whether the rates can be improved cost effectively. NEOF's can be caused by changes in the operating environment, errors in diagnostic procedures, cumbersome test equipment, or the basic design of the system.

The Abrams tank initially experienced failures in some electronic boxes in the high-temperature environment of Saudi Arabia. Failed components were returned to the contractor for analysis, and there was no evidence of failure. Subsequently, it was determined that the heat was causing specific electronic components to fail. They worked fine when the temperature was reduced. The circuit cards were modified, and the NEOF rate was reduced significantly.

It is possible to identify LRU faults incorrectly by measuring voltages on the wrong cable pins when using the breakout box and a multimeter. The more experienced the mechanic, the less likely a component will be identified erroneously as faulty.

The STE–M1/FVS is a classic example of cumbersome, antiquated test equipment. The average setup time and diagnostic run time to execute a test is 3.6 hours. When a fault is found and a repair is made, the test must be re-run from the beginning, because STE–M1/FVS lacks the logic to return to the initial location of the fault in the fault tree. After each subtest, the mechanic must connect and disconnect cables, adapters, and sensors, which is time consuming and frustrating. The natural tendency is for the mechanic to take an educated guess at the location of the fault and swap out the LRU. If that doesn't fix the problem, the mechanic swaps out another LRU. Each time a fully functional LRU is swapped out, we generate an NEOF statistic. The other risk is that, by swapping out the LRU's, the root cause of the failure may not be solved. Then, when power is applied to the circuit, the faulty LRU could cause a different LRU to fail. We observed up to three of the same LRU's being "burned" before the real fault was determined.

The other potential NEOF-generating situation occurs when a mechanic successfully uses STE–M1/FVS to troubleshoot the fault and arrives at an "ambiguity group." An ambiguity group is the point at which the test tells the mechanic the fault is in one of several possible components. The vehicle technical manual has alternate troubleshooting procedures that eventually will lead the mechanic to the faulty LRU. This is a time-consuming, manual process, and, if the commander or shop officer is pressing the mechanic to "get the vehicle up to readiness," the mechanic may just swap out all of the LRU's in the ambiguity group. In previous years, when the Army had more extensive prescribed load lists (PLL's), the NEOF's could be controlled at the battalion level. Since PLL's have gone away, the NEOF's move to the direct support repair activity.

The STE–M1/FVS does perform cable testing very well. Experience shows that the cables in a tank seldom are damaged or fail except through damage to connector pins caused by repeated removal and replacement of LRU's or by having heavy objects dropped on them. The M1A2, which has no automated cable-testing capability, has had little problem with faulty cables. On the infrequent occasions when cable testing is required, it is accomplished as an alternate troubleshooting procedure using a standard breakout box.

Reduced Inventories

The quantity of LRU's and shop replaceable unit's (SRU's) stocked is driven by field demands. If these demands are overstated because of NEOF's, the inventories are sized artificially. This causes the Army to procure unnecessary parts. By reducing the number of NEOF's, the Army can reduce the size and scope of the wholesale supply system.

Shorter Diagnostic Times

By providing the mechanic with embedded diagnostics capabilities, the Army will lower the actual troubleshooting time and allow each mechanic to accomplish more repairs in a given period of time. When each mechanic is more efficient, the number of mechanics required will be smaller.

Fewer Maintenance Man-Hours

If mechanics can identify a failed component more accurately, they will replace fewer fully functional components. Additionally, many failures, such as those in wiring harnesses and cables, are caused by removing and replacing LRU's. The Army can use its maintenance resources more efficiently if mechanics can improve their ability to identify failed components correctly the first time.

Turret and Hull Network Boxes

As mentioned earlier, PM Abrams is redesigning the TNB's and HNB's, because the companies that originally provided the parts for the boxes no longer build them. To have additional components made would be cost prohibitive. Both boxes consist of multiple relays that are analog controlled.

By leveraging our investment in the M1A2 SEP, we can take advantage of the redesign of these boxes to implement digitally controlled switching. As a byproduct of the backplane (a circuit board containing sockets into which other circuit boards can be plugged) added during the redesign, we can use the M1A2 SEP's general-purpose processor circuit card as the basis for BIT in the TNB for the turret LRU's. An M1A2 SEP common memory circuit card will host the BIT software. We plan to use existing M1A1 electrical schematics, coupled with the existing diagnostic flowchart logic used by STE–M1 and a turbine engine diagnostics demonstrator, to develop the BIT software. We also plan to add permanently connected cables between the TNB and the test jack connectors on the LRU's. A similar approach will be followed with the HNB, using as many common components and software as possible. Both the TNB and the HNB will have a self-test capability as part of the obsolescence redesign.

In effect, when the modification project is complete, the Army will have converted the M1A1's to the M1A2 diagnostic concept of an initial BIT run by the crew, with results reported to the direct support maintenance support team. The direct support multicapable mechanic will verify the results of the initial BIT and then run the more in-depth FIT portion of the BIT.

Although no one is happy doing more with less, it is a fiscal reality that Force XXI will have fewer maintainers. New diagnostics in the Abrams fleet will allow them to be more efficient. **ALOG**

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Commentary

Diagnostic Modules in Army Maintenance

by Chief Warrant Officer (W–4) Steve N. Kohn

You're at home working with your computer when the floppy disk drive stops working. It won't read any of the disks you insert. You quickly assess the situation. It could be the 12 volts of direct current going to the floppy drive, or it could be the drive itself. It also could be the drive controller on the motherboard or the cable connecting the drive to the motherboard.

Being the self-reliant type, you open the case and begin troubleshooting. You quickly eliminate the direct current possibility by using one of the other power cables coming off the power supply. That doesn't help. Luckily you have a spare drive controller cable, but that doesn't fix the computer either. Now you are down to the motherboard or the floppy drive. Not surprisingly, you have no spare motherboards or floppy drives lying around.

It is now time to buy either a motherboard or a floppy drive. But which? Wouldn't it be great if you had another floppy drive to try in the computer? In 2 minutes, the computer would either work or not, and you would know exactly which part you needed.

That is the premise of maintenance diagnostic test modules. Not even the best test, measurement, and diagnostic equipment (TMDE) or built-in tests are capable of giving a repairer complete assurance that he has found the faulty repair part that needs replacing.

It is also common for a piece of equipment on the workbench to have more than one fault. Automated test equipment uses sequentially designed tests to tell us to replace the first bad part it finds. We put that part on requisition, then wait a week or two (or three) until the part comes in. We install the part, retest the equipment, and find it is still not mission capable. Sure enough, the automated test equipment has passed by the part we replaced, but now it identifies another one, further down in the test procedure, that needs replacing. We requisition this part, again wait a week or two (or three), and the cycle continues.

If a set of diagnostic modules had been on hand, we could have proceeded through the entire test, using our known-to-be-good diagnostic modules whenever necessary. At the end of the test, the equipment would have been shown to work, and we would have known exactly which components were good and which were defective. We could have requisitioned the needed components all at once instead of one at a time. When the components came in, the equipment could have been repaired and returned to the unit.

The cost of stocking diagnostic modules is obviously high, but the advantages appear to be overwhelming. The Army would save time, money, and lives—time not wasted waiting on a requisitioned repair part that either was not needed or that alone would not repair the equipment, money not spent for repair parts that were not needed (and repair parts of the electronics variety can be stunningly expensive), and lives of soldiers not lost in combat while waiting on the repair of their equipment.

Army Regulation (AR) 750–1, Army Materiel Maintenance Policies, is the foremost authority governing Army maintenance. If you were to look in the regulation for guidance on the use of diagnostic modules, however, you would not find this important troubleshooting aid mentioned. Diagnostic modules are addressed in paragraph 3–16b of AR 710–2, Inventory Management Supply Policies Below the Wholesale Level:

> Shop stocks are authorized for … repair of items requiring diagnostic modules. Diagnostic modules are exempt from the demand criteria for initial stockage. Subsequent stockage will be based on demands or the level prescribed by the technical manuals, whichever is greater.

The last sentence is the kicker. Diagnostic modules are seldom prescribed in technical manuals—over 25 maintenance warrant officers I have spoken to have produced only one example of a diagnostic module required by a technical manual. Stockage based on demands would result in too many modules being turned in for lack of demand.

An Office of the Deputy Chief of Staff for Logistics message, 9 April 1998, Retail Property Accounting and Supply Policy Changes, addresses diagnostic repair parts in some detail. Unfortunately, not all the changes in the message are positive. First, only the prescribed load list (PLL) is addressed, not shop stock, where the need for diagnostic modules is arguably greater. Second, diagnostic modules are identified as PLL items, masking their true character as testing and diagnostic equipment. Some changes mandated by the message are on target, however. The accountability of, and authority for, diagnostic modules are now clear, and their stockage, though counting against the cap in the number of PLL lines, is not required to be demand supported.

Chief Warrant Officer (W–5) Alton Lanier, senior maintenance warrant officer of the 82d Airborne Division at Fort Bragg, North Carolina, and I met with over 20 maintenance warrant officers and 2 Army Materiel Command logistics assistance representatives at Fort Bragg in February 1999. The following proposed changes to AR's 750–1 and 710–2 resulted from this meeting.

Proposed Change to AR 750–1

A paragraph 3–1t, Diagnostic test modules, should be added to AR 750–1 and should read as follows—

> (1) Diagnostic test modules are defined as repair parts used to confirm a fault diagnosis in troubleshooting. They can include hot mockups (i.e., line replaceable units) and working assemblies that contain replaceable repair parts.
>
> (2) The use of diagnostic modules is an indispensable repair procedure in Army maintenance, saving time, money, and lives in combat.
>
> (3) Acquisition, funding, and use.
>
> (a) Acquisition. Diagnostic modules will be programmed into all new equipment fielding. The maintenance allocation charts (MAC's) of technical manuals (TM's) will list required diagnostic modules based on engineering and manufacturing development in the life cycle model. Changes to TM's will reflect subsequent field experience. Until changes to TM's are published, other required diagnostic modules will be identified by maintainers and approved by the battalion commander. When possible, equipment in storage due to force realignment should be made available to maintenance units as hot mockups, though not accounted for as class VII property book items.
>
> (b) Funding. Diagnostic modules listed in the TM but not issued during fielding will remain a "due out" to the unit by the project manager. Major commands should budget and fund both initial issue of and replacements for inoperable diagnostic modules. Units wishing to acquire diagnostic modules for legacy equipment must fund them out of their own budgets.
>
> (c) Use. Diagnostic modules will be clearly marked and controlled to avoid unintended losses in equipment. Diagnostic modules will not be used to repair equipment permanently except at the direction of the battalion commander, as such use will degrade the unit's repair capability until the diagnostic module is replaced.

Proposed Changes to AR 710–2.

A Paragraph 3–XX, Diagnostic modules, should be added to AR 750–2 and should read as follows—

> a. Are defined as recoverable repair parts used to confirm a fault diagnosis in maintenance troubleshooting. Diagnostic modules can include hot mockups (i.e., line replaceable units) and working assemblies containing replaceable repair parts.
>
> b. Are considered test, measurement, and diagnostic equipment (TMDE) modules, not repair parts. As TMDE, however, they:
>
> (1) Do not fall under AR 750–43, Army TMDE Program.
>
> (2) Are neither shop stock nor PLL, and are therefore exempt from demand criteria.
>
> c. Are authorized by either:
>
> (1) Technical manual
>
> (2) Battalion commander
>
> d. Are accounted for by unit hand receipt. If "found on post," are added to the hand receipt.
>
> e. Are stocked with a minimum quantity of one each. Additional modules for maintenance support teams may be stocked depending on the organizational structure of the support unit.
>
> f. Are transferred laterally to another maintenance unit or turned in to the supply system when declared to be excess.
>
> g. Are requisitioned for initial issue and replenishment with an issue priority designator (IPD) of the unit's urgency of need designator (UND) "B."

The following paragraphs should be deleted from AR 710–2—

- Para 3–16b(3).
  [Shop stocks are authorized for] Repair of items requiring diagnostic modules. Diagnostic modules are exempt from the demand criteria for initial stockage. Subsequent stockage will be based on demands or the level prescribed by the technical manuals, whichever is greater.

- Para 4–15b(3).
  [Shop stocks are authorized for] Repair of items requiring diagnostic modules. Diagnostic moduels prescribed by the technical manuals for diagnostic purpose are exempt from the demand criteria for initial stockage. Subsequent stockage will be based on demands or the level prescribed by the technical manuals, whichever is greater.

The above regulation changes would standardize the use of diagnostic repair parts and improve Army maintenance by saving time, money, and lives.

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Unclogging the Battlefield Distribution Pipeline

by Richard W. Price

Enhancing the reliability and durability of individual parts, components, and assemblies of weapons and equipment can decrease significantly the burden on the battlefield distribution system.

The Army research, development, and acquisition (RD&A) community strives diligently to field effective, supportable weapons and equipment for the soldier. Many of its efforts are glamorous, particularly the development, demonstration, and fielding of highly visible systems such as tanks, helicopters, and sophisticated individual weapons. Efforts to design in, and build in, high reliability for future platforms and systems are an integral part of meeting user demands for the Army XXI battlefield and especially for the Army After Next.

Less glamorous, but equally significant, are the RD&A community's efforts to improve the individual parts, components, and assemblies of current weapons and equipment. These efforts seldom are heralded and deserve more attention. Such improvements enhance mission reliability and lower operating and support costs. More importantly, they significantly decrease the burden on the in-the-field wartime logistics system. This benefit is even more important considering the Army's shift to a distribution-based logistics system from one that traditionally has been supply based.

Surveying the Pipeline Flow

A broad survey recently conducted by the Combat Developments Engineering (CDE) Division of the Army Training and Doctrine Command (TRADOC) produced several interesting observations regarding items flowing through the distribution pipeline. This survey identified the best opportunities for improving the reliability of current Army weapons and equipment by enhancing the life expectancy of individual components. Components selected in the survey offer potential improvement in individual durability, at little or no anticipated additional cost. The primary selection criterion was high logistics demand. Targeted candidates included parts with high frequency of replacement, large annual supply demands, or large maintenance manpower demands. From a user perspective, frequent demand for parts suggests undesirable impacts on a system's mission reliability. Item cost was a secondary consideration.

An initial candidate list of parts offering the greatest opportunity for improvement was compiled using input from TRADOC CDE Division field offices. CDE Division personnel perform all reliability and maintainability (R&M) functions in support of TRADOC proponents throughout the United States.

The initial candidate list included parts spanning the entire spectrum of Army weapon systems and equipment. A key additional data source used was the Operations and Support Management Information System (OSMIS) data base maintained by the Cost and Economic Analysis Center of the Office of the Assistant Secretary of the Army for Financial Management and Comptroller. The survey reviewed OSMIS cost reports and data on consumable and depot-level reparable repair parts that were demanded in very large quantities or were frequently replaced. Weapon systems and equipment with high field densities were favored over those few in number. CDE Division and TRADOC proponent school experts, with input from counterpart materiel developer R&M experts, supported the candidates selected. Data on top maintenance manpower drivers provided by the Army Force Management Support Agency at Fort Belvoir, Virginia, also were used as sources and cross references. Additional data and information were obtained through searches of the World Wide Web.

Key Observations

Several interesting observations surfaced during the survey. First, the majority of high improvement opportunity components fell into general categories spanning many systems and equipment. These included tires, batteries, light bulbs, filters, electrical cable assemblies, and circuit card assemblies. Most items in a category had different identification or stock numbers. However, their striking similarity logically led to general category groupings. Likewise, similar groupings were appropriate for parts used on limited types of equipment, such as track pads and shoes on tracked vehicles and rotor blades on helicopters. Few components unique to a single system had demand quantities large enough to be included on the survey's High Opportunity Component Improvement List (at right).

A second observation was that Army procurement policies and practices may contribute to the low reliability and high logistics demands associated with many parts and assemblies. Contract specifications that describe form, fit, and function are easy to write and verify. Conversely, specifying and verifying service-life attributes such as reliability and durability are difficult, time-consuming, and costly tasks. Item managers typically reorder parts and components when inventory quantities drop to predetermined levels (reorder points). Previously used procurement specifications sometimes are reused without updating. Updating specifications could provide opportunities to take advantage of advances that have occurred in materials and manufacturing processes since previous buys. Low-cost items procured in large lots may be purchased using a "lowest cost" (lowest bidder) approach. A "best value" approach based on past usage data potentially could yield components that are more reliable.

The third interesting observation occurring during the survey was that current Army acquisition policies, processes, and procedures do not provide adequate visibility and awareness of the significance of frequent part replacement. Program managers, project managers, and weapon system managers normally do not view frequent part replacements as problems, particularly if costs are relatively low. Instead, the parts are consumed by day-to-day problems within the "box" in which the managers operate. This box has walls, a ceiling, and a floor made of the proverbial "cost, schedule, and performance." Hence, because of current processes, some managers rarely step out of their "boxes" to view from a logistics perspective the huge impacts of frequent part replacements. Replacing the culprit part more often is a tempting artificial remedy for frequent failure but one that further clogs the battlefield distribution pipeline.

A fourth observation perhaps is best described as "low-tech" clogging of the battlefield distribution pipeline. Problems identified with most components on the High Opportunity Component Improvement List do not involve state-of-the-art technologies. Instead, their solutions are "low-tech." Yet, these seemingly innocuous parts (tires, batteries, light bulbs, filters, cable assemblies, and circuit card assemblies) are major impediments to the flow of parts and supplies through the battlefield distribution pipeline. The Army's logistics support concept is depicted as a full, continuously flowing pipeline. That hypothetical pipeline size needs to be tremendously large to accommodate huge quantities of these parts in addition to critical unique components. Improving the reliability and durability of these components would allow for a much smaller, more efficient pipeline.

High Opportunity Component Improvement List

Component	System
Tires	General category
Batteries	General category
Light bulbs	General category
Filters	General category
Electrical cable assemblies	General category
Circuit card assemblies	General category
Track pads, shoes, and kits	Tracked vehicles
Road wheels	Tracked vehicles
Rotor blades	Helicopters
Glow plugs	HMMWV platforms
Brake shoes	HMMWV platforms
Shock absorbers	Bradley platforms
Electrical fuel pumps	Bradley platforms

Efforts Already Underway

The Army RD&A community, with participation by the Army user community, is leading efforts to address high part demands. One noteworthy effort already underway is a power sources task force that will address frequent battery replacement problems along with other power supply issues. Another is a tire team that will address tire issues, including frequent replacement demands and, especially, factors that influence expected tire life.

Components included on the High Opportunity Component Improvement List should not be viewed as problems. Instead, they are prime opportunities for the RD&A community to demonstrate continued leadership in advancing Army weapon systems and equipment to meet the total needs of Army XXI and ultimately the Army After Next. Not only will this guarantee weapons and equipment that are more reliable and less expensive to support, but equally as important, it will significantly contribute to a free-flowing battlefield distribution pipeline.

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Commentary

Achieving Ultrareliability in Military Systems

by Terrence L. Renee

It is an indisputable fact that, to be a ready and responsive force, the Army must have reliable and effective weapon systems. The Army After Next (AAN) concept is designed to guide the Army in determining, anticipating, and where possible, capitalizing on the developments and changes in technology that will benefit and enhance future warfighting capabilities and improve the functionality and reliability of Army systems. AAN's primary focus is on the years 2010 through 2025.

AAN is based on the foundation of six topical pillars—

- National and strategic processes.
- Combat service support command and control.
- Global precision delivery.
- Power and energy.
- Soldier support.
- Ultrareliability.

The last pillar, ultrareliability, is critical to the Army's future warfighting capabilities. To achieve ultrareliability in its systems, the Army should—

- Challenge the notion that it must look to AAN to achieve the goal of ultrareliable systems.
- Recognize the potential for improving the reliability of current legacy systems, as well as emerging and future systems, by integrating and applying embedded sensors, automation, and improved diagnostic and prognostic systems.
- Establish a phased approach to the application of technology, which has the potential to reduce current and near-term operations and maintenance costs, while progressively including new technology as it becomes available for Force XXI and AAN systems.
- Recognize the fact that, even if we can buy and field systems that have an inherent reliability factor of .99, at some point they still will fail or be damaged in combat and will require maintenance. Therefore, the Army should consider not only improvements in systems reliability but also improvements in the maintenance process that will change the emphasis from the current reactive mode to an anticipative one.

Army Initiatives

Reductions in Army procurement funding for new materiel systems force us to extend the life of our current systems well beyond their life expectancies. The Army and the other services are doing just that, and doing it successfully, but at a price. That price is ever-increasing operations and maintenance support costs. To complicate matters, operations and maintenance dollars are in the same budgetary squeeze as procurement funding. As our systems age and log in more hours, miles, and rounds due to increased operational tempo and deployments, our maintenance costs also will continue to grow.

For some years now, the Army has aggressively pursued advances in technology that will improve reliability and at the same time reduce the operations and maintenance support costs of current systems. One such effort is the work being done at the Army Materiel Command's (AMC's) Army Research Office at Research Triangle Park, North Carolina, to develop advanced sensor devices that can be embedded in equipment to predict and isolate failures with higher levels of confidence.

Another effort to improve equipment is the Army Diagnostics Improvement Program (ADIP). The focus of this program is to reduce operating and support costs and improve total force readiness by incorporating advanced technology into current legacy systems and future system procurements. The ADIP is a multiphased approach that includes weapon system program managers as part of the integrated product team process.

Using initiatives such as horizontal technology integration to develop, manage, and field components with common architecture across families of weapon systems and equipment, ADIP will link systems directly to maintenance and logistics support systems. By teaming with industry, we can develop and integrate new sensors, data buses, collection devices, data recorders, processors, and data output systems that will record, monitor, and process system information on potential failures. This will allow us to repair a system before it fails. In some cases it may be possible to build in self-repair routines that could be initiated by the operator or crew.

The Smart Simple Design process is another approach that can improve reliability and reduce operating and support costs for current and future systems. Smart Simple Design is a two-step process. Step 1 is to use computer software that incorporates design for manufacturing, assembly, and service (DFMAS) capabilities. Step 2 is to establish an oversight and comparison process team that will focus on reducing parts counts and ensuring the standardization of parts that make up the end item or system. The DFMAS process has the potential to improve reliability and reduce costs in procurement and life-cycle support. Currently, some 400 companies worldwide are using the DFMAS process in initial design and redesign of their products and are reducing their parts counts and assembly times significantly. Unfortunately, only a small number of Defense contractors use this process.

Commercial Solutions

Industry is leading the way in improving system reliability and reducing operations and maintenance costs. Manufacturers are embedding diagnostic systems and global positioning systems in vehicles and aircraft that can test, identify, and track system failures. Vehicle onboard computers are linked to diagnostic computers using a standard bus system. The diagnostic computers also are linked to the organization's parts supply computer, which enables the tracking of failures, parts usage, and vehicle maintenance history. That history then can be translated into design changes that will increase inherent product reliability and improve maintenance processes for future models. The Cadillac Division of General Motors is using satellite communications technology in its OnStar system to track individual vehicles and provide the operator with remote diagnostic assistance when warning lights come on. The operations center also can dispatch help to the vehicle site.

The majority of improvements in system reliability, both in the military and industry, are based on the development and use of embedded sensors, standardized data buses, and computer-aided, computer-linked, and computer-driven components or systems. Does that also mean that these advances will become the weak link in the system reliability chain? Again, work already has started on improving the computers themselves. A $2.4 million Defense Advanced Research Projects Agency (DARPA)-funded cooperative effort is underway among the Stanford Center for Reliable Computing, the University of Texas at Austin, and Quickturn Design Systems of Mountain View, California. They are researching the feasibility of applying self-adaptive circuitry to improve computer reliability. The goal of this program is to improve the reliability of computer systems by using advanced circuitry that can reconfigure itself while the computer is in use to overcome malfunctions or prevent system failures.

The Army not only continues to work diligently to improve the inherent reliability of ground systems but also is in the process of putting in place a systemic capability that will tie systems directly to the maintenance and logistics support structure. This is the type of aggressive approach that must continue if the Army is to achieve ultrareliability.

The Army must take the operations and maintenance dollars saved from current programs and reinvest them in system improvements and new procurements that will leverage technology for application to legacy systems as well as new systems. Several ongoing in-house programs and a number of joint Army and industry programs are focused on developing or incorporating technology to improve component sensors and diagnostics and prognostics.

Ultrareliability is an achievable goal. Systems can be designed and built that have inherent reliability factors at the .95, .96, and even .98 level. But at some point, if there is no intervention for maintenance, the system will fail, whether due to component failure, combat damage, or operator error. These are indisputable facts. Therefore, while making near-term improvements, the Army must continue to develop the systemic tracking, monitoring, and diagnostic and prognostic capabilities that will transition the Army from its current reactive maintenance application to a truly predictive process and structure. The tools to facilitate this transition are being used to some extent in Army programs today. New tools are being developed and made available for use in commercial and military applications.

If the Army is to accomplish its modernization mission, it must ensure that current funding levels are not only maintained but also increased. The increased funding should be in direct relation to dollar savings and manpower reductions realized from ongoing system improvements. There is no doubt that with modernization our current major weapons will continue to be viable systems beyond 2010. Should system age even be a consideration, we need only look at the Air Force's B–52 bombers to put our minds at ease. Affordability and return on investment will be the determining factors in the future.

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Thinking Small: Technologies That Can Reduce Logistics Demand

by Calvin Shipbaugh

Microminiature devices—some of them drawn from molecular biology—promise to revolutionize logistics support.

At the outset of the Army After Next (AAN) initiative, then Chief of Staff of the Army General Dennis J. Reimer noted that the Revolution in Military Affairs (RMA) required a Revolution in Military Logistics (RML). One of the most valuable insights generated during AAN wargames is that the RML must be two-pronged: it depends not only on dramatically improving the performance of logistics processes, but also on radically reducing demand for logistics support. To achieve a full RML, the Army will exploit the synergy between process improvement and demand reduction.

An important area of technology for exploiting this synergy is microminiaturization, applied to both weapon systems and logistics processes. Although the AAN wargames were dominated by startling mental images of gigantic tilt rotors, cavernous strategic-lift vehicles, and island-sized staging structures, the RMA actually relies more on revolutionary technological advances at the opposite end of the size scale.

The logistics implications of microminiature developments are enormous. As the Army fields future weapon systems, miniaturization technologies will permit it to pursue design and support options that dramatically reduce logistics demands while offering additional opportunities for improving the performance of logistics processes.

Emerging from the "science of the small" are a wide array of theoretical and experimental approaches to engineering tiny machines, ranging from smaller microchips to molecular robots that we cannot even see. Prominent among the new miniaturization technologies are microelectromechanical system (MEMS) devices and nanotechnology.

MEMS: The Second Silicon Revolution

As their name implies, MEMS devices are a mechanical extension of microelectronics. Often described as the "second silicon revolution," these devices are distinguished from conventional microchips by their built-in mechanical functions, which allow them to be used in building integrated sensors and actuators.

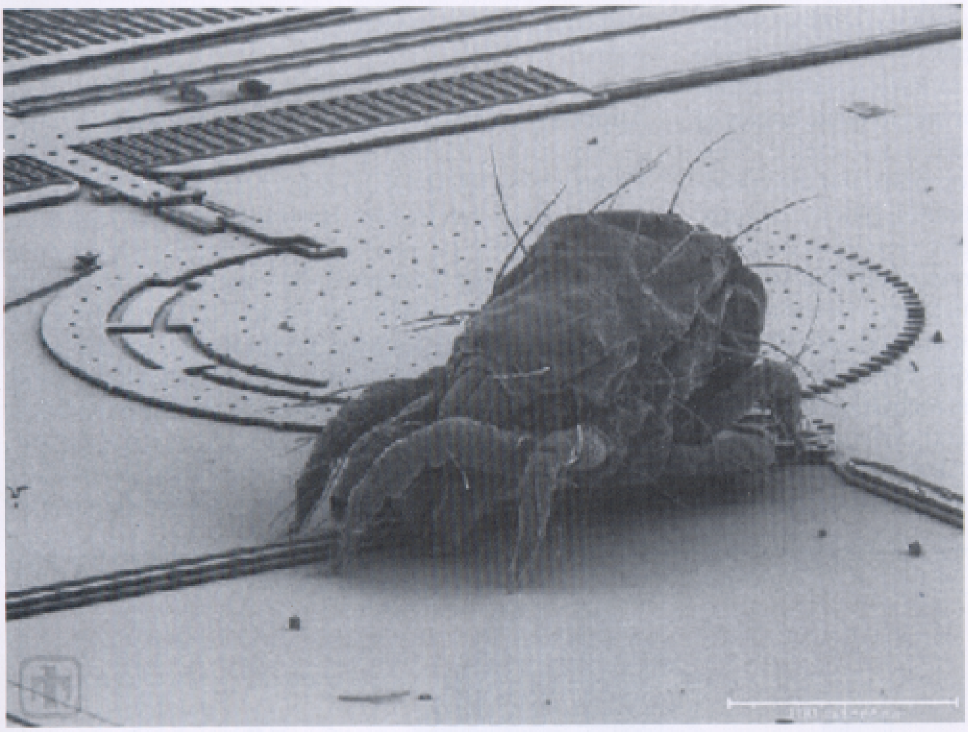
Sensors can react to a range of physical phenomena, including temperature, pressure, chemicals, biological agents, and magnetism. Automotive airbag accelerometer controls and miniature blood pressure devices are examples of today's commercial sensor-based products. Actuators move beyond the sensor function to respond to the environment with applications of force, making possible the creation of such novel devices as Texas Instruments' digital mirror and Sandia National Laboratory's nuclear weapons lock (see the photo at right). MEMS-based ink jet printers are common.

The addition of a control processor to sensors and actuators transforms MEMS devices into complete micromachines. Signal processing, for example, could create true microrobots, which will affect a wide range of applications, such as microassembly, automotive engineering, environmental and medical technologies, and appliances.

Nanotechnology

Nanotechnology pursues miniaturization on a still smaller scale. Derived from the Greek word for "dwarf," a nano is one-billionth of a meter—1,000 times smaller than a micron. Only three or four atoms can be lined up inside a nanometer. Nanotechnology extends the microrevolution to this miniscule domain by developing components that are between 0.1 and 100 nanometers in size and by using well-known physical properties of atoms and molecules to build seemingly fantastic devices.

People working in the field of nanotechnology can be divided between two disciplines. Working from larger to smaller are engineers, who begin with existing devices such as transistors and make them smaller. Working from smaller to larger are chemists and biologists,



☐ **Mite-sized and smaller parts have made possible the development of Sandia National Laboratory's nuclear weapons microlock. (Courtesy of Sandia National Laboratories Intelligent Micromachine Initiative; www.mems.sandia.gov.)**

who attempt to create larger structures by connecting molecules. Their work offers the possibility of developing "wet" nanotechnology, including applications drawn from biology and needing water or solutions as a medium.

"Dry" Nanotechnology

"Dry" nanotechnology includes miniaturization efforts that extend the use of microelectronics and other technologies such as mechanical positioning or machining down to the submicron level. This approach is sometimes regarded as an extension of the MEMS revolution, but dry nanotechnology in fact includes other innovations, like exploiting the electrical properties of carbon-based fullerenes (for example, "buckyballs") and nanotubes. Because the manufacturing capabilities of the U.S. semiconductor industry extend down only to approximately 0.1 micron, nanotechnology is viewed as the key to future integrated circuit manufacturing. Techniques currently exist for producing component features below 100 nanometers. Quantum well devices (such as tuned lasers for fiber optics transmissions) exist now and are just one example of the products emerging from the laboratory.

Dry nanotechnology is not a distant prospect, nor is it limited to semiconductors. It will have a great impact in the near future. An exemplary application of dry nanotechnology in conjunction with MEMS would be a disposable "medical laboratory on a chip" that would allow a medical technician to place a drop of blood on a $5 dime-sized chip, connect the chip to a computer, and immediately receive an extensive diagnosis. This application is now in initial development. In such ways, dry and wet nanotechnologies can work together.

Wet Nanotechnology: From Molecule to Machine

Wet nanotechnology strategies work at the molecular level to increase our ability to control matter. These strategies employ a variety of scientific techniques, such as biotechnology, biomimetic chemistry, and atomic positioning. The Langmuir-Blodgett thin film production technique, for example, embeds uniquely functional molecules in monolayer and multilayer structures. Artificial photosynthesis is an important practical application of this technique and could be used to generate fuels. Theoretically, it should be possible to build molecular structures that self-replicate, just as living cells are able to reproduce themselves.

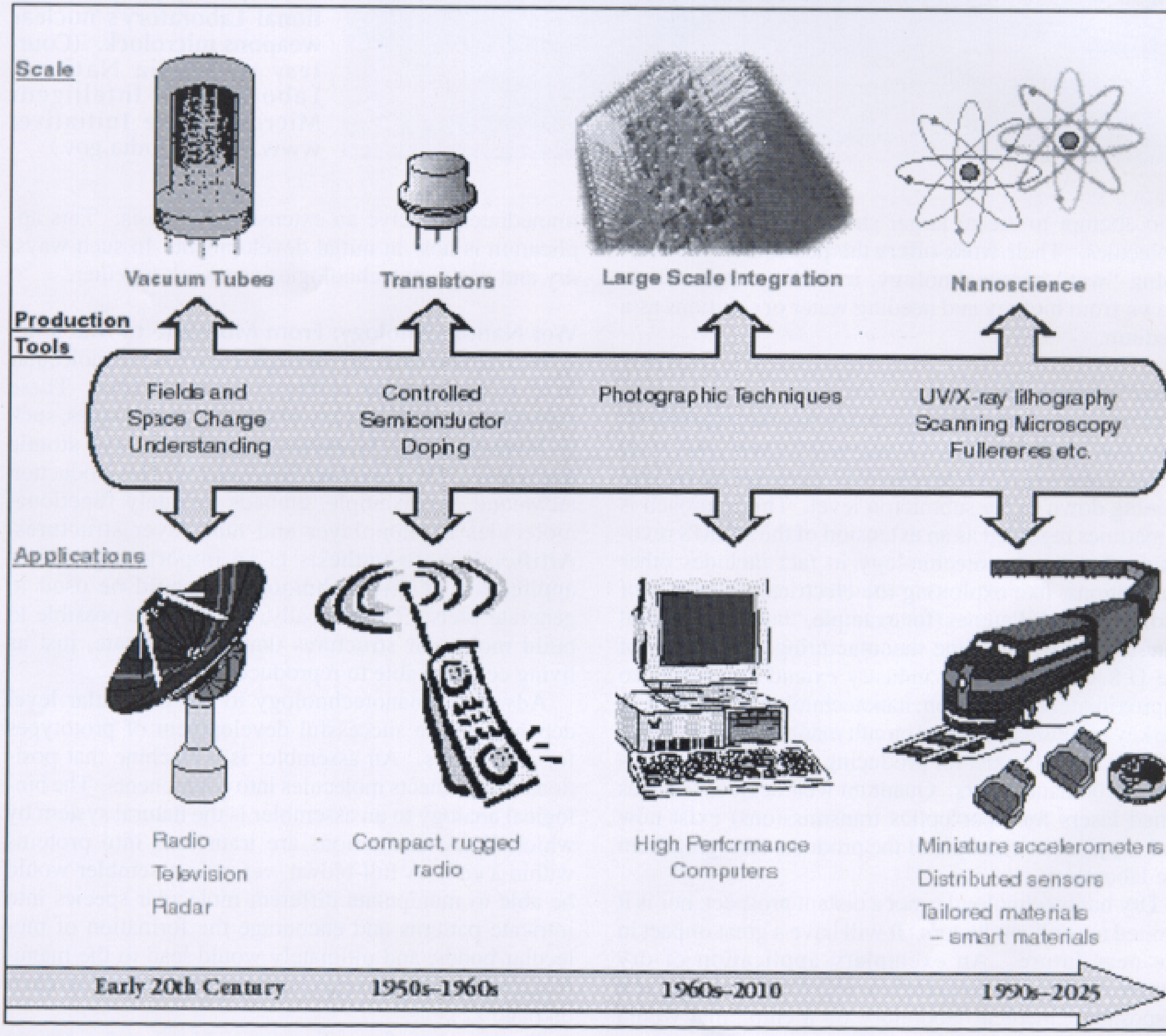
Advancing nanotechnology to the molecular level depends on the successful development of prototypes for assemblers. An assembler is a machine that positions and connects molecules into components. The biological analogy to an assembler is the natural system by which DNA instructions are translated into proteins within a cell. A full-blown, versatile assembler would be able to manipulate different molecular species into intricate patterns and encourage the formation of molecular bonds, and ultimately would lead to the manufacture of nanoscale precision products (see the chart on page 22).

The creation of a replicator would move the concept of an assembler to the next level by allowing copies of the assembler to be made. One nano-assembler working atom by atom would be rather slow because even micron-sized products are made of trillions and trillions of atoms. But a robotic replicator would make copies of itself, and then those copies would make copies. This means that, with enough atomic or molecular feed products, such as carbon-polymer building blocks, oxygen, sulfur, and so on, that specific part or system could be manufactured in quantity wherever additional supplies were needed. Once the control and energy source mechanisms are understood for particular replicator designs, an unlimited number of products would be possible. Self-assembling consumer goods, including food, could be made anywhere from atoms and molecules pumped out of simple reserves of feedstock or obtained directly from the environment. Thus, the advent of advanced replicators would create ultrasustainability in its truest form.

Applying MEMS

According to the Army Training and Doctrine Command's (TRADOC's) *Army After Next Project 1998 Report*, "The single most important area for [logistics] improvement is the need to achieve radical reduction in sustainment requirements." The application of MEMS to military systems will contribute strongly to reducing demands for many logistics products and services.

There is a multiple chain-effect benefit from using MEMS. Three big logistics demands are for ammunition, petroleum, and food. The use of microsensors and microprocessors will improve the precision of military weapons, thereby reducing significantly the demand for



☐ **Manipulation of increasingly small features has permitted the development of increased capabilities.**

munitions. A reduction of this magnitude in turn decreases transportation requirements and the number of personnel that must be fed and supported. Other applications of MEMS devices—such as using adjustable surfaces for controlling airflow and thus reducing aerodynamic losses in military aircraft—have been identified as a primary means of enhancing performance and reducing the demand for fuel.

Incremental developments in MEMS will improve transportation systems. Faster or more efficient aircraft and ships will expedite transport from the continental United States to an overseas theater. Advanced ground vehicles and low-flying aircraft will hasten the movement of supplies around a base or within an area of operations. Logistics efficiency is improved by tagging stored supplies, but improving traffic control of items being moved also would be helpful. In particular, roads near major points of embarkation and debarkation could be designed not only to identify the time, speed, and amount of traffic but also to give information about the mass and probable type of that traffic. Identifying the destination of quickly unloadable items in ground vehicles could be used to send them along optimal routes for unloading and subsequent loading into storage or onto aircraft and ships.

MEMS could help reduce waste and spoilage of supplies. Special packaging could use sensors in combination with MEMS cooling and heating devices to maintain temperatures or to control humidity for perishable products selectively. Biosensors, for example, could assist in controlling food and medical supplies. The entire physical history of a package could even be measured, analyzed, tracked, and recorded; this could be used, for example, to preclude losses at Army supply bases caused by faulty records on the contents of huge sea transport containers. As another example, a microaccelerometer and recorder could profile the jarring received in transport and provide data to be used in developing handling procedures for sensitive items. Fragile packages could be given greater care en route, and robust packages could be transported over more demanding routes.

MEMS should enable the Army to achieve ultrareliability, decreasing failure rates for systems and prolonging the time between needed maintenance actions. Inexpensive, small, low-power sensors would allow the introduction of highly redundant, reliable error-checking architectures. At a recent AAN workshop, the logistics efficiency panel emphasized the importance of microsensors: "Sensors must be embedded in the equipment to enable prognostics to predict failure before the failure occurs." This design architecture could improve the efficiency and effectiveness of repairs and reduce or even eliminate the need for evacuating parts and making contact with an external source of repair.

MEMS will enable smart, efficient logistics operations. In permanent structures, automatic sensing in storage areas would eliminate expensive and wasteful inspections. Chemical sensors could be relied upon to warn of the presence of dangerous materials. In a petroleum, oils, and lubricants depot, for example, robotic mobile sensors could be used to establish the presence and pattern of leaks and impurities and fuel levels. Inventory security is another important application of MEMS. Buildings could be implanted with sensors to interrogate (actively or passively) personnel as well as packages. Base and logistics security would both benefit. Automatic locks and barriers could be added to guard against unwarranted intrusion. Microlocks, as demonstrated by Sandia's nuclear weapons lock, could be incorporated in many items. The ultimate smart package could protect itself against tampering with escalating levels of response (including, of course, the ability to call guards).

In mobile vehicles, embedded sensors could look for improper mixtures of fuel and air or for degraded products that indicate problems with oil and lubricants. Data from embedded sensors could be communicated to supply sources so that needed parts could be ordered and received by the time they would be needed by maintainers, and maintenance centers could prepare equipment on a just-in-time schedule optimized for the expected time of return of that equipment from the field. In such ways, the use of sensors would facilitate the attainment of "anticipatory logistics."

Beyond embedded sensors are repair mechanisms that are designed into systems. The application of MEMS could blur the line between the support system and the system that is supported. As a 1997 TRADOC technology workshop report noted, "Smart structures and micro-engineered machines must be developed in order for a system to repair itself and continue with the mission." Embedded repair capabilities can reduce the need for spares and will be economical for many highly stressed items, such as engines. One simple approach is to use redundant mechanisms that can be switched into play upon failure of a critical component. In this way, small repair problems can be prevented from becoming larger ones. Fluids can be released as needed to seal cracks, force can be applied to counteract developing weak points, and hot spots can be cooled.

Miniaturized homing munitions combining the sensor (hunter), the weapon (killer), and the reporter (target damage assessment) will reduce the size of heavy, expensive, inefficient systems. Even without a munitions package, great benefits will emerge from using MEMS on the battlefield. The widespread use of inexpensive, lightweight MEMS devices will enable the U.S. military to take the first step toward integrating soldiers, packages, and equipment into an information network of individual websites in a networked theater.

For example, micro-air vehicles (MAV's) currently are being developed and tested. Small enough to be carried in backpacks, they typically are no larger than 6 inches by 6 inches and weigh no more than 4 ounces. These miniature reconnaissance planes fly for 20 to 60 minutes at speeds of 20 to 40 miles per hour. MAV's can serve as cheap airborne relays because, even though they have only a tiny half-ounce payload for a guidance system, videocamera, and transmitter, they can communicate and transmit imagery over a considerable distance. Whatever is caught by the MAV's videocamera appears on the screen of a soldier's laptop computer, providing him with valuable information for logistics movements as well as for his own battlefield support.

The enhanced visibility of soldiers and units across depot, base, and battlefield will mean that support demands are anticipated on a real-time basis and that those demands are met as efficiently and effectively as possible. Support from afar could increase because the theater would be networked to the entire global logistics infrastructure.

Applying Nanotechnology

Dry nanotechnology will increase the performance of many types of electronics, such as sensors or computer hardware, in the next several years, and wet nanotechnology might have widely diverse applications in the next few decades. For example, molecular nanotechnology may have important long-term military applications in such critical areas as power sources and biomedicine. As this technology matures, revolutionary progress may be expected in those and related areas.

Nanotechnology could be used to improve batteries and other energy storage devices. For example, much of the mass of current MAV's is created by the lithium battery power source. Processes that could produce even better energy sources are highly desirable. While lightweight solar cells provide a renewable source of energy, a power system developed through nanotechnology might provide high-power density for the prolonged operation of certain equipment with a renewable fuel source.

Replicators and other nanosystems also require power. Acoustic coupling, microwaves, rechargeable nanobatteries, and artificial photosynthesis combined with solar power or lasers have been advanced as potential wet nanotechnology power sources. Nanosystems in turn can tune engines and power systems. To keep such intricate molecular machinery working, control mechanisms would have to include sophisticated levels of repair and fault tolerance.

Applying wet nanoscience could lead to a portable biokit that provides food, water purification, materiel components, and medical supplies. Desalination of water now is possible with the use of polymer membranes for selective filtering. Medical tissues (artificial skin and blood) could assist in repairing wounds. Conventional bioreactors might be used to manufacture genetically enhanced organisms for material products, or even food substances that satisfy nutrition requirements (even if the results are not especially delicious).

The ability to handle tremendous amounts of data efficiently is a well-known logistics problem. More extensive information networks and computational systems can ease the ordering of components and accelerate final assembly. The small component scale possible with dry nanotechnology would permit extremely high-density memory storage and rapid data operations. Wet nanotechnology offers another potential avenue for a solution. Computers currently solve mathematical operations and well-defined problems of logic very well. The general cognitive and imaging functions of the brain, though, are vastly more capable than modern semiconductor-based information systems. If an organic computer or biomimetic brain could be built to imitate the features of the human brain, then training of computational machines one day could become as important as the training of soldiers. The applications of even a low-capability artificial brain can be quite imaginative (for example, a transport package that "talks back" to the user).

Virtual manufacturing by means of high-performance computing is an area in which nanotechnology may provide a series of longer term breakthroughs for logistics supply and repair processes. In principle, small seed quantities of biological organisms could work with portable growth machinery to provide support in the field for compact manufacturing techniques. Some parts could be manufactured entirely on location, leading to the ultimate just-in-time supply process and eliminating long transport lines and storage requirements. One such view sees "matter as software."

Ultimately, computers and data flow may be a two-way street embedded in everything from containers to uniforms to equipment. For instance, imagine a microscopic assembly line where structures, including DNA, travel along a carefully controlled conveyor belt made to imitate cilia (the tiny hairs that extend from the surface of cells); robotic arms, catalytic guides, or some other technique insert individual molecules into the increasingly complex structure; each molecule builds on the last; and the entire micromanufacturing plant fits into a modern printer that spits out an intelligent report with a distributed DNA computer embedded in the paper. The report could be queried, would include the equivalent of a thin-film "monitor screen," and would be connected to other personnel or equipment through an external relay by an embedded short-range communications subsystem. No one knows for certain when this type of capability will be practical, but some envision full-up nanoassembly machines as early as 2020.

Future Developments

While today's MEMS products and nanotechnology devices typically are independent systems uniquely tailored for specific commercial functions, they have enormous potential for wide application in the near term. Moreover, as ongoing developments in these areas are supported and exploited, technological breakthroughs will not be far behind. As Deborah Pollard and C.T. Chase observed in their Army Logistician article (January-February 1999), "It is essential that the logistics community understand what nanoscience is and where it could take us."

U.S. and international support of MEMS and nanotechnology is now on the rise. U.S. Government spending in fiscal year 1999 for nanotechnology research totaled $232 million, and a national initiative designed to increase U.S. research efforts significantly would roughly double the amount of Federal spending through fiscal year 2001. MEMS products are rapidly approaching initial decision points about architecture developments, and some products are already widespread.

Despite increasing investment levels, the timeline for the initial development of assemblers and replicators depends on laboratory breakthroughs that are not easily predicted. There is a physical limit to the growth of capabilities in conventional microelectronic systems as component sizes decrease and quantum mechanics force new architectures and processes to be adopted. If a full assembler actually can be developed within the next 10 to 20 years, and a useful replicator follows shortly thereafter, then an impressive capability for logistics sustainment will arrive during the third decade of the new century.

It is critical that the Army become aware of breakthroughs in assembler developments as they occur. Lack of vigilance by the Army in monitoring developments could create big problems in a short time. The Army must remain involved with nanoscience accomplishments in the civilian world, and that involvement must continue between the big, headline-grabbing breakthroughs.

Near-term support of nanotechnology is needed. For example, development of controllers for the most ambitious nanosystems suggests that technologies that should be given near-term support include biological sensors, chemical sensors, and information components. Smart materials for form and function are important candidates for current support, as are technologies in the area of medical and human support. Over the next few decades, many capabilities will become possible.

Army long-range planning, including logistics planning, should consider contingencies that can accommodate breakthroughs, delays, and technical risks. Recognizing the critical role that miniaturization technologies can play in achieving a revolution in demand reduction, the Army is taking steps to guide research on the most important Army-unique developments. In the Army's Science and Technology Master Plan, nanotechnology is identified as one of the Strategic Research Objectives (SRO's) of the AAN. Microsensors and smart structures also are included in the SRO's.

The topics that these SRO's cover do not stand in isolation from one another. There are many opportunities for synergy among biomimetics, nanoscience, smart structures, and microminiature multifunctional sensors. In order for the coming revolution in technology to be applied smoothly to the Army, the RML must embrace these developments. **ALOG**

http://www.darpa.mil/mto/ultra/index.html
http://foresight.org
http://www.ida.org/mems/
http://www.mdl.sandia.gov/micromachine/
http://www.mitre.org/technology/nanotech/
http://fbox.vt.edu:10021/arch/psk/papa6664/smith/thesis.pdf
http://www.zyvex.com/nano/

☐ Websites that can provide more information on the technologies discussed in this article.

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DLIS Improves Logistics Resources

by Timothy Hoyle and Pat Vandenboss

Military units constantly must test themselves to ensure that they can accomplish their intended missions and are ready to meet whatever need arises. The same challenge exists for personnel of the Defense Logistics Agency's (DLA's) Defense Logistics Information Service (DLIS), in Battle Creek, Michigan, who use the latest technology to offer logistics information management tools that help keep units well supplied with critical items.

Logistics Information Network

DLIS has adapted the Logistics Information Network (LINK) to increase access and search capabilities as technology changes. LINK uses information from 13 Department of Defense (DOD) and General Services Administration logistics data bases to help users locate sources of supply and track the status of their supply requests worldwide.

Several versions of LINK are available to accommodate customers with varying computer capabilities and connectivity. In fact, one of LINK's special characteristics is that it provides logistics information to users in network-poor environments. This makes the system ideal for deployed units and ships underway. People in these situations normally rely on PC [personal computer] LINK versus the World Wide Web. Not all Army units have good access to the web, but PC LINK works well for most because it uses a "burst" method to send queries and receive responses. Users are connected to the network only during transmissions. Otherwise, all other processing, such as building queries and reading responses, is done locally on their personal computers.

Customers who prefer to use web-based products use WebLINK, which has special interfaces that provide real-time access to data bases. Both PC LINK and WebLINK provide a capability called SmartLINK that simplifies search techniques. Together, these different versions helped LINK process 4.75 million queries in 1999.

LINK Capabilities

Batch and automatic queries
Single log-in
Real-time access to three sources
Download responses to spreadsheets
Fused data
Support of network-poor environments

FEDLOG

Customers looking for information off line will benefit from the initiative to offer the Federal Logistics Data on Compact Disc, more commonly known as "FEDLOG," on digital versatile disc (DVD). This new offering consolidates FEDLOG Basic, FEDLOG Characteristics Search, and FEDLOG Drawings onto one DVD rather than several compact discs.

While the discs involved may change, FEDLOG still will use data from the Federal Catalog System to provide customers with essential information. This information includes all of the items available from DLA and service-unique data from the Army, Marine Corps, Navy, and Air Force.

Customers also may view representational line drawings and Army packaging drawings on their computers. Drawings of a more technical nature can be obtained through the Military Engineering Data Asset Locator System. The system is a central index of engineering data that provides information about schematic drawings and allows users to order copies on line.

Cataloging Consolidation

Improvements to data in the Federal Logistics Information System are continuing with catalog consolidation efforts and the introduction of environmental attribute information to catalogs. Centralized DOD cataloging has continued since the Army's catalog operations moved in 1998. DLIS expects to accomplish the combined cataloging mission with fewer resources when Navy catalogers join DLIS early this year and complete the consolidation.

Many new cataloging reengineering initiatives are underway to expedite the processing of new national and North Atlantic Treaty Organization (NATO) stock numbers along with updating the current ones. Maintaining such extensive cataloging data involves more than 62 million transactions annually. DLIS usually makes the updated information available to users within 24 hours. Besides its military customers, DLIS provides cataloging services to the Federal Aviation Administration and the National Weather Service, and it is currently negotiating to support the U.S. Coast Guard.

New cataloging ventures also will make maps, charts, and other imagery from the National Imagery and Mapping Agency (NIMA) more accessible to commanders through NIMA's new relationship with DLIS. The partnership makes it easier to tailor catalogs of NIMA's products to meet the specific needs of each Service. It also lets both DLIS and NIMA focus more directly on their missions while improving customer satisfaction. Army and Marine Corps units, for example, can get help planning ground operations from data on earth contours that they can locate through the Topographic Products catalog. Likewise, the Aeronautical Products catalog benefits the Air Force and National Guard by providing elevation data. Navy, Coast Guard, and other maritime customers benefit from the data on the varying depths of bodies of water available through the Hydrographic Products catalog.

Other collaborative efforts by DLIS involve using commercial product information. Links are being established between bar codes and national stock numbers to implement automatic information technology. Talks are underway between DLA and the Defense Contract Management Command to require vendors to provide universal product code numbers on the items they distribute. The Universal Directory of Commercial Items, formerly known as the Universal Product Code Directory, was created to allow the use of commercial bar codes in managing items whenever possible. DLIS also is revising its Government/Industry Reference Data Edit and Review Program to capture information on bar codes.

Identification of "Green" Products

Environmental attribute information is being captured as data on new products are added to the Federal Logistics Information System. Products that meet strict, definable criteria are identified in the Federal Logistics Information System with an environmental attribute code and are highlighted in the DOD EMALL (DLA's online catalog) and FEDLOG with a green tree icon. The icon helps commanders and procurement personnel identify "green" products easily and facilitates compliance with Presidential executive orders that mandate the increased procurement of environmentally preferable products.

By this summer, customers will be able to use the new DLIS "E–PRO" Environmental Products Guide on the new "Buy Green" website at www.buygreen.dlis.dla.mil. The guide will be hot-linked to the EMALL, where it will display and highlight only those items in the system that meet the rigid environmental standards and criteria of certifying agencies such as the Department of Energy and the Environmental Protection Agency. The site will offer users a convenient one-stop source for a wide range of products that are environmentally preferable over other similar products.

Hazardous Materials

The Environmental Reporting Logistics System offers commanders additional support by allowing them to monitor the levels of hazardous materials on their sites. Future versions of this system also will offer recommendations on environmentally friendly products. Customers who handle, store, transport, use, or dispose of hazardous materials can get more help from DLA's Hazardous Material Information System operated by the Defense Supply Center Richmond, Virginia. This system is a repository of material safety data sheets that offer information to assist with the transportation, labeling, and disposal of hazardous materials.

Customer Assistance

When units are not sure which DLIS product or service is best for their needs, they can receive help from the Battle Creek Customer Support Center. Its agents can be reached by telephone or by using e-mail, voice mail, or fax. The center combines the best business practices and the latest technology to collect questions from customers and respond to virtually any request from anywhere in the world.

The center's major tests came during Operation Desert Fox in the Persian Gulf and Operation Allied Force in the Balkans. Agents worked around the clock during these campaigns without increasing the staff but still provided world-class customer service. As hostilities wound down, DLIS continued to support the humanitarian relief efforts in the Balkans and at several natural disasters. On average, the center answers 25,000 calls per month. The highest volume of calls thus far came last July, when more than 40,000 were answered.

DLIS's primary mission is to support all logistics information functions for DOD, other Government agencies, and foreign governments. Many of its products now are available by accessing the www.dlis.dla.mil website. Demonstrations of many products also can be viewed there. For more information about DLIS, visit its website or call the Office of Public Affairs at (616) 961–7015. **ALOG**

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The Assistant Secretary Talks About Readiness

The Honorable Paul J. Hoeper, Assistant Secretary of the Army for Acquisition, Logistics, and Technology and the Army's Acquisition Executive, is a member of Army Logistician's *Board of Directors. The* Army Logistician *staff asked Mr. Hoeper some questions about readiness, reliability, and logistics for the Army of the future. The questions and his responses follow.*

Army Logistician: Mr. Hoeper, in February 1999 the position you hold was renamed from Assistant Secretary of the Army for Research, Development, and Acquisition to Assistant Secretary of the Army for Acquisition, Logistics, and Technology. You thus acquired responsibility for the logistics function from the Assistant Secretary for Installations and Environment. Can you tell our readers why this change was made, and what it tells us about the state of logistics as we enter the next century?

Mr. Hoeper: The real reason, if you remember, for the merger was that the separation of acquisition and logistics always had been an artificial distinction. You could say that acquisition is actually a subset of logistics because both acquisition and logistics are really about getting soldiers what they need when they need it. In China, one of the top generals in the People's Liberation Army and the Central Military Committee is in charge of logistics. Under logistics, he has acquisition, research and development, science, and, strangely enough, the comptroller function. Our Defense Department also places logistics with acquisition and technology. Congress recently recognized the importance of linking the three areas by formally titling our third-ranking defense official as Under Secretary of Defense for Acquisition, Technology, and Logistics. In light of that, it doesn't seem so strange that the U.S. Army would organize to bring together the common elements of logistics functions.

Besides eliminating the artificial distinction, the real benefit is that it opens the channels for discussion and cooperation to increase the overall operational effectiveness in acquisition and logistics. What we do in acquisition very much affects what we do later on in sustainment. Our logistics requirement for transportability, for example, should be described in detail and sent back into the acquisition process for action. In fact, more information on logistics requirements should be sent even farther back into the science and technology area so that improved operational effectiveness can begin at that level. Let me emphasize here that information about both acquisition and logistics is important to make sure we are developing and distributing the right products and processes. We need to be both effective and efficient. Effectiveness is doing the right thing; efficiency is doing things right. We want to make sure we are doing the right thing and that we are doing that thing the right way.

Army Logistician: Since the end of the Cold War, the Army has been going through a period of profound reevaluation and transition—a process often called the Revolution in Military Affairs. We are moving from a focus on countering one major global opponent to meeting multiple threats and performing missions anywhere in the world; from an emphasis on heavy armored forces to a flexible mix of lighter forces; from forward basing to force projection; and from a traditional linear battlefield to a borderless, sectorless battlespace that puts a premium on speed, communication, up-to-the minute information, and situational awareness. As the Army experiences revolutionary change, in what ways will logisticians have to change how they think and how they see their role within the overall force?

Mr. Hoeper: We all need to think about the implications of that very deep question. The Revolution in Military Affairs is important, and it came at an interesting time. The Revolution in Military Affairs probably is based on two things. It is based on the change in the situation that was described in your question—that we are moving from preparing for global conflict to preparing for two major theater wars and a full spectrum of operations other than war. So, the situation in which the military operates has changed. At the same time, many of the tools have changed. That is what has allowed a Revolution in Military Affairs; the changing situation allows for the insertion of modern communications technologies and information technologies into our concepts of warfare.

Logistics always has been an essential enabler in military operations. The Revolution in Military Affairs allows logistics to become a force multiplier in military operations.

Army Logistician: Last October, the Chief of Staff of the Army, General Eric K. Shinseki, presented a vision statement outlining his views on how the Army needs to change. His central tenet was the need to create more deployable forces that are organized in new ways that move beyond the traditional distinction between heavy and light units. But he emphasized that achieving that goal depends to a considerable degree on the development of new technologies. What technologies do you see as the most important for realizing General Shinseki's new vision?

Mr. Hoeper: We really have to look at the technologies that might be applied to our future combat systems. We haven't, in the past 10 years or so, seen real breakthrough technology in land vehicles. We still rely on tracked or wheeled vehicles, cannon- or gun-based systems, and armor plate. With the Chief's vision of far more rapid deployments and a more lethal, deployable force, we will be looking at technologies that affect our situational awareness, our reconnaissance, and our sensor technologies. We will be looking at robotics. We will be looking at different propulsion systems for ground vehicles and perhaps different drive systems as well. And we are going to have to consider new concepts in the survivability equation. Probably from the logistics point of view, the two key facets of the Chief's vision are in the areas of lift and ammunition. We'll be looking at the logistics implications of transporting an effective force to wherever it is needed in the world and the logistics implications of supplying and using precision weapons.

You could get back to basics quickly in this discussion, because winning a battle is still about what it's always been about. It's still about getting there "firstest with the mostest." Winning wars is about winning battles and then having staying power. If you look back at Kosovo, you could describe the Kosovo operation as a battle—the Battle of Kosovo. We could win the battle from the air, but we need staying power to win the war. We've got to have boots on the ground, and that means Army logistics.

Many of us, I guess, are armchair theoreticians. We like to sit back in our armchairs and think about the tactics that, in retrospect, should have been employed. But, there is that old saying that amateurs talk about tactics and professionals talk about logistics.

Army Logistician: General Shinseki also noted that the Army needs to "squeeze" its organizational structure to get more soldiers into combat roles—in other words, "more tooth and less tail." He observed, for example, that logistics requirements comprise 90 percent of the Army's lift requirements. That logistics footprint must be reduced if we are to attain the deployable force we desire. What do you think are the major issues logisticians will have to address in the coming years in order to reduce the Army's "tail"?

Mr. Hoeper: I think that communications and information technologies have allowed us to start thinking about moving from our supply-based system to a distribution-based system. Our merger actually is a part of that—the merger of the acquisition and logistics organizations with technology. I think we are changing business processes in a very constructive way, a very thoughtful way, and a very rapid way. And when we complete all of the elements of the Global Combat Support System-Army (GCSS-Army), we will have a single logistics and information system that is an essential part of the Warfighter Information Network.

***Army Logistician*:** One possible solution for reducing the number of soldiers in the Army's logistics structure is using more civilians. How do you see the role of civilians in Army logistics evolving in the coming years? What do you think is the best mix of Government civilians and contractors? How great a presence on the battlefield should civilians have?

Mr. Hoeper: Your question has two parts. We're talking about government civilians—Army civilians—and contractors, and I think we are going to have both in the battlespace of the future. We've always had contractors on the battlefield. We had them in the Revolutionary War. We had them recently in Albania supporting the Kosovo operation. I think the use of contractors and contracted support is likely to increase in the 21st century. As to the question of the best mix, we are going to have to find out. We are just going to have to try it and work with it until we know what the best mix is.

One of the strengths of the Army has been its ability to develop doctrine. In the past 12 months, I think the Combined Arms Support Command, Fort Lee, Virginia, has developed some good doctrine for civilians and contracting operations on the battlefield. We'll have to work through that doctrine carefully, because the way you control contractors within the battlespace is going to be different than the way you control soldiers within the battlespace. I think we have a good process for doing it, and I think we will develop additional doctrine that will allow us to put the guns into the hands of soldiers and more of the support activities into the hands of civilians and contractors.

Army Logistician: The Army of the future will be a digitized Army. What are the major problems logisticians will face as the Army makes this fundamental transformation? What vulnerabilities do you think wartime logisticians might face as they increasingly rely on automated systems to do their jobs?

Mr. Hoeper: We are going to digitize the Army and we are going to digitize logistics, so we'll be training soldiers in a different way. That probably won't be as radical as many may think. We are becoming a more digitized society, and we draw our soldiers from society. I don't anticipate great problems; but there will be additional training, and we will have to develop ways to maintain training proficiency.

Now, the vulnerability is an interesting question, because a classic tactic for winning wars is to break the enemy's logistics chain. So you can certainly envision an enemy focused on disrupting our digitized logistics. We will have to rely on the same security procedures that we will rely on for our weapon systems. We'll have to use defense in depth to maintain network and information integrity through the use of the latest firewalls, intrusion detection systems, and encrypted links. This will ensure the security of our digital logistics chain as well as our physical logistics chain.

Army Logistician: How realistic do you think it is to expect the Army to achieve 99.999999999-percent reliability on systems performance, and what is your definition of ultrareliability?

Mr. Hoeper: We're nowhere near a string of nines in systems reliability right now. Very few of our systems approach 99-percent reliability. And reliability varies widely among our systems. We need to achieve far better reliability than we have now, and I think we can do it. We've seen reliability improve in many, many commercial systems—automobiles, electronics equipment, and nearly everything we use. Reliability can be improved. In warfare, it is not enough to improve systems so they won't break on the road. We're operating in an environment where the enemy will try to break our systems for us. So we may work on systems that, first of all, don't fail by themselves but, secondly, have some "self-healing" characteristics, perhaps in the form of subsystem independence, so that they can continue to operate reliably in a wartime scenario. I think that is something we can do. I think the technology allows it. I also think that if we are going to operate in line with the Chief's vision, it is something we have to do.

Army Logistician: If soldiers are to be trained to use integrated sensors, data collection devices, and other diagnostic systems in the equipment they operate, that seems to indicate a need for more specialization in military occupational specialties. Doesn't that run counter to the Army's efforts to create "multicapable" soldiers, particularly in repair and maintenance specialties?

Mr. Hoeper: Two or more specialties often must be brought together on the battlefield to repair and return one disabled system to the fight. This is burdensome, costly, and inefficient. The Army's current effort is to train the soldier to be multifunctional; that is, to repair multiple aspects of a single combat system. The soldier will be trained to use on-board sensors and diagnostic tools to enable him to correctly identify and replace faulty components and ensure that the entire system is operational .

As we move to the objective force, we will increase the commonality of our systems. Accordingly, our multicapable soldiers will be able to service more vehicle configurations.

☐ **At Anniston Army Depot's machine shop, Assistant Secretary of the Army Paul J. Hoeper and General John G. Coburn, Army Materiel Command, learn how combat vehicles and subassemblies are repaired, restored, or fitted with parts manufactured at the depot.**

Army Logistician: How can the Army justify the unavoidable high costs of incorporating diagnostics in individual systems—not only the costs of research, development, and manufacturing, but also the cost of training soldiers to use this specialized technology?

Mr. Hoeper: What's happening with integrating the embedded prognostics and diagnostics is that the commercial world is helping us quite a bit. It would be very, very expensive if we had to develop this by ourselves. I think we are going to be able to capitalize on the commercial trends in this area and insert these capabilities at a very reasonable cost and in a very cost-effective way. And we'll get a high payback for it.

☐ **Mr. Hoeper tours Anniston Army Depot's combat vehicle disassembly/reassembly facility where M1A1 Abrams tanks, M88 recovery vehicles, and the M113 family of vehicles are repaired. Shown left to right above are General Manager for Production Operations Jesse Poor, Mr. Hoeper, Director of Production Frank Bosworth, Alabama Senator Jeff Sessions, Major General John Caldwell from the Tank-automotive and Armaments Command, General John G. Coburn from the Army Materiel Command, and Alabama Congressman Bob Riley.**

Army Logistician: The Army in recent years has put much emphasis on reducing stockpiles of materiel and relying instead on "just-in-time" supply procedures favored by many businesses. This practice has worked well in peacetime. Do you foresee any problems with just-in-time supply management in wartime? Is there a need to maintain large inventories of certain types of materiel "just in case"?

Mr. Hoeper: When businesses started looking at how they managed and controlled inventories, they identified two systems as reference points—the stockpile-management approach and the just-in-time approach. Even in a business context, they are reference points. So the just-in-time approach could be thought of as the part arriving in the assembly worker's hand just at the moment he is ready to put it on the product. Now, that's a reference point in business. But it is not a goal for most businesses. We certainly wouldn't want to have that sort of just-in-time in military operations, but we do want to understand and take advantage of the ability to manage the flow of equipment from the source to the soldier. I don't think we want to use the phrase "just-in-time" in the military. What we want in military operations is a logistics system that gets us "enough" on time to enable us to win wars, and by that I mean providing what the soldiers need when they need it.

In order to get the soldier enough of what he needs when he needs it, we'll need asset visibility so we can find it quickly. We recognized that we needed better supply procedures during the Gulf War, when we had an awful lot of things in the theater. There was plenty; we just couldn't find it. And if it can't be found, the soldier won't get it. The soldier has to have enough equipment, supplies, ammunition, and fuel to operate effectively, but not so much that he is burdened by it.

Army Logistician: Thank you, Mr. Hoeper, for sharing your views with our readers. Your responses to our questions have clearly illustrated the importance of the acquisition and technology communities working together with logisticians to increase readiness and reliability and to prepare our Army for the future. **ALOG**

Incorporating Diagnostics in Military Equipment

by Major Steve March, USAR

Existing and emerging technologies will enable the Army to incorporate automated diagnostics and prognostics into its future equipment and weapon systems.

Logistics support of Army After Next (AAN) forces will differ radically from today's logistics system. AAN battle forces will be self-sufficient for long periods of time, move two to three times faster than current units, and operate at great distances from higher level sources of support. This will require weapon systems and other equipment to be significantly more reliable than those in use today. System reliability of 90 percent is acceptable for current equipment, but 99 percent or higher will be required for AAN equipment. It will have to be "ultrareliable." Thus, ultrareliability is one of the 6 pillars of the AAN support concept.

In this context, the term "ultrareliability" means to provide failure-free operations. New equipment and weapon systems need to be designed to be inherently reliable, which will require advances in design engineering and greater emphasis on reliability standards by materiel developers. However, this approach may prove to be too costly to attain the improvements in reliability needed for AAN forces. Another approach, which may be much less expensive, is to embed automated diagnostics and prognostics into weapon systems. The goal would be to predict failures in all weapon subsystems and components and to make that information available to commanders and support personnel in real time. Achieving this goal will require the use of emerging and future technologies and a revolution in the way the Army maintains its equipment.

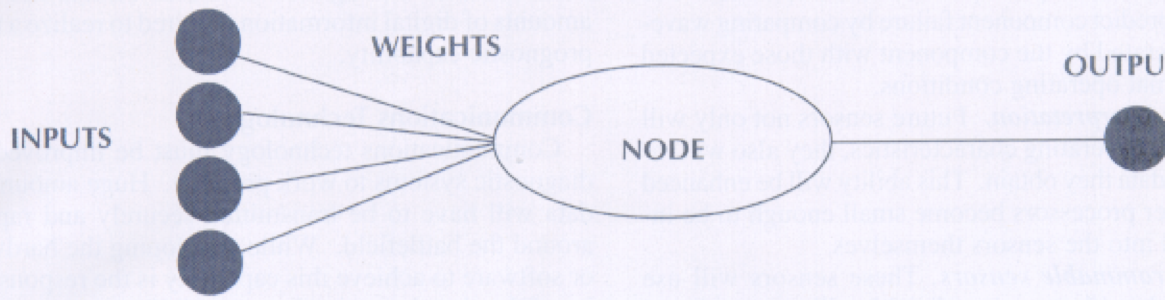
Horizontal Technology Integration

The Army's commitment to its plan to remain the dominant military force in the period 2010 to 2025 was emphasized by Major General Robert H. Scales, Jr., Commandant of the Army War College—

> We believe the Army has seized upon a highly compelling vision of its future role in land warfare. It has also carefully thought through a comprehensive process that will determine the key science and technology investments enabling it to achieve this vision.

In 1997, the Program Manager for Test, Measurement, and Diagnostic Equipment (PM TMDE) was tasked to create a plan for embedding diagnostics in all Army equipment. The result called for a horizontal technology integration approach that would allow new technologies to be applied to multiple weapon systems. In January 1998, the Automated Diagnostics Improvement Program (ADIP) was approved as a horizontal technology program, and embedded diagnostics and prognostics were identified as tenants of Army XXI and AAN. Now all weapon system PM's must coordinate with the PM TMDE to ensure that diagnostics and prognostics are incorporated early in the new system acquisition process.

Facing reduced budgets, the Army must find ways to reduce the operating and support costs of current and



□ **Elements of an artificial neural network.**

future equipment while continuing to purchase technologically superior weapon systems. The ADIP planners recognize that the Army is lagging behind the commercial sector in the use of diagnostics and prognostics. Thus, the ADIP master plan stresses the need to use commercial off-the-shelf and nondevelopmental items.

ADIP Master Plan

The ADIP master plan describes phases, or thrusts, that will take place concurrently, with early results being used to generate even greater advances in the later stages.

The first thrust involves inserting available commercial diagnostic technology into current weapon systems and replacing current support equipment. An example of diagnostics that already have been incorporated into a weapon system is the turbine engine diagnostic expert system that diagnoses faults in the M1 Abrams tank's turbine engine. Using artificial neural network technology, sensors in the engine analyze fuel flow and provide data to the crew and support personnel. The system has made diagnosis easier and reduced the number of "no evidence of failure" faults in turbine engines returned for repair.

The goal of thrust two is to develop an anticipatory maintenance system. This will be accomplished by the Failure Analysis and Maintenance Planning System, which will be a submodule of the Global Combat Support System-Army (GCSS-Army)—the Army's system that will digitize the support structure. Data will be collected using electronic sensors and exported using improved data buses, the tactical Internet, and satellites. Analysis of the data will give users the ability to predict maintenance needs, as information from across the Army is placed in a data base and made available to personnel at all levels. In addition, ordering parts and processing work orders will be automated fully.

Thrust three will result in the fielding of an embedded diagnostic system in all new Army equipment. Advanced research and development projects begun in the first two phases will yield a true prognostic capability and complete the revolution in weapon systems maintenance. Programmable sensors will monitor and collect data on all parts of a system continuously. These data will be analyzed by on-board processors and will be made available, through interactive interfaces, to the crew, commanders, and logisticians. The data also will be transmitted in real time to central data bases at theater level and to the continental United States. It may even be possible to provide a level of self-healing to a weapon system.

Required Technologies

Technological advances in several key areas are needed if the goals outlined in the ADIP master plan are to be realized. These include—

- Developing sophisticated sensors to collect data on a weapon system's performance.
- Dramatically improving the analysis and data storage capabilities of digital hardware.
- Perfecting communications technologies that will enable the transfer of vast amounts of data in real time and with extreme reliability.

Incorporating advances made in these areas by the commercial sector will enable Army materiel developers to field weapon systems that have a true prognostic capability.

Sensor Technology

Sensors can gather data on weapon system performance and status. Factors such as temperature, noise, pressure, and vibration can be measured and used as diagnostic signals. Some notable innovations in this area include—

• ***Vibration analysis***. This can be used to monitor the condition of many weapon system components. The tester can predict component failure by comparing waveforms generated by the component with those expected under normal operating conditions.

• ***Data interpretation.*** Future sensors not only will measure key operating characteristics, they also will interpret the data they obtain. This ability will be enhanced as computer processors become small enough to be incorporated into the sensors themselves.

• ***Programmable sensors***. These sensors will use advanced algorithms and artificial intelligence to boost their processing potential. Sensors will transmit the data they obtain to other digital devices using built-in antennas.

Data Processing and Storage Technology

One technology that has great promise is the artificial neural network. An artificial neural network mimics the way the human brain functions. A node receives input from a number of sources, the input is evaluated using weighted factors, and a total output is found (see chart on page 33). This output is compared to an expected value. The neural network then "learns" by repeating the calculations either forward or backward through the system. In effect, it becomes "smarter," or more accurate, over time. Researchers are finding ways to make these artificial neural networks more complex by adding additional processors or layers of nodes. The ability of the neural network to "learn" is what makes it such a powerful tool.

The turbine engine diagnostic system mentioned earlier makes use of this type of artificial intelligence to monitor the M1 tank's turbine engine. With M1 tank engines, each turbine has slightly different operating characteristics due to varying tolerances in machining and other factors. The turbine engine diagnostic system on each tank comes to recognize the peculiar operating characteristics of its engine and bases its analysis of that turbine's operation on those specific factors. This use of artificial intelligence has hundreds of commercial applications and has great potential in the military.

After a sensor collects data, the data must be processed to be useful. Advances in digital storage capacity are necessary to make efficient use of the large amounts of data that will be collected from hundreds or thousands of sensors. Computer processing power is expanding at a phenomenal rate. In the 1950's, it took a billion billion atoms to store one bit of information; by 2025, it could take 1,000 atoms. In fact, in the laboratory, researchers have been able to store a bit of information on a single atom. Similarly, in 1956 it cost $10,000 to store a megabyte of information, while today it can be done for 10 cents. By 2025, it may be possible to store a terabyte (1,000 gigabytes) for only $1. Advances like these will make it possible to have on-board data storage devices that collect the vast amounts of digital information required to realize a truly prognostic capability.

Communications Technology

Communications technology must be improved for diagnostic systems to work properly. Huge amounts of data will have to be transmitted securely and rapidly around the battlefield. While developing the hardware or software to achieve this capability is the responsibility of the signal community, not ADIP, some emerging technologies are worth noting—

Digital cellular networks are beginning to appear in North America and Europe. In addition, much larger satellite communications networks will come on line in the next decade.

Short-range radio frequency links may become an effective way for logisticians to transfer data over short distances.

Data compression technology, encryption, and ***methods of using the full spectrum of bandwidth*** will further improve our ability to move information from point to point.

Internet transfer of information is being researched. The Navy, in conjunction with the Electric Power Research Institute and Pennsylvania State University's Applied Research Laboratory, is testing the data transfer capabilities of the web. Data obtained remotely are sent over the Internet to an expert system and evaluated.

To support the rapidly moving, self-sufficient AAN forces, equipment will have to be nearly failure free. Embedded diagnostic and prognostic systems will be needed to monitor the equipment and identify problems before they occur. The ADIP lays out a plan for achieving this goal using horizontal technology integration. It provides the means to use commercially developed products within Army systems. Using current and emerging technologies, the Army will provide the ultrareliable equipment that AAN forces will need to get the job done.

Major Steve March, USAR, is an Active Guard/Reserve officer assigned to the 310th Theater Support Command at Camp Zama, Japan. He is a graduate of the Ordnance Officer Advanced Course, the Combined Arms and Services Staff School, and the Army Logistics Management College's Logistics Executive Development Course, for which he prepared this article.

Sea-Based Logistics: An Option for the Army?

by Commander Andrew J.M. Smith,
Royal Australian Navy

The author argues that using the sea to provide logistics support is a logical extension of the Army's air assault doctrine.

The history of Army rotary-wing aviation and the evolution of air assault doctrine are characterized by significant, continuous improvements in the range, speed, lift capacity, survivability, and lethality of aircraft. These advances have increased the Army's potential for deep penetration, eliminated the traditional boundaries governing unit maneuver, and reduced reliance on ground lines of communication. As a result of these developments, the options for locating logistics support assets also have increased.

The Army is now in a position to challenge the traditional notion that use of the sea for operational maneuver is limited to Navy and Marine Corps forces. At present, operational maneuver from the sea and its supporting concepts of ship-to-objective maneuver (STOM) and sea-based logistics are limited to the Navy and Marine Corps. We need to understand that these concepts are entirely consistent with the Joint Vision 2010 concepts of dominant maneuver, precision engagement, full dimensional protection, and focused logistics. In many respects, they employ the same principles as, and are a logical extension of, the Army's air assault doctrine.

After examining existing trends in military aviation, the future potential capabilities of aircraft, the benefits of air assault doctrine, and the imperatives of Joint Vision 2010, I believe that sea-based logistics is a concept that the Army should investigate as a mobility option for Force XXI and the Army After Next.

The Army's experience with air assault operations and logistics places it in a sound position to exploit the sea battlespace. A large number of factors must be considered if sea-based logistics is to succeed. The most significant factors concern air transport and integrated command, control, communications, and intelligence systems, although the development of suitable ship platforms for sea-based logistics also is very important. From the Army perspective, many of these factors also affect air assault logistics, and in many cases developmental programs to exploit technology for operational maneuver from the sea and for Army air assault operations are complementary. To achieve success, paradigms need to be challenged and technology exploited; it is no coincidence that these underlie Joint Vision 2010.

What Is Sea-Based Logistics?

Sea-based logistics is an operational- and tactical-level naval concept primarily focused on support of amphibious operations. This developing concept seeks to leverage technology and capabilities to exploit the natural advantages of the sea as a maneuver space. Sea-based logistics will provide new possibilities for operations by deploying forces and for supporting those forces from bases located over the horizon at sea. The traditional requirements to build up a force on a beachhead and then seize and control intermediate objectives to maintain ground lines of communication will be eliminated.

Sea-based logistics is identified by "Joint Vision 2010: Naval Warfare Imperatives" as a significant element of future warfare. STOM is the primary conceptual tactic for achieving operational maneuver from the sea. It describes combined arms penetration directly to an objective from an over-the-horizon sea base. Organic aircraft provide the physical means of connecting the sea to the land battle.

Why Is Sea-Based Logistics Relevant to the Army?

Sea-basing complements all of the concepts of Joint Vision 2010—

Dominant maneuver. Sea-based logistics reduces or eliminates the logistics footprint on land and enhances the speed and flexibility of maneuver forces. It increases the capability for rapid force projection by capitalizing on the total lift capacity of ships and their ability to operate close to an area of operations while remaining in international waters. Sea-basing contributes to deterrence while providing the basis for deployment and sustainment during direct conflict.

As Army mobility timeframes shorten and the effectiveness of Marine Corps STOM becomes a reality, the distinction between Army and Marine Corps capabilities for force projection may become blurred. Since the Marine Corps is a small force and the potential application of sea-basing is so great, the Marine Corps' capacity for supporting operations from the sea could be exceeded quickly. In that situation, the Army could capitalize on its substantial air assault experience by developing the capability to place the logistics base at sea.

Precision engagement. Sea-based logistics increases the ability of maneuver forces to engage targets without relying on ground lines of communication for deployment or sustainment. It also enables forces to redeploy to meet new threats with maximum speed and flexibility.

Full dimensional protection. The reduction in logistics footprint that sea-based logistics provides also reduces security requirements, and that enables maneuver forces to focus on tactical objectives. This is particularly important as alternative methods of warfare that ignore international conventions and leverage the power of the media become more popular. The effectiveness of this type of war is out of proportion to the size of the land force involved and generates significant security requirements for ground-based logistics elements. At this time, seaways remain relatively free of the risks of unorthodox warfare and therefore can provide a more secure logistics base. Countries or factional groups likely to resort to unorthodox tactics frequently have inferior air and sea forces.

Focused logistics. Sea-based logistics provides opportunities to throughput strategic, mission, and unit-configured loads directly from strategic mobility platforms to the customer in forward areas of the battlespace. The Army also may be able to incorporate pre-positioned stocks into the sea-basing concept.

Sea-basing increases the potential for rapid redeployment to different theaters. Sea-based logistics, however, does retain the capability to deploy combat support and combat service support (CSS) functions ashore as the factors of mission, enemy, troops, terrain, and time (METT–T) allow. Suitable, secure operating bases and port facilities sometimes may be available in a theater; in such cases, basing the theater logistics effort ashore may be the best option.

What Factors Affect the Success of Sea-Basing?

For sea-based logistics to become a reality, many enablers will have to be achieved. According to M.W. Beddoes, in a 1997 article in *Naval War College Review*, the primary enabler needed for sea-based logistics is "the coupling of sea-based ships to shore transport with network-based, advanced logistic information technologies to provide in-stride sustainment at sea or ashore to forces on the move."

There are six factors that may influence the success of sustainment operations from sea bases.

Paradigms that limit our ability to achieve a revolution in military logistics. There are several arguments against sea-based logistics that need to be challenged before its potential for the Army can be assessed objectively. They include—

- "The sea is the sole province of Navy and Marine Corps." But if sea-based logistics works for the Marine Corps, why can't it work for the Army? Changes for both the Navy and Army would be required to implement this joint capability, but such changes should enhance, rather than reduce, the effectiveness of the Army. The concept of sea-based logistics acknowledges the requirement for logistics support to be located ashore when required. There is no need for sea-based logistics to be purely a "Navy" concept. It offers the Army the potential to leverage its air assault experience and can enhance the overall dominant maneuver capability of all the armed services substantially.
- "This will only work for small task forces." If aviation can support air assault operations at the division level, then support of division- or corps-level operations from sea bases should not be considered fantasy.
- "The land must be occupied." Dominance is achieved through positioning and employing dispersed combat forces that possess high mobility. Logistics support activities do not necessarily need to occupy land.
- "Helicopters are vulnerable." Operations in the Ia Drang Valley during the Vietnam War demonstrated the resilience of aircraft. Out of hundreds of sorties to Landing Zone X-Ray, all but two helicopters were able to return to base, despite the fact that numerous aircraft sustained intense small-arms fire and shrapnel damage. Modern aircraft have considerably greater survivability features than those of the 1960's.
- "The troops will be stranded." The performance of the 1st Cavalry Division in Vietnam demonstrated that such concerns can be resolved by developing sound doctrine and realistic, comprehensive training. Marine Corps operations also demonstrate that habitual relationships are effective in building trust and enhancing the overall capabilities of a combat team.

Ship limitations for maneuvering in littorals. [A littoral is a shore or coastal area and adjacent waters.] While STOM avoids the need for exclusive reliance on littorals for maneuver, the ability to use those spaces will increase the range of options available. The ability of a ship acting as a sea base to maneuver in littorals will determine the extent to which that space can be used in sustainment operations. A large number of factors influence the ability of the sea-based logistics ship to maneuver in littorals—

- The draft, speed, and handling characteristics of each vessel.
- The threat from shore, surface, subsurface, and air.
- The weather, sea state, and visibility.
- The depth of the water in which the vessels operate.
- The volume and types of civilian maritime traffic.
- The capabilities and limitations for underway and vertical replenishment at sea, including the frequency and duration of replenishment activities.

Ship storage capacity for ground-force supplies. The total volume and weight of equipment and stores required to sustain ground forces is a significant factor in determining the number and sizes of ships needed for sea-basing. An aspect of individual ships that can affect sea-basing is access within a ship to replenishment points, storage locations, mission-loading consolidation areas, and flight deck positions. Because of the trend in current logistics to hold smaller quantities of stocks, integrated joint inventory and movement management systems that provide total asset and intransit visibility are critical. Factors expected to be significant for each class of supply under sea-basing include—

- Class I (subsistence): Weight and volume.
- Class II (clothing and individual equipment): Weight and volume.
- Class III (petroleum, oils, and lubricants): Weight and volume. The variety of fuel requirements and packaging for mission-loading also are potentially significant.
- Class IV (construction and barrier materials): Weight and volume.
- Class V (ammunition): Weight and volume, explosive mass storage limitations, special handling equipment, and break-pack and mission-loading facilities.
- Class VI (personal demand items): Not expected to be significant.
- Class VII (major end items): Weight and volume and maintenance requirements.
- Class VIII (medical materiel): Weight and volume. Restricted substances, short shelf-life items, and products with environmental control requirements require specific attention.
- Class IX (repair parts and components): Weight and volume and range of items.
- Class X (materials for nonmilitary programs): Weight and volume.
- Water: Weight and volume, capacity of the ship to make potable water, and packaging requirements for mission-loading.

Ship space and facilities for embarked group forces and CSS functions. Ship facility requirements include—

- Space to conduct break-pack tasks.
- Mission- and unit-load building facilities. Loads need to be combat ready with minimum essential packaging.
- Accommodations for maneuver forces and related logistics personnel.
- Space and facilities for aircraft and other direct support activities, such as maintenance.
- Facilities for CSS functions, including water production, laundry, medical, mortuary, mail, and finance.

Joint command, control, communications, information management, and intelligence systems. Requirements for such systems are extensive. Relevant factors include—

- Integrated joint operations and logistics command, control, and communications systems will ensure accurate and timely anticipation of and responses to ground commanders' requirements.
- Load-scheduling will maximize the use of limited airlift capacity while taking into account deception requirements and competing priorities for tactical movement of troops and medical evacuations. Development of multiple, concurrent missions will require significant planning and decision support tools.
- Ships will be dispersed and constantly maneuvering, thus adding an additional dimension to planning and scheduling of vertical sustainment operations.

Sea-to-shore transport from sea-based aircraft. Factors to be considered in using aircraft for logistics support include—

- Aircraft type. The size and operating characteristics of aircraft drive requirements for shipboard hangar space and the number and positioning of flight deck spots. The number of spots then becomes significant in determining overall capacity for conducting concurrent flight operations. Other characteristics, such as the availability and speed of aircraft blade folding and the time needed for stowing, ranging, refueling, and re-arming aircraft, also are important.
- Fuel capacity and efficiency. In current aircraft, fuel capacity is a significant factor in determining the range for flying operations. The capacity of internal fuel tanks can be extended in some aircraft by attaching external fuel tanks. However, this "fix" may limit options for configuring weapons and decrease the range or lift capacity of the aircraft. Improved designs, such as tilt-rotor configurations, have the potential to improve substantially the range and lift capacity that an aircraft can achieve from a given fuel quantity.
- Total payload capacity. Sea-basing generally increases requirements for aircraft-fitted equipment, such as ditched-aircraft survivability features, radar, and direction-finding equipment. Sea-basing also extends

intratheater lines of communication and requires greater fuel reserves, since aircraft will depart from and return to the sea base after each mission. Apart from range considerations, locating ships at sea and the need to land in poor weather and sea states place additional stress on an aircraft's fuel margins. All of these factors can increase an aircraft's payload requirements.

- Weapons fit. The nature of the threat will influence the weapons added to multipurpose helicopters, which will affect their lift capacity and range. The threat level also will determine the need for air-to-air and air-to-ground attack aircraft, which may affect the number of flight deck spots available.
- Terrain. Mission requirements, threats, and terrain also may affect aircraft range and lift capacity. Fuel requirements for nap-of-the-earth flying are different from those for level-transit flying. A requirement for deception operations also may increase the need for helicopter or sortie numbers or limit ranges or lift capacities.
- Aircraft reliability. Aircraft reliability parameters influence the frequency of catastrophic failures, the need for corrective maintenance, and the total number of aircraft that are available for tasking.
- Aircraft maintenance requirements. Aircraft reliability levels are sustained by preventive and corrective maintenance. The complexity, duration, and frequency of maintenance and the overall maintenance philosophy are factors that will affect the mission availability of aircraft. The degree to which aircraft have been prepared for the maritime environment also will affect their availability.
- Aircraft survivability. The level of armor, redundant critical systems, and self-sealing fuel cells are examples of factors that influence aircraft survivability, the level of aircraft attrition, and ultimately the number of aircraft available for tasking.
- Aircraft operating limitations. Factors that can limit aircraft operations at sea include wind speed and direction, sea state, direction of current, and pitch and roll. The impact of these factors on flying usually differs for each combination of ship and aircraft types and is derived from factors such as flight responsiveness, lift power, and ability to absorb deck impacts.

In general, the factors affecting sea-based logistics demonstrate that it is a highly complex concept that requires extremely high levels of commitment, detailed planning, capital investment, and coordination.

Is a Revolution or an Evolution Required?

The solutions to the technological challenges presented by sea-basing are more evolutionary than revolutionary. For example, the design considerations for ships needed to achieve sea-basing are extensions of existing amphibious ship technology rather than anything dramatically new. Similarly, requirements affecting the weight and volume of equipment and stores required by ground forces, or the range and lift capacity of air transport, can be attained through extensions of existing air assault technology.

For the most part, many of these challenges already are being addressed by Army Force XXI and Marine Corps combat developers. Initiatives such as one-man portable reverse osmosis water purification units, tilt-rotor aircraft, and unmanned guided parafoil aerial delivery systems are closing the gap between vision and reality. Changes to Army doctrine, such as strategic, mission and unit-configured loading, together with Marine Corps initiatives for 6- to 12-man sustainment distribution teams and prepackaged sustainment packs, are other examples of current developments that are bringing sea-based logistics closer to reality.

Likewise, the tools to synchronize the entire effort through joint, integrated command, control, and communications, information management, and intelligence systems should be considered an extension of existing information and communications technology employed by all of the armed services. The Army Integrated Warfighter Information Network—which integrates the Global Command and Control System (GCCS), the Global Combat Support System (GCSS) (which integrates supply, maintenance, and ammunition functions), and the Transportation Coordinator's Automated Information for Movement System II (TC AIMS II) (which provides intransit visibility)—is an example of the initiatives that are bridging the gap in this area. Marine Corps development and testing of enhanced, real-time, integrated battlefield command, control, communications, and computer (C4) systems is another.

How Realistic Is the STOM Concept?

The following scenario illustrates how STOM concepts could be applied to Army forces. Is such a scenario achievable?

Extremist elements of a minority faction have seized control of infrastructure throughout the republic of Nufolia. Government forces were overwhelmed and are restricted to a small number of dispersed defensive positions in the southern part of the country. The civilian population is living in terror of continuing, widespread sectarian violence. U.S. forces already are involved in Operation Hornet, a major theater-level war (MTW). Fearing that a second MTW might develop, Congress has voted against involving U.S. forces directly in Nufolia.

However, a regional coalition task force has assembled. Its intelligence assessments indicate that destruction of the minority faction's key headquarters, communications, and ammunition supply points will relieve pressure enough to enable Government forces to launch a counterattack and restore order. The terrain of Nufolia is extremely mountainous, with poor roads. Because the few airports, seaports, and locations suitable for amphibious landings are heavily defended, coalition forces cannot contemplate assaulting them without causing significant civilian casualties. Neighboring countries are fearful that the Nufolia civil war will escalate into a conflict that will affect the entire region and therefore have rejected requests by the coalition to use their territory for operating bases. So the task force has been directed to conduct search-and-destroy missions against a number of targets identified by the intelligence assessments.

On D-Day, Task Force Camelion, comprising two guided missile frigates, two fast deployment and sustainment platforms (FSP's), two tactical afloat support ships, a submarine, and an air assault battalion-sized group, inserts four air assault companies and headquarters elements at the first objective, which is 250 miles inland. D-Day weather is extremely poor visibility and a heavy sea state.

Fires are provided by tilt-rotor vertical take-off and landing (VTOL) aircraft, which are organic to the FSP's and available throughout the operation. Additional aircraft can be ready for use with 10 minutes' notice before launch. Naval fires from frigates also are possible when the ships are within range. Submarine- and frigate-launched missile attacks can be directed against both strategic and tactical targets.

Each FSP carries a battalion group comprising three rifle companies, an anti-armor company, an aviation unit maintenance company, an air assault company, and a headquarters and support company. CSS facilities onboard include a level III medical facility, a maintenance area, and storage areas for the battalion group for all classes of supply. These facilities allow CSS to be provided exclusively from sea or to be deployed ashore in modules on short notice. An air assault rifle company and the anti-armor company remain at sea with each FSP with air assets ready for launch on 20 minutes' notice.

On average, the entire ground force is moved within the area of operations once every 2 days, which confuses the enemy into thinking that a much larger force has deployed against them. In addition, one rifle company is returned to the ship for rest every 4 days. Resupply missions are flown twice daily to meet the commander's requirements communicated electronically through the on-line digital tactical battlefield C4 internet.

The task group maneuvers extensively at sea to alter the point of attack. The FSP's are resupplied every 6 days by combat stores ships. Resupply missions using organic medium- and heavy-lift aircraft throughput supplies directly from strategic sealift or combat stores ships, depending on METT–T considerations. After 30 days of continuous operations by the coalition forces against 15 target locations, enemy command, control, and communications are seriously weakened. Counteroffensive operations launched by Nufolia Government forces on D+25 capitalize on the enemy's weakened resolve and succeed in restoring order. The task force reconstitutes at sea and remains in international waters close to Nufolia until D+60, when it redeploys to a new theater.

Coincidentally, Operation Hornet commences on the same day with the insertion of an air assault division-sized strike task force at an objective 400 miles inland. Opposition forces are overwhelmed by concentrated firepower from highly dispersed, independent task groups. All ground forces are sustained directly from the sea for more than 90 days.

I hope that this scenario will encourage the reader to challenge existing paradigms about sustainment operations. Developing the capability to deploy, support, and reconstitute a brigade-sized operation directly from the sea would require time and resources, but it does not stretch the imagination. Whether employing such a concept is feasible, cost efficient, and operationally effective at the division, corps, or Army level is not clear, but it warrants investigation. Support of a brigade-sized group using air assets exclusively has been achieved already, and sustaining such an operation directly from the sea using organic air assets is being tested by the Marine Corps.

The sea is part of the total battlefield maneuver space and can yield operational and tactical advantages to ground forces by providing dispersion, mobility, and security to their logistics support functions. Can the Army afford to ignore the sea-based dimension of war?

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Swords Into Plowshares: Improving BRAC

by Colonel Stover S. James, Jr.

The military is burdened with excessive infrastructure. The base realignment and closure (BRAC) process is designed to solve the problem. But BRAC needs to be reformed to increase its effectiveness and gain popular and political support.

The process of downsizing the U.S. military and its associated infrastructure remains a daunting task for our political and military leaders. With very little fanfare, political debate, or public objection, the size of our armed forces has been reduced by nearly 50 percent since the overwhelming success of the Persian Gulf War in 1991. This downsizing was accompanied by a decrease in available Department of Defense (DOD) funding for modernization, training, housing, and military personnel benefits. Yet, while the force is smaller and defense spending is lower, the operational tempo required of the military in support of national security objectives has increased drastically in recent years.

Before the Persian Gulf War, congressional leaders passed base realignment and closure (BRAC) legislation designed to eliminate unneeded military infrastructure more efficiently and expeditiously. The first rounds of BRAC were considered by most observers to be successful and were viewed as the best way to handle the potentially painful and politicized process of reducing military infrastructure. There was, after all, much Cold War excess infrastructure from which to choose. However, as the process moved into the most recent two rounds, in 1993 and 1995, the reality of how painful BRAC can be to local communities, coupled with the possibility of negative impacts on the careers of local politicians, raised awareness and sensitivity levels to new heights. A new cottage industry evolved, specifically designed to assist communities and installations in reducing their vulnerability to BRAC.

The battle lines were drawn by the time the 1995 BRAC Commission submitted its recommendations to the Secretary of Defense. Then the BRAC process was complicated further when the language of the 1988 and 1990 BRAC laws was subjected to creative and flexible interpretations, most notably in the cases of two Air Force bases, Kelly in Texas and McClellan in California. The 1995 BRAC Commission recommended that both bases be closed, but the Clinton administration decided to keep them open by means of "privatization in place" (a process in which Government jobs are replaced with private, commercial contractor support). The combination of continuing fallout from the previous three rounds of BRAC and the perception that the adjustments to the 1995 commission's recommendations were politically motivated has resulted in congressional rejection of additional rounds of BRAC legislation and distrust between the Congress and the White House.

There are some valuable lessons to be learned from the previous rounds of BRAC, both good and bad. An analysis of our military infrastructure demonstrates an undeniable need for future rounds of base closings. However, simply conducting more base closures using the same procedures as in the past may not be sufficient. The BRAC process needs to be reenergized and improved through changes to the law and DOD policies in order to transform the "swords" of DOD bases and installations into the "plowshares" of economic growth for affected local communities.

Specifically, three broad areas need attention—

This article expresses views of the author, not the Department of Defense or any of its agencies.

• Timeliness and efficiency of the implementation process.

• Scheduling and scope of BRAC rounds.

• DOD's joint cross-service group process, which focuses on gaining efficiency and harvesting savings through interservice consolidation of underutilized facilities.

It may be impossible to exclude political considerations from the BRAC process completely. But changes not only can enhance the effectiveness of BRAC, they also may increase the acceptability of the process to those communities and their representatives potentially affected by BRAC. With an improved BRAC process—one that has the confidence of contractors, local communities, local and national politicians, and the armed services—our military forces will move closer to becoming as efficient as they are competent in defending the vital interests of our Nation into the next century.

DOD Criteria for Selecting Bases for Closure or Realignment

Military Value

1. Current and future mission requirements and the impact on operational readiness.

2. Availability and condition of land, facilities, and associated airspace at both the existing and potential receiving locations.

3. Ability to accommodate contingency, mobilization, and future total force requirements at both the existing and potential receiving locations.

4. Cost and manpower implications.

Return on Investment

5. Extent and timing of potential costs and savings.

Impacts

6. Economic impact on communities.

7. Ability of both the existing and potential receiving community's infrastructures to support forces, missions, and personnel.

8. Environmental impact.

The BRAC Process

It is estimated that the four rounds of BRAC conducted so far will save DOD nearly $25 billion by the year 2003, with estimated savings exceeding $5.6 billion for every year after that. The BRAC process already has closed or realigned 152 major DOD installations and 235 smaller ones at a cost of $23 billion. BRAC is perhaps the greatest DOD cost-savings program in history.

BRAC is a very complicated process that is established by law and guided by installation closure and realignment recommendations submitted by the armed services and DOD. These recommendations are based on the National Security Strategy and mission requirements. The methodologies and criteria used to assess base structure and the recommendations of the services and DOD have worked extremely well.

The BRAC process requires each service and Defense agency to—

• Develop its recommendations based exclusively on a published force structure plan and final selection criteria.

• Consider equally all military installations located in the United States.

• Analyze its base structure using similar categories of bases.

• Use objective measures for the selection criteria wherever possible.

• Allow for military judgment to be exercised in selecting bases for closure and realignment.

The law that guided BRAC beginning in 1990 required the Secretary of Defense to base all recommendations on a 6-year force structure plan and on criteria covering a broad range of military, fiscal, and environmental considerations (see chart above). Although the criteria have proved to be effective tools for identifying bases for closure and realignment, the application of the criteria arguably has been inconsistent across all of the services' analyses.

BRAC involves two distinct phases: base recommendation and selection, followed by implementation (which consists of base closure, cleanup, reuse, and disposal). Both phases include robust community and economic assistance, personnel placement, and educational programs. Each BRAC recommendation is measured against the published, Secretary of Defense-approved criteria, which give priority consideration to military value, then cost savings, and finally economic and other impacts on local communities.

The BRAC Commission's role does not come into play until after the services submit their recommendations to the Secretary of Defense, who then submits his recommendations to the commission. According to the law, the commission has total access to all of the services' data, analyses, and recommendations and is required to hold public hearings. Moreover, the BRAC Commission can add bases outside of the Secretary's recommendations and can change a service's recommendations if it determines that the service secretary deviated substantially from the force structure plan or the final selection criteria.

The most recent Secretary of Defense report on BRAC (1995) found that the process had worked well "so far." Not mentioned in that report is the fact that, despite legal prohibitions, political meddling has been prevalent throughout the BRAC preparation and decision process. In fact, the political nature of the process can be seen in the selection process for BRAC Commission members: two are chosen by the Speaker of the House of Representatives, two by the Senate Majority Leader, one each by the House and Senate Minority Leaders, and two by the President. Clearly, before the commission even has a chance to begin its work, the political battle lines are drawn. BRAC was designed to be objective, open, and fair. Unfortunately, it falls considerably short in objectivity and fairness, thanks to the politics involved throughout the process.

Case for BRAC

Over the past 15 years, the armed services have experienced a 40-percent decline in real spending and a 30-percent reduction in manpower. In contrast, the infrastructure needed to support today's military has declined by only 21 percent. Unless this infrastructure is reduced proportionately, the tail will swallow the teeth of our armed services. This mismatch creates the fundamental requirement for new BRAC legislation.

However, in 1998 and again in 1999, Congress rejected the Secretary of Defense's requests for additional BRAC rounds. These rounds could have provided tremendous savings for DOD, possibly adding another $21 billion in total savings through 2015. The fact that DOD infrastructure is disproportionate to the size and funding of today's, or tomorrow's, force structure is undeniable. DOD needs additional rounds of BRAC to remain affordable and effective in meeting the current National Military Strategy.

Lessons Learned

Given that BRAC is necessary in the future, some consideration to improving how it is conducted is appropriate. A thorough analysis of the four rounds of BRAC since 1988, including discussions with numerous participants in the process, reveals some significant problem areas and lessons to be learned—

- The BRAC process tends to be too long. A shorter implementation period would save money and increase effectiveness.
- Environmental cleanup issues are difficult to resolve and tremendously expensive. DOD and local communities need to negotiate cooperative agreements on environmental concerns early in the process.
- Revenues from the sale of BRAC-related property have been significantly less than anticipated and are not worth the disruption to implementation and the prolonged caretaker costs that result from the process as currently structured. Those directly affected need to become stakeholders in the outcome, particularly at the local and state levels.
- Joint cross-service groups can be extremely effective in identifying areas for major costs savings, but they have lacked sufficient time and authority to get the job done. This has resulted in the failure to realize some opportunities for joint consolidation of facilities.
- The BRAC implementation process is Government-run and is not managed by a single agency, which contributes to inefficiencies, duplication of effort, and poor auditing of costs. Privatization can lead to "win-win" situations.
- The timing of BRAC rounds makes it difficult to build congressional and political support and does not meet the services' needs for adjustments to closure and realignment plans and phased changes.

Improving BRAC

Despite its problems and shortcomings, the overwhelming majority of BRAC participants and observers agree that BRAC remains the best method for closing and realigning bases and reducing infrastructure. Closing bases always will be an extremely difficult and painful process, not only for the affected communities but also for the services. Although politics is a given in the process, and cynicism, pessimism, and flaws notwithstanding, the Congress should approve at least two more BRAC rounds in the future.

To develop more effective BRAC legislation, and to equip DOD to take better advantage of the opportunities offered by BRAC, several legal and procedural changes should be incorporated into future efforts.

Recommendation 1. The law and the corresponding regulations and policies governing BRAC should be amended to promote expeditious closures, environmental remediations, and realignments where required and appropriate.

Recommendation 2. Collection of revenues from selling BRAC lands should be terminated. A version of the Johnson-Breaux amendment should be adopted to expedite deed transfers to the affected stakeholder communities directly involved in a base closure. (The Johnson-Breaux amendment called for BRAC-related property to be offered first to the governor of the state and then to the local community at no cost before a public sale was pursued. It was withdrawn and not voted on.)

Recommendation 3. Advance cooperative agreements between DOD and affected communities concerning environmental policies, studies, and cleanup procedures should be established and executed. Specifically, the remedial investigation/feasibility study process should be accelerated. DOD should encourage the most timely methods of environmental cleanup, not the cheapest.

Recommendation 4. Once BRAC Commission recommendations are approved by Congress, all bases, regardless of service ownership, should be transferred to a single agency or contractor for closure and remediation or for realignment implementation as quickly as possible in accordance with appropriate laws and regulations.

By necessity, the armed services must retain control of an installation until the mission conducted there can be transferred. This is a complicated process that admittedly may require considerable time. However, once this stage of "operational closure" is attained, there should be an expeditious hand-off of the installation from the service to the designated agency or contractor for transition to full closure. Furthermore, the land transfer process should not be focused solely on local reuse authorities but also should include private industry. In addition, the involvement of DOD and service personnel in base closure and transition office (BCTO) activities should be reduced.

Recommendation 5. The timing of BRAC rounds should be set at one every 6 years to reduce the potential political liability of members of Congress, and each round should not require specific new legislation to commence. Each BRAC round should include a post-BRAC review so the services can adjust the implementation of previous BRAC Commission decisions to correct oversights or meet changed circumstances and execute phased infrastructure realignments, without violating the somewhat fragile integrity of the BRAC process. Furthermore, BRAC should not be limited to only two more rounds. The services need the authority to plan for and accommodate changes in the National Security Strategy, technology insertion, and real-world contingencies.

Recommendation 6. The joint cross-service group (JCSG) process should be continued, and it should be made more robust and given greater authority. The studies and findings various JCSG's made in conjunction with the 1995 BRAC round should be updated and considered for implementation. In the future, JSCG recommendations should be submitted directly to the Secretary of Defense, along with the comments of the services. A pre-BRAC interservice consolidation review panel process should be instituted ahead of each BRAC round to establish interservice cooperative agreements for consolidating work loads in depots, laboratories, test and evaluation centers, and undergraduate pilot training facilities.

In a December 1998 discussion, Secretary of Defense William S. Cohen stated that he was concerned that Congress would not approve additional rounds of BRAC because of the perception that the pain, difficulty, and controversy of the process outweighed the potential benefits. The changes in the BRAC process that I have recommended are intended not only to increase the efficiency of the process, thereby saving millions of dollars in implementation and caretaker costs and lost opportunities for savings, but also to improve the attractiveness of BRAC to politicians and affected communities. Several BRAC officials I have spoken with feel strongly that BRAC will become most effective and beneficial for all concerned when communities with BRAC candidates volunteer their military bases for closure or realignment. The many benefits that BRAC could bring to local communities, military personnel, and DOD should not be jeopardized because of politics or a failure to appreciate DOD's infrastructure burden. **ALOG**

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A Logistics Perspective on Closing Fort McClellan

by Major Kent D. Davis

The 1995 Base Realignment and Closure Commission (BRAC) voted to close Fort McClellan, Alabama, and end its active-duty mission on 30 September 1999. The Army Military Police School and the Army Chemical School would be relocated to Fort Leonard Wood, Missouri, and the Department of Defense (DOD) Polygraph Institute would move to Fort Jackson, South Carolina.

A unique characteristic of this closing was that Fort McClellan was directed to continue its training mission right up until the end. Typically, other installations were given a date of last training 1 year before the official closure date.

Personnel assigned to Fort McClellan when the closure was announced soon departed, so planning for the closure did not began in earnest until a crew of planners came on board in the summer of 1997. This is the story of how that crew orchestrated the move of over 10 million pounds of personal property and 12 million pounds of unit equipment in connection with the conclusion of military operations at Fort McClellan.

Activating the IMMC

In April 1998, the garrison commander decided to establish an installation materiel management center (IMMC) to control the movement of personal property during closure. He had visited the DOD Polygraph Institute and was impressed with its inventory control system that used bar-code labels. He subsequently included a similar system in his vision for how Fort McClellan's closing would proceed and directed the chief of the new IMMC to implement it.

BRAC's "bible," the Base Reuse Implementation Manual (BRIM), defines personal property as "all property except land and fixed-in-place buildings, naval vessels, and records of the Federal Government." Two independent process action teams (PAT's) had recommended that Fort McClellan's IMMC be staffed with up to 21 people. However, the installation already was suffering from a personnel shortage and could not staff the IMMC as recommended by the PAT's. Instead, the IMMC was formed by merging the Installation Property Book Section with the Personal Property Inventory Section. The Installation Property Book Section was staffed by civilians—a GS–12, a GS–9, and two GS–6's—who managed the table of distribution and allowances (TDA) and property hand receipts for the installation. The Personal Property Inventory Section had a GS–9, a GS–5, and a supply sergeant.

The IMMC officially stood up on 1 June 1998, 15 months before the closure date of the installation, with six civilians and two military personnel on board. The IMMC's mission was to determine the disposition of all personal property and oversee its disposal during the closing of the post. The property would be used first to fill requirements of the realigning units, such as the Military Police School and the Chemical School. The remaining property then would be matched with requirements of the Alabama Army National Guard enclave, other Army units, and other Federal agencies, in that order. Any property still remaining would be shipped to the Defense Reutilization and Marketing Office (DRMO). The property was to be disposed of according to BRIM guidelines and in a way that would pass the scrutiny of any audit and keep reports of survey to a minimum.

Personal Property Inventory

By law, Fort McClellan had 6 months from the official notification of closure to provide the local reuse authority (in this case, the Joint Powers Authority [JPA]), with an inventory of personal property available for reuse. In July and August 1995, the installation began to compile an inventory listing. Each activity was required to list all property under its control in a data base. The data bases from the various activities were merged into one. The resulting inventory listed most items on post, but it often did not include accurate nomenclatures, national stock numbers (NSN's), or serial numbers. For example, a brown chair could have been called a "chair, brown" or a "brown chair." Line item numbers and Army Master Data File prices were not confirmed.

In January 1996, the installation provided the JPA with an inventory. Items coded with an "X" were deemed not available for reuse, and those marked with an "R" were available for reuse.

The first thing the chief of the IMMC did when he reported for duty on 1 June 1998 was look at the state of the installation and TDA hand receipts. He knew that, in order to accomplish his mission, he had to gain accountability of all installation-level personal property. The property book office had been maintaining somewhere in the neighborhood of 270 primary hand receipts spread among approximately 220 primary hand-receipt holders. Some of the hand receipts contained only a half page of property. About 70 percent of them did not have current signatures.

The IMMC chief knew that getting the existing primary hand-receipt holders to re-sign their hand receipts would merely account for the property on paper and that some of the equipment still would not be accounted for physically. The discrepancies would not be discovered until the primary hand-receipt holders were attempting to clear their hand receipts at closure time, and the installation would not have the personnel on board then to conduct reports of survey. The IMMC needed new primary hand-receipt holders who actually would conduct a 100-percent, hands-on inventory.

The chief of the IMMC also realized that the IMMC could not deal with 220 primary hand-receipt holders while conducting its other missions. Therefore, with the support of the garrison commander, he consolidated the number of primary hand-receipt holders. He gave the Military Police School, the Chemical School, the Training Brigade, and the base operations activities the leeway to decide how many primary hand-receipt holders they wanted.

For this undertaking to be palatable to the units, it had to include an easy way to sub-hand-receipt property to the user level. The quick answer was to use the Unit Level Logistics System (ULLS)–S4. However, ULLS–S4 is fed by diskette from the Standard Property Book System-Redesign (SPBS–R), and only 15 percent of the personal property on post met the requirements for inclusion in SPBS–R. The BRIM required the installation to maintain a listing of all personal property on post. The IMMC felt that trying to add the other 85 percent of the installation's personal property to SPBS–R would add a degree of difficulty that would become insurmountable. Besides, the garrison commander already had given the IMMC his vision for the closure, and it did not include using ULLS–S4.

Automated Installation Property System

Thus the IMMC had two inventories of property. The first was the inventory of personal property developed in 1995. The second was the inventory of property book items from SPBS–R. The challenge was to get both listings combined into one, and in a format easy for hand-receipt holders to use. That single listing had to include—

- A sub-hand receipt feature for the primary hand-receipt holders.
- A component hand-receipt feature.
- The ability to control property as it left the installation.
- The ability to identify disposition instructions easily.
- The ability to determine fair market value in accordance with the Defense Finance and Accounting Service's DFAS–IN–37–1. (DFAS–IN–37–1 is the regulation that governs the sale of property owned by DOD to private organizations.)

The options available were to add everything to SPBS–R, which would allow the use of ULLS–S4, or create a unique system that would give the IMMC the capability to control property at the installation level. The biggest drawback to using ULLS–S4 for this was that it did not provide information on where property was going or determine its fair market value.

The option chosen was to develop a property control system that would include all of the capabilities the IMMC needed. The Fort McClellan Directorate of Information Management hired a recent graduate of a local university, Jerrod Harvey, to develop a program based on the IMMC's needs. He had helped design the system used by the DOD Polygraph Institute that had attracted the garrison commander's attention. Mr. Harvey came on board in mid-June 1998.

In the beginning, the IMMC had a massive personal property inventory maintained in dBASE IV. However, the data base was not Microsoft Windows-based, so Mr. Harvey converted the entire personal property inventory to Microsoft Access. At the time, the IMMC was using Windows 95 and Office 97.

While the units were determining the number of primary hand-receipt holders they wanted, the IMMC personnel gave Mr. Harvey their requirements for the system. As much as possible, they wanted a system that was totally automated. It had to give primary hand-receipt holders the ability to change items from one sub-hand receipt to another without having to retype the sub-hand receipts. They wanted to be able to identify the ultimate user of the property and to determine the fair market value of an item. They wanted each item to have a bar-code number assigned to it and a method of tracking the numbers easily. Finally, the IMMC wanted the primary hand-receipt holders to be able to inventory their property using bar-code scanners.

Armed with this guidance, Mr. Harvey used a combination of various programming languages to create what the garrison commander named the Automated Installation Property System (AIPS). Merging data bases created by about 200 different people all over post generated the personal property inventory. The goal was to reduce the list of names of the persons managing specific blocks of property to a manageable level by appointing primary hand-receipt holders who would manage both the personal property inventory and the SPBS–R hand receipts. In the end, the Chemical School asked for seven primary hand-receipt holders, the Military Police School asked for nine, and the Training Brigade asked for five. The garrison commander directed that each base operations directorate would have only one primary hand-receipt holder.

The IMMC then had to divide the various personal property inventories among the newly appointed primary hand-receipt holders. A column that showed the name of the primary hand-receipt holder for a particular item was added to the data base. The old managers of the various personal property inventories became the sub-hand-receipt holders of the property.

In the beginning, the IMMC managed one primary hand receipt at a time to ensure that the records were as accurate as possible. Before moving data into AIPS, the IMMC would scan the various SPBS–R hand receipts and compare them against the personal property inventory. The goal was to ensure that all the SPBS–R property was listed in AIPS. This procedure was going fairly well until late August when Mr. Harvey left to assume another position.

Then the IMMC was forced to move all the various inventories directly into AIPS without first double-checking the SPBS–R hand receipts against the inventories. During this time, the IMMC continued to make improvements to AIPS. One new feature allowed the primary hand-receipt holders to create component hand receipts for items that required that type of accounting. Before leaving, Mr. Harvey was able to put a module in AIPS that could create hand-receipt listings by component when required.

AIPS Inventories

In September 1998, the IMMC chief asked the Director of Plans, Training, Mobilization, and Security to task the Military Police and Chemical Schools and the Training Brigade to conduct 100-percent inventories using the AIPS-generated hand receipts by 18 December. The purpose of this was twofold: he wanted the units to verify the data listed in AIPS, and he wanted to ensure that the primary hand-receipt holders physically inventoried the SPBS–R hand receipts. So when the IMMC chief gave the primary hand-receipt holders their inventory packets, he also gave them an AIPS hand receipt and all the SPBS–R hand receipts for which they were assuming control.

As soon as units received their tasking, the IMMC chief noted a substantial roadblock in the path of completing the inventories. There were not enough supply specialists (military occupational specialty 92Y) available to assign one to each primary hand-receipt holder. In a normal environment, a company commander signs for property, and a supply sergeant manages his hand receipts. The supply sergeant takes care of all of the documentation needed to maintain a lengthy hand receipt, such as administrative adjustment reports, lateral transfers, and turn-ins. In a line unit, if a 92Y is not authorized, someone with another military occupational specialty is trained to perform the mission.

At Fort McClellan, very few people understood how to maintain a hand receipt. Consequently, the IMMC was flooded with hundreds upon hundreds of administrative adjustment reports and lateral transfers as the inventories got underway in earnest. The use of the International Merchants Purchase Authorization Card (IMPAC) also posed interesting problems. Most of the automation equipment acquired in the last 4 years had been purchased using the IMPAC card. A large majority of that equipment had never been added to the property book. Units also were flooding the IMMC with reports of survey. On numerous occasions, surveys were started, only for the equipment to be located later across post in another office.

While they were inventorying SPBS property, units were adding to AIPS non-SPBS property that was not previously included on the personal property inventory. This wreaked havoc on the IMMC. There were literally thousands and thousands of items to be added. In their initial development of AIPS, the IMMC created a module that allowed units to add items at their level. Uploading this module would enable the main AIPS to recognize those additions. This plan worked with one minor glitch. The user version of AIPS generated a distinct bar-code number that, when uploaded, occasionally replicated a bar-code number on another hand receipt. After a few months, the IMMC finally worked out that issue. In the meantime, a lot of data was entered manually.

Personal Property Shipment

One of the IMMC's missions was to control the personal property as it was shipped. Units were to send their shipping requests to the IMMC each quarter. Requests for shipment of equipment during the first quarter of fiscal year 1999 were due by the end of June 1998. Second-quarter requests were due by the end of August 1998, and all remaining requests were due by the end of November 1998.

The original plan for entering shipping requests into the data base called for units to prepare the requests by hand using a format based on Microsoft Excel. In reality, the units filled them out on their computers and sent them by e-mail to the IMMC. The IMMC printed the first 5 or so, but after over 100 were received by e-mail, they realized that it was going to be impossible to maintain control with hard copies.

With assistance from co-op students from nearby Jacksonville State University, the IMMC developed a shipping request data base. All of the shipping requests in Excel were converted into a Microsoft Access table. There was one table for each major subordinate command. The data base allowed the installation transportation officer (ITO) to manipulate data to determine the transportation assets needed from the Military Traffic Management Command.

The data came in sporadically, which was no surprise to the chief of the IMMC. He knew that units would not know 7 months in advance what they wanted shipped during a particular quarter.

Property Disposition Codes

AIPS had a module that allowed input of what the chief of the IMMC termed "property disposition codes," or PDC's for short. If an item was needed at Fort Leonard Wood, the IMMC would put "FLW" in the PDC spot. If something was destined for the Alabama Army National Guard, "ANG" would be added.

The shipping request format included a column for bar-code numbers. The IMMC intended to extrapolate the bar-code numbers from the shipping requests and update AIPS. The IMMC was to follow established priorities for property disposition, and anything that a realigning unit needed was the first priority. Therefore, had the shipping requests included bar-code numbers, the IMMC could have identified readily those items to be given only to units with first priority. The goal was to have a PDC assigned to every piece of property in AIPS by 31 December 1999.

The fact that the AIPS occasionally replicates bar-code numbers drastically impeded the IMMC's plan to update AIPS with the PDC's. When the IMMC finally got the problem corrected, 60 percent of the shipping requests were on file, and the vast majority of them did not have bar-code numbers because accurate bar-code numbers were not available.

Base Operations Inventory

The last realigning unit completed its personal property inventory early in February 1999. The IMMC took a month to regroup and then started inventorying the base operations activities in mid-March. During that time, the IMMC was beginning to form a plan for helping the ITO to control shipments. The IMMC used the shipping request data base to produce a report that listed the shipping dates of each school and the training brigade.

Going further, the IMMC developed a report for the ITO called "Working Documents." The ITO could generate automatically an exact list of what an activity wanted to ship on specific dates, where each item was located on post and its dimensions, the ship-to address, and the point of contact. Using those reports, the ITO conducted a face-to-face coordination meeting between the shipping company and the activity requesting to ship property. Often the activity asked to add items to the shipment at that coordination meeting.

To put a halt to last-minute additions, the chief of the IMMC started a weekly meeting attended by a representative from each school and the training brigade. The IMMC asked the ITO and her assistant to be present as well. The meetings were held on Friday mornings and were treated much like training meetings. The Friday morning meetings represented the cut-off point for changes to shipping requests for the following week. The IMMC locked in shipping dates 2 weeks in advance. It was difficult to lock in dates any further out because activities were still training soldiers, and their training schedules often changed as basic training companies consolidated.

Using information obtained at the Friday meetings, the ITO was able to adjust dates of shipments to ensure that transportation assets were used efficiently. For example, if the Chemical School requested to move a partial truckload on Wednesday and the Military Police School requested to move a partial truckload on Friday, the IMMC would consolidate the shipments and coordinate a ship date suitable to both parties.

Property Accountability

Property to be shipped from Fort McClellan and accounted for in SPBS–R required strict control. When entire primary hand receipts of equipment are shipped from one installation to another, the transfer of accountability usually is simple. A hand receipt is downloaded to a floppy disk and attached to a signed paper copy. When the packet reaches the gaining property book, the property book officer loads the disk into his computer, prints a hand receipt, and compares it to the copy of the hand receipt that accompanies the disk. If they match, he assumes accountability for the property.

Because Fort McClellan was required to conduct training while closing, the IMMC did not have the luxury of transferring accountability so easily. Of the 125 primary hand receipts the IMMC had when shipping started, not a single one was moved in its entirety. To provide flexibility for units, the ITO and IMMC opted to ship the property commercially. The ITO felt that the schools could close operations at Fort McClellan and begin them again at Fort Leonard Wood more easily if their property was shipped door to door instead of through a central receiving point.

In the beginning, the IMMC told units their Department of the Army Forms 3161 (Request for Issue or Turn-In) had to be delivered to the property book officer 4 working days before a scheduled shipment. This was to give the property book officer time to process the document and ensure its accuracy. The IMMC then sent someone to the unit to scan the bar-code labels on items planned for the shipment. The intent was to match the scan against the 3161's and ensure that no additional SPBS–R items were added or deleted without the property book officer's knowledge. The 4-day lead-time for the 3161's was sufficient for a while, but as the volume of shipments increased, the IMMC added 6 days to the requirement.

As the property was loaded onto a truck, a scanner stood at the truck's door and scanned the bar-code labels. This sounds simple, but often it was not. In the beginning, as many as six labels were printed for each piece of equipment—one for the actual piece of equipment, one for the box it came in, and one for the shipping box. The IMMC always threw in as many as three extras as a precaution. After the IMMC scanned all of the shipment, the scan gun was downloaded to generate an attachment to the Government bill of lading (GBL). A representative of the shipping company also copied the bar-code numbers of the items onto his inventory, which also was affixed to the GBL.

The IMMC regarded the GBL as authority to drop the property from AIPS. The IMMC dropped items from SPBS–R only after Fort Leonard Wood returned the 3161's with their own document numbers indicated.

Lateral Transfer Tracking System

The chief of the IMMC had projected a large number of 3161's, and he knew the IMMC had to have a method of tracking them, so he started what he called the lateral transfer tracking system, which was a data base created in Microsoft Access. With a couple of mouse clicks, the system gave the IMMC the 3161's they were tracking, the 3161's that had not been returned from Fort Leonard Wood, the 3161's that were returned but not posted, and, finally, the 3161's returned and posted.

Lateral transfers were tracked in two files. One contained the 3161's specific to each primary hand-receipt holder, and the other contained 3161's filed by shipping date. All related 3161's were filed with the appropriate GBL. Using a scanner, the IMMC also copied each 3161 onto a hard drive. This provided a way of determining the status of property when discrepancies arose. Often, Fort Leonard Wood called to say they had not received an item listed on a 3161. The IMMC first noted the item's bar-code number and then determined the GBL on which the item had been shipped by finding it in the AIPS archive system and looking at the GBL entry. Then they looked on a hard copy of the GBL for the item's bar-code number. This enabled them to tell Fort Leonard Wood the specific GBL on which the item had been shipped and when it left Fort McClellan.

☐ The former Army Chemical School at Fort McClellan is now the home of the Department of Justice Center for Domestic Preparedness.

BRAC Disposal Property Book

To clear the primary hand-receipt holders while maintaining accountability of property, a "BRAC disposal property book" was created. When a primary hand-receipt holder shipped out all of his property and was ready to clear his hand receipt of the remaining property, a meeting was convened with representatives from the Alabama Army National Guard (ALARNG), the JPA, and the DRMO. The DRMO representative walked through and showed the primary hand-receipt holders the items classified as scrap. Following that, the National Guard and JPA representatives walked through and identified the items they wanted by putting a distinctively colored label on each.

In most cases, the JPA was going to take over the building and use it for other purposes later, so anything the JPA wanted was left in place. The ALARNG had to take anything it wanted out of the building immediately. The primary hand-receipt holder involved was responsible for removing the items classified as scrap and items that neither the National Guard nor the JPA wanted.

Approximately 2 weeks after that initial meeting, the primary hand-receipt holder signed over the contents in the building to the JPA. Fort McClellan personnel maintained control of the building. When the turnover occurred, IMMC personnel scanned all of the bar-code labels, made a printout of them, and attached a BRIM-prescribed transfer order. When the scan gun was downloaded, data on all items were moved into a data base maintained at the IMMC. Deed transfer of real property cannot be completed until environmental remediation is complete. Once remediation is complete, the BRAC disposal property book data base file will accompany the deed as it is transferred to the new owner.

Combined, the personal property and unit equipment moved from Fort McClellan filled 896 tractor-trailers. That was a lot of heavy lifting, but, thanks to today's automation technology, the mission was completed on time.

ALOG

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Single Stock Fund Demonstration

by Sue Baker
and Lieutenant Colonel Michael J. Mannion, USA (Ret.)

The Army is beginning a demonstration of the Single Stock Fund concept at three installations. This test will be a major step toward achieving the goal of the Single Stock Fund: an integrated logistics and financial system.

The Single Stock Fund (SSF) is a Department of the Army (DA) initiative to reengineer inventory management functions and associated financial processes throughout the Army. It represents one of the most sweeping changes in logistics functions and business processes in recent memory. When it is fully implemented, the SSF will consolidate the management of existing wholesale, theater, corps and installation, and division authorized stockage list (ASL) inventories into a seamless logistics and financial system, thereby creating a single virtual supply and maintenance operation. The SSF will change the way the Army operates at every installation, every corps and division support command, and every Army Materiel Command (AMC) integrated materiel management center.

The implementation strategy for the SSF is being coordinated by a program manager, who is appointed by the DA Deputy Chief of Staff for Logistics. An SSF General Officers Work Group, which meets quarterly, and an Executive Steering Committee coordinate and approve major elements of the program. A separate SSF Board of Directors, consisting of the commanders of the four-star major Army commands (MACOM's), is the authority that approves moving the SSF program from one milestone to the next.

Milestones to Achieving the SSF

The SSF Campaign Plan, approved by the Vice Chief of Staff of the Army in November 1997, serves as the blueprint for current efforts to create an SSF. It originally called for implementing a single Army Working Capital Fund-Supply Management Army (AWCF–SMA) account according to the following schedule—

- Milestone 0, which was accomplished from October 1997 through September 1998, was the initial planning phase for the SSF. It set the conditions for the SSF by integrating the financial management actions of the retail stock fund elements with the wholesale stock fund.
- Milestone 1, which originally was set to begin in October 1999, will merge existing wholesale and retail (theater, corps, and installation) AWCF–SMA inventories into a single fund.
- Milestone 2, which was targeted to begin in October 2000, will extend the scope of AWCF–SMA operations by incorporating redistributable operations and maintenance, Army (OMA), stocks above the division ASL level.
- Milestone 3, which was (and still is) scheduled to start in October 2001, will extend the fund through division ASL's; this will incorporate all O&M stocks above the prescribed load list (PLL)/shop stock level.

Subsequent decisions by the SSF General Officers Work Group adjusted these target dates to ensure that they would be synchronized with the Army's budget and programming processes. The current plan is to implement milestones 1 and 2 concurrently beginning in October 2000. (See the chart below.)

SSF Demonstration

Under the SSF Campaign Plan, one of the requirements that must be achieved before SSF implementation moves to milestones 1 and 2 is a successful demonstration of SSF business practices. Following an extensive Army-wide integration and planning effort, the Army is scheduled to conduct the SSF demonstration at Fort Sill, Oklahoma (part of the Army Training and Doctrine Command); Fort Lewis, Washington (under the Army Forces Command); and Redstone Arsenal, Alabama (an AMC installation), from May through July 2000. This demonstration will permit early identification and quantification of the impact of the new SSF processes on installations, field MACOM's, AMC, and non-Army sources of supply.

A demonstration plan that was staffed extensively with the field identifies the new business rules, processes, policies, procedures, and technical solutions needed to achieve the required SSF functions. It consists of eight separate chapters that address roles and responsibilities; key logistics, financial, and automated system elements; training requirements; procedures for assessing the effectiveness of demonstration operations; areas of risk; and the Army plan for mitigating those risks. Technical guidance and reference materials that amplify these chapters are contained in separate annexes.

Key Demonstration Features

The goal of the SSF demonstration is to operate the business processes needed to achieve milestones 1 and 2 at the selected installations successfully and in a way that links the national AWCF–SMA to installation customers without degrading either their materiel readiness or the fiscal solvency of the AWCF.

The exit criteria that will determine if the demonstration has been completed successfully include achieving—

- An effective single point of sale for AWCF-funded items.
- An effective single credit process.
- Integrated processes for determining requirements.
- National maintenance management by AMC.

Special interest areas identified by the SSF General Officers Work Group include reducing impacts on mate-

What We'll See . . . and When

	May-Jul 00 at demo sites	Jul-Sep 00	1 Oct 00	Oct 00 – Mar 01 Conversions to achieve Army-wide re-engineering
Single point of sale	•Direct billing to operations & maintenance customers •Single general ledger account		Army-wide	✓
Single credit process	•NSN-by-NSN credit --Serviceable/ unserviceable --Army-managed item (AMI)/non-Army-managed item (NAMI) --Needed/not needed	•Capability to broadcast credit data to the field	•Implement credit policy --Serviceable/ unserviceable --AMI/NAMI --Needed/not needed	✓
Requirements determination	•AWCF-SMA asset visibility in CCSS •Field RO's/ROP's/RL's included in CCSS •National procurement offsets identified	•Budget stratification (CCSS)	Fully interfaced requirements–maintenance data (CCSS-EMIS)	✓
National maintenance management	•Asset visibility of AWCF-SMA assets & repair programs •Limited off-line adjustments to GS/RX repair programs			✓ Stabilized workloading for minimum 18 months

riel readiness, maintaining the solvency of the AWCF–SMA, suspending requisition order number/document order number (RON/DON) operations (so that all requisitions will be passed to the Commodity Command Standard System [CCSS] rather than the Standard Army Retail Supply System [SARSS]), and revising procedures for handling partial issues.

Site Surveys

The SSF Program Management Office (PMO) conducted multiple site surveys of the three installations and associated Defense Finance and Accounting Service operating locations to prepare for the demonstration and share information among participants. During these visits, the PMO finalized intraservice support agreements that specify the roles and responsibilities of all parties in the demonstration.

Concept of Operations

The SSF PMO began establishing small functional teams at each demonstration site in January 2000 to oversee preconversion activities and coordinate the details of executing the demonstration. The functional teams began working with their installation counterparts by tackling the SSF training requirements. An aggressive training plan based on the new equipment training approach was coordinated with the installations and refined during the site surveys.

Once the demonstration begins, the SSF PMO will host weekly program reviews to identify areas that need corrective action or policy changes. The results of these reviews will be posted on the SSF homepage on the World Wide Web during the demonstration.

Automation Changes

To achieve the business processes required for the SSF, a number of automation changes are underway. The current wholesale logistics system, CCSS, and the field logistics system, SARSS, will remain in place, but changes are being made to both systems to ensure that business processes are synchronized.

In addition, software interfaces will link CCSS and SARSS to create the SSF logistics and functional environment. The software strategy will use an interim architecture—called middleware—to link current retail and wholesale legacy systems until objective solutions, such as the Global Combat Support System-Army and the Wholesale Logistics Modernization Program, are developed. The middleware will intercept incoming and outgoing transactions, modify them in accordance with SSF business rules, and route them to the appropriate recipient using the existing logistics and financial Standard Army Management Information Systems.

Certain financial accounting systems will be eliminated or significantly altered under the SSF. AMC's Retail Army Standard Financial Inventory and Accounting System (RASFIARS) no longer will be required. The Standard Army Financial Inventory and Recording System (STARFIARS) suite of financial and accounting systems will be altered so that it is not a true financial accounting system; it is being renamed the Installation Supply Buffer (ISB), and its primary function will be routing transactions.

Evaluating the Demonstration

The SSF PMO will perform normal internal evaluations of the demonstration and will generate the demonstration after-action report. An independent team will conduct a separate evaluation under the auspices of AR 73–1, Test and Evaluation Policy. This team will be composed of representatives from the Army Audit Agency and the Army Operational Test Command, augmented as needed by other evaluation staffs.

Following a successful demonstration and approval by Army leadership, the three installations will remain converted to the SSF business processes. The target date to begin implementing milestones 1 and 2 is 1 October 2000. We anticipate that, over a 1-year period, all Active Army and Army Reserve installations and activities will be converted to the SSF in a phased approach.

We will provide a complete assessment of the demonstration's operations in a future edition of *Army Logistician*. In the meantime, readers can review SSF program highlights and demonstration results at the SSF website at http://www.army.mil/ssf/index.html/. **ALOG**

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Ammunition Logistics for Operation Noble Anvil

by Thomas J. Slattery

Many of the ammunition depots and plants of the Army Industrial Operations Command (IOC), headquartered at Rock Island, Illinois, have provided ammunition to our Nation's warfighters since World War II. The latest conflict for which they supplied large quantities of high-priority munitions on short notice—in this case primarily to the Air Force—was Operation Noble Anvil, the United States' support to the North Atlantic Treaty Organization's (NATO's) Operation Allied Force. In that operation, NATO forces conducted an air campaign against Yugoslav-Serbian military forces from 24 March to 9 June 1999. IOC supported Operation Noble Anvil from early April through the termination of the operation, and it continues to support several peacekeeping missions in the Balkan region.

As the Army's primary field operating agency for the Single Manager for Conventional Ammunition, IOC manages all ammunition, ranging from bullets to large projectiles, for the Department of Defense. This includes production, storage, preparation for shipment to the front lines, and demilitarization. IOC's subordinate Army War Reserve Support Command is responsible for implementing the Army's pre-positioned stocks mission. Following the Cold War, Army strategists predicted that regional conflicts would flare up in various parts of the world as we enter the next century. Under the leadership of Major General Joseph W. Arbuckle, IOC is in the process of updating standard procedures for future "short of total war" contingency operations.

> *The Army cannot go into any conflict, like Kosovo or others, without the IOC.*
>
> —Major General Joseph W. Arbuckle
> Commanding General
> Army Industrial Operations Command

Lessons Learned

Army combat forces deployed to an overseas theater initially fight with pre-positioned stocks and replenish them with munitions requisitioned from IOC ammunition storage facilities in the continental United States (CONUS). IOC, therefore, is critical to the "ammunition lifeblood" of our combat forces. With this in mind, Colonel William R. Pulscher, IOC Chief of Staff, directed all IOC organizations to submit Operation Allied Force/Noble Anvil lessons learned to the command's Emergency Operations Center (EOC).

More than 80 potential lessons learned were submitted to the EOC. The Mobilization-Operation Team, which operates the EOC, organized a board representing a cross-section of the command to review the lessons.

Management Agility and Flexibility

The Single Manager for Conventional Ammunition Center; the Joint Munitions Transportation, Readiness, Deployment, and Sustainment Center; and the Industrial Base Management Center were key IOC headquarters organizations that helped the ammunition depots and plants ship ammunition to Europe to support Operation Noble Anvil. During the operation, these IOC centers and teams learned valuable lessons about the need to interface with one another during an emergency.

Once the depots and plants became heavily involved in the outloading of munitions, the IOC EOC provided briefings at 0830 each morning. These briefings provided an opportunity for representatives of the various centers and teams to share information. The lessons learned board recommended that the EOC continue to hold the 0830 briefings during future contingency operations.

In the future, the EOC must continue as the central source for the distribution of contingency information. As the hub of communication activity, the EOC will provide IOC leadership with a complete logistics picture of outloading ammunition in support of contingency operations. This will increase the command's ability to circulate information, make decisions, and take action. For this to happen, the EOC must extend its hours early on in an operation to ensure communications get to the proper headquarters personnel on time.

Transportation

Though many of the lessons learned could be classified under several categories, a majority of them concerned either depot outloading activities or transportation. In a positive lesson learned, the IOC Joint Munitions Transportation Coordinating Activity (JMTCA) provided a temporary liaison at the U.S. Transportation Command (TRANSCOM). The liaison officer acted as a link between the two organizations and ensured that ammunition shipments within CONUS went smoothly. The liaison worked with the TRANSCOM Crisis Action Team, providing information on ammunition availability, movement status, delivery times, and confirmation of receipt at the designated port of embarkation. The liaison also used the Joint Operation Planning and Execution System to verify unit line-number status. This information was used to expedite ammunition shipments during Operation Noble Anvil. As a result, high-priority ammunition shipments arrived on time at the port of embarkation. The temporary IOC liaison was so successful that the position was made permanent after the operation.

JMTCA developed and coordinated munitions movement plans for the many munitions shippers who supported Operation Noble Anvil. These plans affected items managed by the Single Manager for Conventional Ammunition and component-unique munitions not managed by the Single Manager. JMTCA planned, coordinated, and directed the shipment of more than 1,400 ammunition containers in support of the operation. IOC provided munitions ranging from small arms ammunition to 500-pound and 750-pound bombs to HYDRA–70 rockets.

Air Force High-Priority Requisitions

The most prominent IOC support of Operation Noble Anvil was a high-priority Air Force requirement for a very large number of bombs. The Air Force sought to replenish its stock of M117 (750-pound) and Mark (MK) 82 (500-pound) bombs in Europe. Blue Grass Army Depot, Kentucky; Hawthorne Army Depot, Nevada; and McAlester Army Ammunition Plant, Oklahoma, stocked the majority of the needed bombs.

IOC received an initial requisition from Hill Air Force Base, Utah, for 45,000 M117 and MK82 bombs just before the Memorial Day weekend. More requisitions soon followed, pushing the total to 60,000. Hawthorne and McAlester provided the M117 bombs, and Blue Grass provided the MK82 bombs. The installations outloaded bombs from 29 May through the first week of June.

Working over a major holiday weekend to prepare the bombs for shipment made filling this requisition a challenge. Ammunition handlers, forklift operators, and blockers and bracers, who normally prepare the ammunition for shipment, had been released for the weekend. However, the installations welcomed the business. They quickly recalled as many employees as possible to work over the Memorial Day weekend. McAlester, with a larger work force than Blue Grass or Hawthorne, had an easier time handling its portion of the shipment. Still, McAlester augmented its work force with Oklahoma Army National Guard soldiers from the 1245th Transportation Company as well as employees from the plant's production, planning, and public works directorates.

The challenge was to overcome the extremely close delivery dates of 5 June for the initial 45,000 bombs and 8 June for the follow-on order of 15,000 bombs. In seven 12-hour days, McAlester filled 385 military and commercial metal containers with more than 13,000 bombs and bomb fins and loaded the containers aboard 96 flatcars for shipment to the east coast. McAlester successfully used load-and-roll pallet containers to prevent delays in outloading caused by the shortage of leased containers.

The requisitioned quantities were too large for air transport, so the bombs would be moved by rail and then on ocean vessels to Europe. They were loaded onto eight trains for delivery to Military Ocean Terminal Sunny Point, North Carolina. Six of the trains had arrived at Sunny Point, and two vessels loaded with bombs had headed for Europe when the Yugoslav Government agreed to NATO's peace terms. The two remaining trains were diverted to storage depots.

Meeting the Personnel Challenge

IOC demonstrated its agility by temporarily shifting personnel and using Army Reserve units to supplement the three installations' staffs. Sixteen members of the Army Reserve 125th Transportation Company (Cargo Transfer), Lexington, Kentucky, were transferred temporarily to Blue Grass, where they fabricated blocking and bracing materials for the munitions shipments. Air Force reservists assisted Blue Grass personnel with bomb-loading operations. Blue Grass, with a work force of 410 employees, packed bombs into 469 containers to fill Air Force requisitions.

Although the IOC installations train for contingencies that have an increased tempo, it quickly became apparent that Hawthorne Army Depot was not ramping up fast enough with its available personnel. Forty-five Army reservists from the 802d Ordnance Company, Gainesville, Georgia; the 3d Corps Support Command, Des Moines, Iowa; the 125th Ordnance Battalion, Billings, Montana; and the 351st Ordnance Company (Ammunition), Romney, West Virginia, were diverted from Operation Golden Cargo to Hawthorne Army Depot to assist with the outloading. The Army reservists proved to be invaluable and stayed to assist the depot with loading containers destined for Korea before returning to their home stations on 10 June.

Hawthorne also received temporary assistance from Sierra Army Depot, California, and Tooele Army Depot, Utah, which sent 7 and 12 civilians, respectively, to assist the depot with loading bombs. The civilians returned to their depots once the mission was completed.

When depots shift to a wartime mode, certain peacetime operations, such as demilitarization, are halted. Efforts and resources are diverted to prepare ammunition for shipment. Employees temporarily leave their normal jobs and help load ammunition during periods of mobilization in support of contingency operations. Firemen at Hawthorne picked up saws and hammers and worked as temporary carpenters. They cut lumber into blocking and bracing materials used to build the bulkheads that secured the bombs during shipment.

The shifting of IOC personnel to sites where they were needed urgently was an effective use of available personnel when resources were scarce. But with downsizing, will personnel continue to rise to the occasion to fill high-priority requisitions requiring extended duty hours? Current work load levels and manpower strengths at Tier 1 ammunition sites need review to ensure that they have sufficient personnel to prepare ammunition for shipment on short notice.

The depot and plant commanders coordinated and communicated with one another on available personnel and reserve component issues. However, it may be beneficial to establish an official channel through which commanders can voice their views on shipment decisions. This may eliminate a commander's urge to lobby customers directly for shipments during contingency operations.

Demilitarization of Munitions

The Air Force directed the IOC Single Manager for Conventional Ammunition Center to stop all demilitarization of M117, MK83 (1,000-pound), and MK84 (2,000-pound) bombs with a condition code E or better. They wanted them held for possible shipment in support of Operation Noble Anvil. This halt in demilitarization activity was a precautionary measure; none of these bombs were shipped to meet Air Force requirements. The Air Force also considered requisitioning "dumb" bombs scheduled for demilitarization to use in the air war rather than depleting the satellite guided "smart bomb" stocks.

Blocking and Bracing

The board reviewed several lessons learned that addressed blocking and bracing issues. One of these recommended that the Defense Ammunition Center produce a videotape on blocking and bracing for training personnel temporarily assigned to that task.

Blue Grass encountered problems with loading side-opening containers. Their personnel strongly contended that the drawings for the blocking and bracing used in the side-opening containers contained faulty measurements that hindered their blocking and bracing activities. They believed the dunnage requirements for the

□Members of the 125th Transportation Company (Cargo Transfer), USAR, helped employees at Blue Grass Army Depot make blocking and bracing materials for munitions shipments.

□The rough-terrain container handler lifts a MILVAN loaded with 750-pound bombs onto a railcar at Blue Grass Army Depot.

side-opening containers were excessive and that the loading and bracing drawings needed review. (Dunnage is packing material that protects cargo from damage during transport.) The Defense Ammunition Center is reviewing these drawings.

Railcar Availability

A serious readiness concern during Operation Noble Anvil was the lack of available railroad flatcars to transport loaded containers. Shortfalls in railcar support were evident at Blue Grass and McAlester. Blue Grass, in particular, had to halt its loading operations on one occasion because railcars had not arrived.

Before Operation Noble Anvil began, IOC had asked the Army Strategic Mobility Program to buy and preposition over 1,300 railcars to support an initial 5-day contingency requirement. This figure was reduced to 321 railcars based on a carrier availability study performed by the Logistics Management Institute.

The selected contractor's delivery schedule did not satisfy IOC's distribution needs, either in quantity or timely delivery. IOC had to use a significant portion of the pre-positioned Army Strategic Mobility Program railcars to meet the Operation Noble Anvil bomb requirement that equated to less than 2 days of ammunition outload in a major theater war. A lesson learned submission recommended increasing the number of prepositioned flatcars to 1,300, as originally requested, and distributing them to appropriate sites.

Low Shipping Container Availability

Due to the slow delivery of leased containers, Crane Army Ammunition Activity, Indiana, shipped over 100 containerized ammunition distribution systems (CADS's), often referred to as Government-owned containers, to Blue Grass, and Tooele Army Depot shipped over 150 CADS's to Hawthorne. Hawthorne experienced a high rejection rate on both the CADS and the leased containers they received, which impeded their container-loading operations.

With low CADS availability, IOC decided to use the container-leasing market to meet the Air Force requirements. A sole-source contract was established, but the contractor could not deliver the required quantity of containers in time, which delayed munitions distribution. The lessons learned board recommended using multiple sources for leasing containers to meet contingency requirements. This would help reduce delays caused by lack of available containers from a single source.

Major General Arbuckle saw the questionable availability of shipping containers as a potential bottleneck. He had IOC's Joint Munitions Transportation, Readiness, Deployment, and Sustainment Center work with the Military Traffic Management Command to find more shipping containers. Unavailability of flatcars and shipping containers posed a threat to the just-in-time delivery of the bombs. The lessons learned board recommended that the Munitions Carriers Readiness Program and Joint Planning Advisory Group work together to establish carrier delivery procedures. The Army needs to seriously study pre-positioning rail flatcars and containers at IOC ammunition depots and plants for immediate use in critical situations. They could be either leased or Government owned, depending on which is more economical and practical. The plants cannot wait several days for the commercial industry to round up railcars and containers.

Blue Grass Army Depot, Hawthorne Army Depot, and McAlester Army Ammunition Plant met the challenge. They successfully completed the high-priority Air Force requisitions on very short notice. IOC now is actively reviewing many ideas combed from the lessons learned submitted by their employees—all in an effort to improve readiness, save time, and eliminate mistakes. The lessons learned from Operation Noble Anvil reaffirmed the importance of the logistician's ability to ship large quantities of munitions on short notice to our warfighters overseas. **ALOG**

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