

ARMY LOGISTICIAN

NOVEMBER–DECEMBER 2006

Lean Six Sigma in Depots

Also in this issue:

**Brigade and Battle Staff Functions
During Convoy Operations**

Battlefield-Ready Civilians

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Cover: Lean manufacturing concepts have been adopted successfully at many locations throughout the Army and Department of Defense. This issue contains several Lean “success stories,” beginning on page 2 with the events that led up to the implementation of Lean concepts to the small emplacement excavator vehicle recapitalization program at Red River Army Depot in Texas. The program subsequently was expanded to include high-mobility, multipurpose wheeled vehicles (humvees). On the cover, Red River employees install splash shields on humvees being rebuilt on the Lean production line. In fiscal year 2006, Lean initiatives enabled the depot to improve productivity by approximately 75 percent and reduce lead times by approximately 70 percent. (Photo by Pam Barrett, Red River Army Depot Information Management Office.)

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REDESIGNED CLC3 COMING

Beginning in February 2007, officers entering the Combined Logistics Captains Career Course (CLC3) will follow a redesigned curriculum. Under the old curriculum, CLC3 lasted 19 weeks and 4 days and included three phases. The first phase, conducted at the Army Logistics Management College (ALMC) at Fort Lee, Virginia, lasted 6 weeks and included common core instruction on company command and battalion staff skills and tactics. The second phase was the branch technical phase and was conducted at the branch schools; it lasted 6 weeks (originally 5 weeks). The third phase was the multifunctional combat service support (CSS) phase; it lasted 7 weeks and 4 days and was conducted back at ALMC.

The redesigned CLC3 beginning in February will last for 20 weeks and 3 days and consist of four phases. The common core and multifunctional instruction (the first and third phases under the old course) will be held before the branch technical instruction (the second phase of the old course). Students will spend 14 weeks and 3 days at ALMC taking common core (7 weeks) and multifunctional (7 weeks and 3 days) classes; this will actually be phase 2 of CLC3. The new phase 1 will be added, providing 1 week and 1 day of common core instruction to be taken by distributed learning before or during the resident phases. Phase 3 will be the branch technical instruction and will continue to be taken at the branch schools; it will last 5 weeks. Students will return to ALMC for phase 4, which will include 1 week of nongraded common core instruction, end-of-course administration, and graduation.

The redesigned course is structured to eliminate redundancies by providing multifunctional instruction before branch technical instruction. It also adds agile leadership as a subject of instruction, extends the cultural understanding block, and adds some unit logistics topics to the ALMC phases that apply to all CSS companies.

Students attending the last two CLC3 courses before the redesigned course begins in February will attend a modified course that covers the required topics but maintains the old common core-branch technical-multifunctional sequence.

NEW CONCEPT SYNCHRONIZES CENTCOM DEPLOYMENT AND DISTRIBUTION

In June, the Combined Forces Land Component Commander (CFLCC), U.S. Central Command (CENTCOM), approved the Director of Mobility Forces-Surface (DIRMOBF-S) concept in order to establish a single entity to integrate total force and materiel flow from the port of debarkation to a designated in-theater destination. Over a 5-month period, the pilot program will incrementally build a DIRMOBFOR-S for the theater. Working under the CFLCC Director of Logistics, the DIRMOBFOR-S and its supporting staff element—the Deployment and Distribution Operations Integration Center—will integrate surface deployment and distribution priorities set by the commander.

More than a year ago, CENTCOM identified the need for a single organization in theater to synchronize operational surface transportation. An analysis by the U.S. Transportation Command (TRANSCOM) showed significant surface movement gaps in all combatant commanders' theaters. As a result, TRANSCOM initiated the DIRMOBFOR-S concept.

Because of CENTCOM's high operational tempo, TRANSCOM worked with U.S. Forces Korea (USFK) to demonstrate and develop the concept during USFK's Reception, Staging, Onward Movement and Integration '06 and Ulchi Focus Lens '06 exercises and with the Air Force to test the concept in its Global Mobility '06 wargame. The lessons learned from these exercises and wargame were used by CENTCOM as a basis for creation of the DIRMOBFOR-S.

ERRATUM

A number of readers have contacted us about the photo appearing on page 14 of the July–August issue. They pointed out, correctly, that the photo shows a violation of Army practice: a Soldier wearing what appears to be an iPod portable media player while on duty. Although this photo was cleared for public release, it should not have been printed in an Army publication. We accept responsibility for the error. We also apologize to the author, who did not select the photo.

—Editor

(Continued on page 45)

Lean Manufacturing and the Army Industrial Base

BY COLONEL FRED L. HART, JR., USA (RET.)

It has been exciting to see Lean manufacturing concepts adopted widely in the Army and throughout the Department of Defense (DOD). In case Lean has not yet been introduced in your workplace, I will define it. Lean is a philosophy that, when appropriately applied to a production process, reduces or eliminates the expenditure of unnecessary time, materials, and effort. Now coupled with a concept called Six Sigma, Lean has evolved into a successful program instead of slipping into history like so many management fads.

Thanks to General Paul Kern, former Commander of the Army Materiel Command (AMC), all of AMC's depots have implemented Lean Six Sigma. When Lean began at Red River Army Depot, Texas, in 2001, AMC was hesitant to get involved. But once Red River got the process up and running, AMC took note, and so did the Tank-automotive and Armaments Command (TACOM), Red River's parent organization. [TACOM is now called the Army TACOM Life Cycle Management Command.] The other Army depots were skeptical, but the Lean results at Red River were powerful and compelling.

Before 11 September 2001, Lean was an unknown concept in Army depots. However, it was on that date that the Red River Deputy Director for Operations and I, then the Commander of Red River, attended a Lockheed Martin Multiple-Launch Rocket System program review in Camden, Arkansas. During Lockheed Martin's presentation, we were introduced to Lean manufacturing. The concept sparked our interest and resulted in a lengthy discussion of the feasibility and possibility of implementing something like Lean at Red River. We had been struggling to find ways to improve production and cycle time so that Red River could compete in the commercial market for more of the Army's recapitalization workload. (Recapitalization is an Army program designed to bring an end item back up to a zero-miles-zero-hours standard.) Red River then would be better positioned to prevail before an upcoming Base Realignment and Closure (BRAC) Commission.

The Rise and Fall of the Depots

Historically, the workload of Army depots has been characterized by either feast or famine. All five of the

Army's major maintenance depots (Anniston Army Depot, Alabama; Corpus Christi Army Depot, Texas; Letterkenny Army Depot, Pennsylvania; Red River; and Tobyhanna Army Depot, Pennsylvania) share a beginning rooted in World War II. The depots were state-of-the-art complexes built to augment industry and provide the War Department with the capability to produce, repair, rebuild, and surge to meet wartime demands. The depots were a tremendous asset

We had been struggling to find ways to improve production and cycle time so that Red River could compete in the commercial market for more of the Army's recapitalization workload.

and made significant contributions to the war effort. However, after World War II and during the periods before the Korean War, the Vietnam War, and the Persian Gulf War, the depots often had little funding and were unable to keep up with industry standards and production improvement techniques. They became burdens to the Army with large, antiquated machinery, outdated production methods, and workloads too small to sustain an aging workforce.

By the mid-1980s, the Army had nearly ceased assigning military personnel to the depots. This fact has led to a general lack of knowledge and understanding of depot operations by Army officers, particularly Ordnance Soldiers. When the Depot System Command (DESCOM) at Chambersburg, Pennsylvania, was disestablished in 1995, the Army stopped training Ordnance Soldiers in depot operations. The maintenance depots' ability to interact with the field diminished, and they were no longer the "go to" level of maintenance for problem solving, equipment rebuilding, and expertise.

By the mid-1980s, fielding of the first high-tech weapons to divisional units started, and contractors began to make major inroads in providing the field maintenance and support that depots had provided in the past. In order to survive, the depots quickly attempted to increase their workloads by appealing



These photos were taken before (above) and after (below) Lean Six Sigma principles were applied to the small emplacement excavator (SEE) vehicle recapitalization program at Red River Army Depot. In the photo below, parts are organized and easy to find. The repair kits are standardized, so a worker can see quickly if all parts of a kit are on hand.



to interested congressional leaders. Through the late 1980s and most of the 1990s, depots scavenged for work and got little or no budget funding for infrastructure, capital equipment, and workload. They also found it difficult to compete with weapon system program managers who were linked with the weapon systems' original equipment manufacturers.

In some cases, weapon systems that were being fielded did not have a published depot support plan or depot-level maintenance task list. As a result, the depots got little sustainment work and often were not on an equal playing field with industry because of their antiquated business practices, lack of funds, and poor interface with program managers.

Lean to the Rescue

Innovation and the desire to be competitive in the looming 2005 BRAC deliberations led Red River to explore Lean and to discover a book called *Lean Thinking*, by James P. Womack and Daniel T. Jones. This book offered a great starting point and some valuable insights on how Lean thinking can improve production, eliminate waste, and save money. I asked my secretary to purchase a dozen or so copies of the book and then hosted a discussion group with key depot personnel to review the book, its ramifications, and its possibilities for Red River. Everyone was given a copy.

After reading the book, everyone agreed that, by using Lean production processes, Red River potentially could be developed into a competitive and efficient DOD industrial facility that would save taxpayers time and money. We formed an "Industrial Strike Force" that would help make us competitive and insulate us against the upcoming BRAC.

We continued to research Lean and learned that several firms provided Lean training. In the fall of 2001, we were fortunate to have an Installation Management Agency Reserve officer assigned to Red River. Second Lieutenant [now Captain] Dave Meyer's civilian job with industry had exposed him to Lean, so we immediately assigned him to the Lean team. Later that fall, the team attended a Lean seminar conducted by Simpler Consulting, Inc., at Warner Robins Air Force Base, Georgia. The seminar provided us with a wealth of knowledge and convinced us that Lean

could turn Red River around. Warner Robins had become the showcase for Lean in the Air Force, a fact that increased our commitment to pursue Lean at Red River. Now that the team was sold on Lean, we had to find a way to get TACOM, AMC, and the workforce to buy into our plan.

Applying Lean to Recapitalization

We set out to convince the TACOM and AMC leaders that Lean was worth the investment that would be required. Because we were unable to obtain funding from TACOM for a Lean event at Red River, we decided to fund the effort out of the depot budget. The team determined that the best candidate for Lean would be the recapitalization program for vehicles used by combat Soldiers in the field. We knew that, by using Lean techniques and processes, we could build a better product and save the customer money on the completed item.

We contracted with Simpler to introduce Lean to Red River at the first Lean event ever held in the Army. Before bringing in Simpler, we prepared the workforce using commander-sponsored Lean awareness briefings. It was essential for the workforce to understand Lean and buy into the concept.

After a few town hall meetings about Lean, we scheduled our first value stream mapping (VSM) event. It was also important to have the leaders of the depot participate and observe the employees who were completing the VSM. [Value stream mapping is a planning tool designed to help companies focus on when and where Lean concepts should be applied to make the most impact. The VSM process involves identifying value streams or product groups in the organization, mapping the current material and information flow, assessing inherent wastes, and designing an improved state of how the value stream or product group should perform.]

Lieutenant Meyer was tapped to lead the Lean effort for the small emplacement excavator (SEE) vehicle recapitalization program and the Lean process we called the "Red River Production System." His knowledge and experience with Lean proved to be a superb catalyst for getting the program up and running. Lieutenant Meyer was tasked to develop an introductory briefing for the Deputy Commander of

No institution will go through fundamental change unless it believes it is in deep trouble and needs to do something different to survive.

—Louis V. Gerstner, Jr.
IBM Chief Executive Officer, 1993–2002

Lean Involves Seeing and Eliminating These Forms of Waste

1. Personal (employee injuries, unmanageable workload, and misapplication of personnel).
2. Overproduction.
3. Excessive wait time.
4. Unnecessary transportation.
5. Redundancy (overprocessing).
6. Inappropriate inventory.
7. Unnecessary motion.
8. Defects or rework.

AMC. All who saw the presentation, including the Deputy Commander, seemed to be impressed with the benefits of Lean. We began to make progress in selling the merits of Lean to TACOM, and the TACOM commander soon saw the connection between Lean and efficiencies that could save the Army time and money. He later became a principle advocate and supporter of Lean Six Sigma and pushed the program throughout the depot system.

To validate our Lean thinking further, we contacted Stewart & Stevenson Tactical Vehicle Systems, the manufacturer of Army Family of Medium Tactical Vehicles trucks, which had incorporated Lean into its production line. We made several trips to their facilities and sent many mid-level managers and production-line workers there to view their Lean model. We continued to brief the workforce on Lean and established goals to implement Lean in other recapitalization programs.

Lean in AMC

In the spring of 2002, General Kern visited Red River for a briefing on the initial results of Lean in the SEE vehicle production process. He was pleased with the briefing and expressed interest in the Lean process. After his visit, I arranged for Simpler to present the introductory Lean briefing to General Kern and other senior AMC leaders. General Kern recognized the potential impact of Lean concepts in other Army depots and, within 6 months, started an AMC-wide Lean program. TACOM headquarters had already come on board and expanded Lean further by including the Six Sigma process into Lean thinking.

Today, Lean Six Sigma is practiced in all Army depots, arsenals, and ammunition plants. As a result, the state of the Army's depots is changing slowly. They are again being used to perform the kind of missions they were intended to perform. They are gaining experience in operating in an environment in which

they must compete with DOD contractors. Depots now operate forward in current areas of operations, augmenting and expediting programs such as up-armored high-mobility, multipurpose wheeled vehicles and working closely with forward AMC logistics support elements to handle battle losses and repair of battle-damaged equipment.

I have often thought that Lean Six Sigma is really a good dose of solid common sense that leads to careful examination of what you do and how you do it. When I look back on the Battalion Motor Officer Course that I attended in 1977, I see that the principles ingrained in young lieutenants by crusty old motor sergeants and warrant officers, though called by different names, are the same as Lean Six Sigma's six principles: safety, sort, straighten, scrub (or shine), standardize, and sustain.

It is interesting to note that the Ordnance Corps has adopted the Lean Six Sigma concept. The Ordnance Corps should consider reintegrating the depots into the corps. The depots could prove to be valuable assets for training Ordnance Soldiers. It is time to reestablish the depots as national assets and again involve the Ordnance Corps in their manning, staffing, and officer assignments so that they can better serve the Soldier, the Army, DOD, and the Nation.

The Lean Six Sigma culture is transforming the DOD industrial base into a competitive "industrial strike force" that ensures that our Soldiers in the field have the highest quality products built in the most efficient manner possible without compromising standards along the way. Lean Six Sigma exemplifies the Red River motto, "Building it as if our lives depend on it—theirs do!" The wheels of progress continue to turn, bringing more changes throughout the Army. As these changes occur, I believe Lean Six Sigma will continue to play an integral role in making the Army more efficient and more accountable to itself and the Nation's taxpayers.

ALOG

COLONEL FRED L. HART, JR., USA (RET.), WAS THE COMMANDER OF RED RIVER ARMY DEPOT, TEXAS, FROM JULY 2000 TO JULY 2002. DURING HIS TENURE, HE INSTITUTED THE LEAN SIX SIGMA PROGRAM AT THE DEPOT. RED RIVER SUBSEQUENTLY BECAME THE FIRST ARMY DEPOT TO OBTAIN INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO) 9001 CERTIFICATION. COLONEL HART RETIRED FROM ACTIVE DUTY IN 2004 AS THE ASSISTANT DEPUTY G-4, U.S. ARMY EUROPE. HE IS CURRENTLY A BASE ASSIGNMENT AND CLOSURE STRATEGIC PLANNER IN THE DIRECTORATE OF LOGISTICS AT FORT BENNING, GEORGIA.

Lean Six Sigma at Anniston Army Depot

BY COLONEL ALEXANDER B. RAULERSON AND PATTI SPARKS

In recent years, conversations about management issues, in both the Army and the private sector, often have included two terms: “Lean” and “Six Sigma.” Although both terms originated in the private sector as managerial concepts, they quickly coalesced into a philosophy to live by—and, more important, survive by—throughout the Department of Defense.

Commanders, officers, noncommissioned officers, Soldiers, managers, shop-floor workers, administrators, secretaries, clerks, mechanics, drivers, equipment specialists—literally everyone in every Army organization—now are, or ultimately will become, involved in Lean Six Sigma activities.

Implementation of Lean Six Sigma is not easy, nor will it ever be, because these processes involve new and different ways of thinking. A “business as usual” attitude cannot be tolerated by any organization wishing to remain competitive in the 21st century. The changing of long-established and deeply ingrained habits is the most difficult challenge any organization faces in adopting Lean Six Sigma. Fortunately, the Army has had some success in meeting the challenges of implementing Lean Six Sigma, and one of its success stories can be found at Anniston Army Depot, Alabama.

Depot Operations

Army Materiel Command (AMC) organizations such as Anniston Army Depot do not receive appropriations to fund their operations. Instead, they must pay their way using the revenues they generate from the missions they are assigned.

Anniston’s primary missions are maintaining and upgrading both heavy and light combat vehicles and their components and individual and crew-served weapons, land combat missiles, and small arms. Receiving, storing, and shipping conventional munitions are also key components of the depot’s overall activities.

Ultimately, the depot’s bottom line is a process that continually produces a high-quality product, on time and within or below established budgets, so that equipment can be returned to the warfighter quickly and at the lowest possible cost to the taxpayer.

Because of the extensive support the depot is providing for our Nation’s ongoing conflicts, Anniston’s workload is greater than ever. For instance, in 2004 the depot was given the task of completing 4 million

direct labor hours of mission-essential work. This workload increased to 5.5 million hours in 2005 and is projected to be 6.3 million hours in 2006. The ongoing conflicts in Southwest Asia also have created a need to shorten repair-cycle times to ensure that readiness is maintained.

As the depot has increased the size of its workforce in recent years to handle its expanding workload, the expansion has been managed to maintain the right mix of worker skills. Normal attrition and potential future retirements have been considered in developing long-range hiring plans. Such planning has been essential to ensuring that a capable core workforce continues to be available and that, when a workload decrease does occur, no reduction-in-force actions will be necessary.

Anniston Starts Continuous Improvement

Continuous improvement—the operational philosophy underlying Lean Six Sigma—is nothing new at Anniston Army Depot. In the spring of 2002, the depot began implementing a new way of doing business called the Process Optimization Initiative (POI). This is a holistic approach to improving all depot processes, whether in production or administration. POI encompasses several improvement strategies, but its major components are Lean manufacturing and the tools of Six Sigma.

Continuous improvement concepts also have been applied to the depot’s organizational structure. As in most industries, the depot was organized by departments such as Planning, Material Handling, Production Continuous Improvement, and so forth. Early on, depot managers realized that each department had different objectives, which often led to conflicts within the overall depot production operation. Organization by departments also did not create a single process owner for what the depot did.

Today, Anniston is organized by value streams, with each value stream having a process optimization manager who has total control over the resources needed to accomplish its mission. [For definitions of such Lean Six Sigma terms as “value stream,” see page 10.] Each day, depot personnel recognize the benefits provided by this structure, which allows them to focus on a common goal in each industrial process.

Working Smarter, Not Harder

Lean manufacturing is based on a commonsense approach to improving efficiency. It does this by identifying and removing waste from various processes and by adding or streamlining organization, standard work, and visual aids. In other words, it is based on working smarter, not harder.

Six Sigma tools are not new. They are just a matter of taking many of the improvement tools that have been around for years and packaging them into a single toolbox. Six Sigma is a structured approach to improving overall effectiveness by implementing the “define, measure, analyze, improve, and control” process.

Implementing Six Sigma projects follows a more rigid approach because each project must be presented to the depot’s Lean Six Sigma Review Board. The board, composed of top-level managers, reviews all proposed projects for their impact on depot operations and return on investment before it approves implementation. The board also reviews projects periodically to determine if they should continue or be cancelled. Completed projects ultimately are presented to the board for final approval and permanent implementation.

All of Anniston’s improvement efforts are focused on the things that are important to its customers. For instance, troops in the field do not care about costs; they just want to receive quality products in a timely manner. Bill-paying customers, such as AMC’s major subordinate commands and program managers, want to get the most for the dollars they are spending. So the depot’s day-to-day focus continues to be on all factors that affect cost, quality, and schedule.

The depot’s plan is to continue to use Lean manufacturing principles to increase efficiency and Six Sigma tools to provide further improvements in identified processes. By using an aggressive approach within all production value streams and administrative areas, the depot anticipates that it will achieve additional cost-avoidances and savings. This will benefit not only the depot and the taxpayer but, most important, the military forces who are the ultimate users of depot products.

The Hardest Part: Change

The hardest part of a continuous improvement effort is change since the initial reaction of almost everyone involved is resistance. To be successful, however, everyone has to buy into the recommended improvements, from the hands-on worker on the shop floor to upper-level managers and everyone in between. It is essential that any improvements that are implemented are not viewed simply as a program but become a way of life for all parties.

Too many times, proposed improvements in an organization fail because individuals resist or do not buy into the need for change. Attitudes such as “But we’ve

always done it this way,” “If it’s not broken, why fix it?” and “If I hold out long enough, they’ll go away and leave me alone” reflect mindsets that often are found in the workplace.

Implementing Lean Six Sigma Processes

A continuous improvement process starts with a brainstorming session called a “value stream analysis.” This is where process owners map out the current process and identify the wastes and inefficiencies of that process. The next step is to develop an “ideal state map” that lays out what the perfect process would look like if there were no constraints. A “future improved process map” then is developed that fits in somewhere between the current and ideal states. This future map identifies what is (or might be) achievable within 6 to 12 months. Finally, an action plan is developed that identifies all of the activities that must take place to achieve the future improved process. This plan includes things to do, projects, “kaizen” (continuous improvement) events, and Six Sigma projects, complete with identification of action officers and due dates.

The kaizen events follow a standard 7-week cycle. During the first week, the process management group develops a kaizen team profile that includes the scope, measurable objectives, and team members for the event. Kaizen teams are made up of floor-level workers, managers, upstream and downstream customers, and process support personnel. Team members then use the next 2 weeks to collect and process data and plan the specific improvements that will occur in the fourth week, which is the actual kaizen event week and the time when dramatic changes take place. On the Friday of the kaizen event week, the kaizen team briefs top-level managers on the results of their efforts. Briefing top-level managers conveys to all floor-level workers the importance of the improvements.

The data-collection phase is critical because data not only are needed to determine success or failure but are vital to determining what the new process will be. The last 3 weeks of the cycle are used for follow-ups to ensure that the new process is working as intended and to hand off the new process from the kaizen team to the first-line supervisor.

The important thing to note in this process is that, while the kaizen team is presented with objectives, it also is empowered to find ways to achieve them. Management provides guidance and pulse checks, but only in rare cases do the workers have to be told what to do, for they truly are the experts on their processes.

Transforming to a One-Piece Flow Operation

Even with this very structured process, success is not always immediately achievable and persistence is required. Anniston Army Depot’s most successful



One of Anniston Army Depot's major Lean Six Sigma success stories is the M1 Abrams tank assembly line. Workers went from a bay-style operation (above) to a one-piece flow operation (at right), which reduced throughput time by 56 percent (from 4.5 to 2 days).



work cell—the AGT-1500 M1 tank turbine engine rear module assembly line—probably was the hardest to transform.

Before implementation of Lean, assembly of the module was performed “bay style,” with each employee assembling an entire module from start to finish. The objective of the kaizen event was to install a balanced, one-piece flow process in which the work of assembling a module is broken down into balanced segments.

The team members worked on the cell's operations and made some improvements. They organized the work area and eliminated unneeded work steps. However, they said that a one-piece flow operation would not work in their area. They then were asked to go

back and try again, but they again returned with the same negative answer. On their third attempt, they decided to prove to management that implementation of the one-piece flow system would not work. However, what actually happened was that team members proved to themselves that the one-piece flow process really did work. This change reduced the assembly time by 2.2 man-hours for each module and the staffing requirement from five to four workers.

Today, the members of this team would fight long and hard before going back to the bay-style assembly process. They recognize the benefits of the one-piece flow process and are some of the strongest advocates of Lean at the depot. One heavy mobile equipment

mechanic in the module cell said recently that “breaking down the production line into stages along a single line makes it easier to train new employees and simplifies the operation for all concerned.”

An added benefit of the one-piece flow process is that, if a quality problem arises, there are fewer variables to consider, which makes it easier to identify and fix the problem quickly. Mechanics also use toolkits that contain only the exact number of tools and kits needed, which has cut the cost of tools contained in each toolkit by about \$3,000. Multiply this number by 65 toolkits, and immediate savings of \$195,000 are realized.

Lean Six Sigma Across the Depot

Another of the depot’s Lean Six Sigma success stories involved the M2 machinegun assembly line. This project eliminated waste and transformed work cells from batch processing to a continuous, one-piece flow system. Assembly time for this weapon went from 2.5 man-hours to 1 and required staffing from 18 to 15; production increased from 50 to more than 100 machineguns per month. Projected savings for fiscal year 2006 are \$1.1 million, and these savings will continue in the future. Similar improvements on the M16 rifle process allowed the depot to produce an additional 1,200 weapons—a 25-percent improvement.

As indicated earlier, one of the depot’s primary missions is the disassembly, refurbishment, and reassembly of light and heavy combat vehicles. Under the refurbishment process, the depot brings old equipment back to a like-new condition before returning it to service. Although refurbishment often produces additional challenges, Anniston’s continuous improvement activities ease those challenges significantly. By going to a one-piece flow process with point-of-use tools and standardized work, the M1 Abrams tank disassembly line process time was reduced from 260 to 230 hours—a 12 percent improvement.

Before the implementation of Lean Six Sigma in the depot’s reassembly operations, mechanics often spent a significant amount of time chasing down needed parts; this obviously was not part of the mechanics’ job. Now, parts are configured by workstation requirements and are placed at the point of use by materials handlers. This allows the mechanics to continue “turning wrenches” and produce a refurbished combat vehicle in a shorter timeframe.

To improve efficiency, signals have been put into use in the assembly area. If a mechanic encounters a problem, such as a missing or defective part, a “red flag” is raised—literally—and help is soon on the way.

Another recently completed Six Sigma project improved the first-pass yield for the M1 tank’s AVDS (air-cooled, V-engine-configuration, diesel,

superturbocharged) 1790 engine by 10 percent. This success is expected to have a return on investment of \$1 million over the next 3 years.

Anniston Army Depot has an aggressive improvement plan. In 2006, the depot expects to complete 186 kaizen events and 42 Six Sigma projects. The goal is to achieve efficiencies that save at least 900,000 direct-labor hours. A reduction in hours creates increased capacity and shorter repair-cycle times.

But users of Lean Six sigma should be warned: At times, the multifaceted Lean Six Sigma processes can be very frustrating. This is particularly true in the beginning, when employees often are very reluctant to actually buy into the processes.

Lean Six Sigma also can be soul-searching and gut-wrenching when nothing seems to be going according to plan. It is extremely challenging to try to make all the pieces of depot operations fit together logically and logistically. However, it is very satisfying when positive things happen and results are apparent to all participants. Ultimately, it is exhilarating when the final product is delivered and goals once thought unachievable have been accomplished.

Today, throughout the depot, workers are encouraged to come up with solutions to problems. The person doing the hands-on work is usually the best one to devise a solution to a problem. Unfortunately, before the implementation of Lean Six Sigma, workers often were not asked to provide input or their ideas were dismissed out of hand by managers.

Continuous improvement is a never-ending journey and has now become a way of life at the depot. Lean Six Sigma is a fast-moving train and ultimately a great ride.

For additional information on Anniston Army Depot’s Lean Six Sigma activities, contact Patti Sparks at patti.sparks@us.army.mil.

ALOG

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PATTI SPARKS IS ANNISTON ARMY DEPOT’S CONTINUOUS IMPROVEMENT MANAGER AND HAS BEEN INVOLVED IN THE DEPOT’S LEAN SIX SIGMA ACTIVITIES SINCE THEIR INCEPTION. SHE IS A GRADUATE OF GADSDEN STATE COMMUNITY COLLEGE IN ALABAMA AND THE QUALITY ASSURANCE INTERN PROGRAM.

A Lean Six Sigma Glossary

Lean Six Sigma has developed its own vocabulary to express its underlying concepts and operational processes. Here are definitions of some of the more commonly used terms. Because of Lean's origins in Japan, Japanese equivalent terms are shown in parentheses in some cases.

The “5 Whys.” The “5 Whys” typically refers to the practice of asking 5 times why a failure has occurred in order to get to the root cause of any problem. Of course, a problem can have more than one cause. Generally, root cause analysis is carried out by a team of people who are related to the problem. No special technique is required.

The “5S’s.” Five terms beginning with “S” are used to create a workplace suited for visual control and Lean production.

- Sort (Seiri). Eliminate everything that is not required for the current process and keep only the bare essentials.
- Straighten (Seiton). Arrange all items so that they are easily visible and accessible.
- Shine (Seiso). Clean everything, and find ways to keep everything clean. Make cleaning a part of every-day work habits.
- Standardize (Seiketsu). Create rules by which the first three S’s are maintained.
- Sustain (Shitsuke). Keep 5S activities from unraveling.

Balanced scorecard. This is a strategic management system used to drive performance and accountability. It balances traditional performance measures with more forward-looking indicators, such as finances, integration and operational excellence, employees, and customers.

Benchmarking. This is an improvement process that an organization uses to compare its performance against best-in-class companies. It then uses the information gathered to improve its own performance. Subjects that can be benchmarked include strategies, products, programs, services, operations, processes, and procedures.

Black Belt. Six Sigma team leaders responsible for implementing process improvement projects to increase customer satisfaction levels and business productivity are known as “Black Belts.” They are knowledgeable and skilled in the use of Six Sigma

methodology and tools, typically have completed 4 weeks of training, and have demonstrated a mastery of the subject matter through the completion of projects and an examination.

Cell. A cell is a group of people, machines, materials, and methods arranged so that processing steps are located adjacent to each other and in sequential order. This allows parts to be processed one at a time or, in some cases, in a constant small batch that is maintained through the process sequence. The purpose of a cell is to achieve and maintain an efficient, continuous flow of work.

Continuous flow. Each process, whether in an office or plant setting, makes or completes only the one piece that the next process needs; the batch size is one. Single-piece flow, or one-piece flow, is the opposite of a batch-and-queue process.

Cycle time. This is the time a person needs to complete an assigned task or activity before starting again.

DMAIC. This acronym stands for “define, measure, analyze, improve, and control. It is the heart of the Six Sigma process and refers to a data-driven quality strategy for improving processes. It is an integral part of any company’s Six Sigma quality initiatives.

Green Belt. A Green Belt is an employee who has been trained on the Six Sigma improvement methodology and will lead a team. The degree of knowledge and skills associated with Six Sigma is less than that of a Black Belt or Master Black Belt. Extensive product knowledge is a must in a green Belt’s task of process improvement.

Heijunka. This Japanese term refers to the act of leveling the variety or volume of items produced by a specific process over a period of time. This system is used to avoid excessive batching of product types or volume fluctuations, especially with a pacemaker process.

JIT. “JIT” stands for “just in time.” This means producing or conveying only the items that are needed by the next process when they are needed and in the quantity needed. This process can even be used between facilities or companies.

Kaban. This is a signaling device that gives instructions for production or conveyance of items in a pull system.

Kaizen. “Kaizen” is the Japanese word for improvement. However, it implies more than improvement in the basic production processes. Kaizen represents a philosophy by which an organization and the individuals within it undertake continual improvements in all aspects of organizational life, based on the idea that a process is never perfect.

Lean. This is simply a thought process, not a tool. The key thought processes within Lean are identifying waste from the customer’s perspective and then determining how to eliminate it.

Master Black Belt. These are Six Sigma quality experts who are responsible for strategic implementations within an organization. Their main responsibilities include training and mentoring of Black Belts and Green Belts; helping to prioritize, select, and charter high-impact projects; maintaining the integrity of Six Sigma measurements, improvements, and “tollgates” (control points); and developing, maintaining, and revising Six Sigma training materials.

Material flow. The movement of a physical product through the value stream.

One-piece flow. In its purest form, one-piece flow means that items are processed and moved directly to the next station one piece at a time. Each processing step completes its specific work just before the next process needs the item; the transfer batch is one.

Opportunity cost. This is the foregone value of an alternative that is precluded by choosing another alternative. Other types of costs may include variable, fixed, direct, indirect, period, and product.

Overproduction. This is the process of producing more, sooner, or faster than is required by the next process or customer.

Procedure (Poka Yoke). This is a mistake-proof device or procedure designed to prevent a defect from occurring throughout the system or process.

Productivity. This is the ratio of measured outputs over measured inputs, such as the number of widgets produced per man-hour.

Six Sigma. The Six Sigma process is designed to eliminate variances in a process in order to allow the

best flow of work using the necessary analytical tools and processes.

Standard work. This term refers to a precise description of each work activity’s cycle time, “takt time” (see below), sequence of specific tasks, and the minimum inventory of parts needed on hand to conduct the activity.

Supermarket. This is a very visible, controlled inventory of items that is used to schedule production at an upstream process.

Takt time. This is the rate of demand from a customer. Takt time equals the available operating time or requirement.

Theory of constraints. This theory describes the methods used to maximize operating income when an organization is faced with bottleneck operations.

Value. This term refers to a product or service capability that is provided to a customer at the right time and at an appropriate price.

Value stream. This term encompasses all activities, both value added and non-value added, that are required to bring a product, group, or service from the point of order to the hands of a customer and a design from concept to launch to production to delivery.

Value stream mapping. This is a pencil-and-paper tool used to—

- Follow a product or information (or both) activity path from beginning to end and draw a visual representation of every process—whether value added and non-value added—in the material and information flows.
- Design a future-state map that has waste removed and creates more flow.
- Produce a detailed implementation plan for the future state of the organization.

Waste (Muda). Waste includes anything that does not add value to a final product or service, such as an activity that the customer would not want to pay for if it knew it was happening.

Waste types. Sources of waste can include overproduction, excess inventory, defects, overprocessing, unneeded motion, wasted employee talents, waiting, transport delays, and reprioritization actions.

WIP (Work in process). These are items—material or information—that are between machines, processes, or activities waiting to be processed.

Letterkenny Gets Lean for War

BY KIM C. RUSSELL

With the onset of Operations Enduring Freedom and Iraqi Freedom, the Army's depots were called on to answer the immediate needs of the warfighter. The depots, described in some circles as being as agile as a three-legged turtle, had to transform to meet the increasing demands of an Army at war. The management challenge was simple: How do you change a three-legged turtle into a thoroughbred?

Letterkenny Army Depot, Pennsylvania, has used Lean techniques successfully to meet the wartime challenge. Lean is based on the Toyota Production System, which Toyota Motor Corporation developed and implemented from 1949 to 1975. The success of that system inspired the concept of Lean manufacturing, which was first presented by James Womack in his 1990 book, *The Machine That Changed the World*. The application of Lean manufacturing (in the form of the Toyota Production System) is often credited for Toyota's progress in becoming the world's leading automobile manufacturer.

The Lean process exemplifies what can be done using "the art of the possible," when both management and workers are focused on making changes in a business model. The key to making Lean work is to have the workers, including union leaders, believe in it. It is important to understand that Lean is not an acronym, an event, or a program. It is a philosophy for deciding what products and services an organization should provide and how the organization can provide them in a rapid, efficient manner.

Early Success Supporting Special Forces

Letterkenny Army Depot started its Lean journey in 2002, when the depot commander, Colonel William Guinn, introduced the Lean concept. The original intent was to improve depot maintenance processes to attract new customers. As the depot transformed into a "capabilities-based depot," it was imperative that the depot provide its customers the "biggest bang for their buck."

Early in fiscal year 2003, Letterkenny experienced its first opportunity to apply Lean concepts in support of the Global War on Terrorism. The U.S. Army Special Operations Command (USASOC) had designed a specially modified high-mobility, multipurpose wheeled vehicle (humvee) known as the ground mobility vehicle (GMV) to provide a fighting platform for the anticipated invasion of Iraq. As war approached, USASOC turned to Letterkenny to accelerate production of GMVs.

Letterkenny had established a special relationship with USASOC in 1998 with the production of GMV kits for the specially modified HMMWVs. When USASOC made its urgent request known to the depot, depot managers decided to employ their newly formed Lean team to make improvements in the GMV process. The first task was to transform the depot's existing GMV maintenance and rebuild production line. The initial goal was to turn new humvees into GMVs within a 10-week turnaround time, measuring from when a vehicle came in the door to when it went out the door. Before the project could be completed, the requirement quickly changed to a turnaround time of 3 weeks.

As USASOC's requirements changed, Letterkenny successfully ramped up production to 24 vehicles a week. Turnaround time was reduced from 10 weeks to 3 weeks and then to just 8.8 days, and the floorspace required for the operation was reduced by 50 percent. Not only was the depot able to supply the warfighter with vehicles in a greatly reduced time, it also provided the customer with savings of \$990,000. The depot used the savings generated to produce 18 more GMVs and thus provide USASOC with an additional fighting capability that previously had been unfunded.

Transforming Patriot Recap

The Patriot missile recapitalization (recap) program is designed to bring the ground support system to a condition of near-zero hours or miles of operation. Letterkenny is responsible for the recap of one battalion a year. In fiscal year 2003, the depot transformed its Patriot launcher rebuild program into a true Lean operation. The depot was able to generate savings of \$1.2 million for the customer. Based on these savings, the Patriot Lower Tier Project Office asked the depot to overhaul four additional Patriot launchers that had not been funded.

Resetting Patriot and Avenger

By this time, Operation Iraqi Freedom was in full swing and Baghdad had fallen. The threat of Scud missile and air attacks had been eliminated, and the depot's attention turned to resetting both Patriot and Avenger missile systems returning from the war. The depot decided to incorporate Lean concepts in the initial planning sessions for the reset missions. This meant a shift in traditional thinking. The concept required a virtual look at a reset line and the implementation of Lean

before the reception of assets. A member of the Lean team was dispatched to Fort Bliss, Texas, to establish the reset “line.”

Team Letterkenny successfully reset three Patriot battalions 2½ months ahead of schedule. The turnaround time was critical to the redeployment schedule of air defense artillery units. Letterkenny not only completed these missions ahead of schedule but also saved the customer \$1.5 million. The result was revitalized Patriot air defense systems that Soldiers could trust to accomplish their missions.

Avenger missile systems also had seen considerable action during the march to Baghdad. Avenger systems were sandblasted by windstorms, and many suffered battle and transportation damage. The depot conducted a series of Lean events, and substantial changes were made in the assembly and disassembly processes. The Lean concept eliminated unnecessary steps in the refurbishment process and created a “parts supermarket” close to the depot’s work cells. The Avenger reset program saved the Army another \$1 million.

Letterkenny’s implementation of Lean returned Patriot and Avenger missile systems to the field faster than expected and provided \$2.5 million to the customers to support other unfunded requirements associated with the Global War on Terrorism.

Armoring Vehicles for Iraq

As a result of the depot’s Lean initiative, Letterkenny was able to add several missions, including work on chemical-biological defense equipment, Army humvee recap, generator rebuilds, Force Provider, and several armor programs.

One of the initiatives implemented under Lean during the armor processes was the use of a “pull system.” Under this system, workers do not walk back and forth to obtain parts and tools; everything they need for their work is located beside their work areas in carefully marked bins.

Lean cuts waste, consolidates operations, and, as a result, frees floorspace. The additional floorspace was critical as the depot worked to bring in new missions to support Soldier needs. Letterkenny quickly put this additional floorspace to use to meet an urgent call for armor boxes that were needed in the battle for Fallujah. The armor plating arrived on a Friday night, was cut over the weekend, and was delivered for ballistic testing at Aberdeen Proving Ground, Maryland, in less than 72 hours. The depot implemented a true Lean pull system to produce 36 of these boxes in less than 14 days.

The next call was for humvee armor door kits. Lean concepts were incorporated into the production system, and weekly output increased by 200 percent. The one-piece flow system allowed changes in configurations to be implemented immediately in the production

run. Letterkenny was asked to increase its production to 860 humvee armor door kits, and the last of the kits was produced 2 weeks ahead of schedule.

Armor kits for the M969 5,000-gallon tanker provided a new challenge because the tanker had undergone a variety of design changes. However, the depot produced 150 armor kits, each containing 82 pieces and weighing over 2,400 pounds. The letter of intent to build the kits was received on 19 November 2004, and the last kit was completed on 21 January 2005. The M969 kits were completed 4 weeks ahead of schedule and \$1 million under budget.

The depot also was asked to produce armor cabs for the M939 5-ton truck. Letterkenny began with a modest production rate of 5 kits a week in January 2005. Each kit included 382 pieces and weighed a total of 5,870 pounds. By using Lean processes, production was steadily increased to 25 kits a week without increasing the amount of floorspace needed. Based on the accelerated production rate, the depot was asked to produce 70-percent more kits than called for in the original program. The 400th cab was completed in early July 2005.

In October 2005, Letterkenny’s success in implementing Lean was recognized when the depot became the Army’s first winner of the Shingo Prize for Excellence in Manufacturing. The Shingo Prize was established in 1988 to promote excellence in manufacturing, but a Shingo Public Sector Prize was not established until 2005 to recognize government entities in the United States that have demonstrated outstanding achievements in “manufacturing, industrial, or ‘maintenance, repair and overhaul’ (MRO) type activities of the public sector.” The depot had won the coveted prize referred to by *Business Week* as “the Nobel prize of manufacturing . . .” Letterkenny also won a second Shingo Prize in 2006, the Silver Award for the depot’s humvee recapitalization program using Lean processes.

Today, Letterkenny continues to use Lean to provide greater value and responsiveness in support of the Nation’s warfighters. Guided by Lean principles, the depot continues to return savings to its customers, increase throughput, and respond to customer needs. The warfighters deserve no less. **ALOG**

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In With the Old— Out With the Reconditioned

BY TINA M. BELLER AND PAUL D. PRINCE

The USACAPOC (A) mission support team reconstitutes battle-fatigued equipment to help ensure that Soldiers have what they need for the fight.

After the tragic attacks on our Nation on 11 September 2001, the U.S. Army Civil Affairs and Psychological Operations Command (Airborne) [USACAPOC (A)] underwent the largest mobilization of Reserve civil affairs (CA) and psychological operations (PSYOP) forces in the command's 15-year history. Since 9/11, USACAPOC (A) has mobilized approximately 12,000 personnel and corresponding amounts of equipment to support operations in Afghanistan, Iraq, and the Horn of Africa. USACAPOC (A) provides the mobilized Reserve CA and PSYOP forces, which amount to 96 percent of the Army's total CA and PSYOP forces.

Equipment readiness is paramount to Soldier success. The high operating tempo and the harsh climate in Southwest Asia have taken a heavy toll on the equipment used there. Operational fleets are aging at a rate

four times greater than anticipated. To better support the high demand for ready equipment, USACAPOC (A) collaborated with the U.S. Army Reserve Command (USARC) to establish the USACAPOC (A) reconstitution program at Fort Bragg, North Carolina. Originally operating from three temporary facilities, the USACAPOC (A) reconstitution program moved to a 5,000-square-foot equipment reconstitution site in October 2005. This facility is the only one of its kind in the Army Reserve.

Mission Support Team

The 10-person mission support team (MST) that runs the reconstitution site has three main missions: maintenance, supply, and transportation. It is responsible for reconditioning vehicles, accounting for sensitive items, and coordinating the recalibration of both weapons and radios with other agencies on the installation. The MST is essential in reversing the effects of combat stress on equipment before it is deployed again.

"Our team can do a wide variety of things, including first and second shop maintenance items like replacing humvee [high-mobility, multipurpose wheeled vehicle] windshields, batteries, tires, and CV [constant velocity] joints," said Major Terry Wescott, the MST officer in charge at the reconstitution site. "They are also responsible for ordering, cataloguing, and maintaining replacement parts listed on the prescribed load list."

The MST also prepares pallets that are used in transporting the equipment either back to the units' home stations or overseas for deployment. The reconstitution site as a whole serves as USACAPOC (A)'s program manager for the reset and recapitalization programs.

Reset and Recapitalization

Reset is a generic term that represents a series of actions taken to restore units to a desired level of combat capability commensurate with mission requirements

A light-wheel mechanic extracts a generator from the engine compartment of an M1026 humvee.





A Soldier inventories the tools, parts, and miscellaneous equipment in the tool room at the USACAPOC (A) reconstitution site.

and available resources. With USACAPOC (A), vehicles are reset at an assigned Army depot. A vehicle of the same model is returned to USACAPOC (A); however, it may not be exactly the same vehicle. The base model remains the same, but the serial number may change.

The recapitalization program, on the other hand, is a Department of the Army program that removes damage and stress incurred during deployment (in some cases restoring it to 0 miles or 0 hours) to 17 specific systems. For example, the program assists Army units in meeting armored vehicle demands by converting M998, M998A1, and M1038 model humvees into M1097R1 model humvees. The engine, transmission, and suspension of each vehicle are upgraded to base model M1097 (heavy variant). This model can serve as an armored platform without degrading the mobility or carrying capacity of the vehicle. Other systems also are checked and repaired, and each vehicle receives a new data plate and new serial number.

Mobilization Station for USACAPOC (A) Units

On 13 December 2002, the Army Forces Command identified Fort Bragg as the single mobilization station for all USACAPOC (A) units. Locating the reconstitution site on a major installation enables USACAPOC (A) to take an active role in refurbishing their gear and decreases turnaround time for equipment processing.

By comparison, most USARC units typically return vehicles and equipment for reconstitution to the installation that is home to the maneuver element they were attached to while deployed, which could be several

CA and PSYOP Soldiers are on point for the Global War on Terrorism. They should be [assured that] they have all the equipment they need to get the mission done right.

—Lieutenant General James R. Helmly
Chief, Army Reserve

states away from the Reserve unit's geographic home station. "We've been doing this for 3 years," said Sergeant Roger Adkins, MST shop foreman. "Our team bonds well, and you can see it in our finished products. Whether the equipment is going back to the unit or down range, we know it's in good condition and will meet the mark for the Soldiers to either train or fight."

Program Results

Since USACAPOC (A) first deployed to Operation Iraqi Freedom in January 2003, the following reset, recapitalization, and reconstitution actions have been taken—

- **Reset.** The MST has processed 88 vehicles and 10 generators through its reset program. Reset repairs are performed at the directorate of logistics or depot level. (The vehicles have been reset and returned to their units, and the generators are awaiting processing at the depot.)

- **Recapitalization.** More than 420 pieces have been submitted to the recapitalization program.

- **Reconstitution.** The MST reconstituted more than 960 pieces of redeployed rolling stock and 10,600 pieces of nonrolling stock, most of which came from Operations Enduring Freedom and Iraqi Freedom. The success of the reconstitution site has been essential to unit readiness.

The "old" equipment—the reconditioned equipment that they take with them when they deploy—serves USACAPOC (A) Soldiers well. The reset and recapitalization programs are key to bringing the state of the equipment back to acceptable condition, but the reconditioning of equipment at the reconstitution site is the backbone of USACAPOC (A)'s preparation of equipment for future operations. **ALOG**

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Field Reset at Fort Bragg

BY COLONEL ALBERT N. LOVE, USA (RET.)

The Fort Bragg Directorate of Logistics used Lean Six Sigma to improve its equipment maintenance and repair processes in order to help the XVIII Airborne Corps reset after its return from Operation Iraqi Freedom.

The redeployment of Headquarters, XVIII Airborne Corps, from Operation Iraqi Freedom to Fort Bragg, North Carolina, in January 2006 signaled the end of the corps' mission in Iraq. However, as the welcome-home celebration ended, we in the Directorate of Logistics (DOL) knew that our mission was not finished. The field reset of tactical equipment for corps units that had begun with the return of early deploying units in September 2005 was not quite at its midway point when the corps headquarters returned.

Since 2003, DOL had been instrumental in preparing Active and Reserve component units for deployment. During that time, DOL had pushed nearly 100,000 pieces of combat-ready equipment without missing a port call. With its modern, well-equipped maintenance facility and highly skilled labor force, DOL naturally played a key role in the reset effort when the units redeployed.

The DOL reset program was established in 2004 as equipment began to return from Afghanistan and Iraq. This reset experience prepared our materiel maintenance division (MMD) to reset the corps when it returned from Operation Iraqi Freedom 04–06. However, the MMD and our primary logistics contractor, ITT Corporation, Systems Division, now had another tool in their kit bag that has since propelled productivity well beyond our highest expectations—Lean Six Sigma.

Lean Six Sigma Analysis

ITT brought in a Lean Six Sigma master black belt to measure and analyze

Personnel from Headquarters, XVIII Airborne Corps, return from Iraq in January 2006, signaling the end of the corps' mission in Operation Iraqi Freedom 04–06.

our overall maintenance process. The value stream map he developed showed only 4 percent value-added time (time in which activity was being directly applied to improve the condition of a vehicle). The MMD goal for value-added time was 25 percent, which is the world-class standard for an activity of this type. The value stream map also proved to be an excellent tool for identifying the value-added and non-value-added steps in our maintenance process. It was a tough measuring stick.

When the original value stream map was developed, the MMD field reset program was completing about 50 vehicles per month. The vehicles returning from the desert, particularly those that had operated in the mountains of Afghanistan, were in bad shape. They needed a lot of hands-on time in the pits and component repair shops to restore their serviceability. The ITT process improvement team began identifying and eliminating the sources of non-value-added time by analyzing the primary causes of wait time for shop space, tools, parts, equipment, technical



Three ITT pit crew mechanics complete repairs to the engine compartment of a humvee.

inspectors, and repair teams. Surprisingly, the analysis showed that 60 percent of the non-value-added time was attributed to awaiting shop space, primarily at the body shop. Although we knew that we had a problem there, the deliberate measurement and analysis techniques used in Lean Six Sigma clearly showed the magnitude of the problem. More importantly, it identified where we needed to improve to get the results we needed.



Process Improvements

Based on the results of the Lean Six Sigma analysis, we—

- Improved the process of moving equipment from one value-added step to another.
- Redesigned workspace to limit unnecessary motion.
- Developed repair parts kits.
- Outsourced work when requirements exceeded our capacity.

At the same time, we applied Six Sigma to identify the key input and output variables and establish the metrics that would help us measure performance and control the process.

The results were impressive. The MMD doubled its field reset program production in the first year of the program. Although we were making tremendous progress, this level of production still would not meet the timeline for the reset of corps units redeploying later in the year.

In July 2004, we implemented what became known as the field reset “pit stop” program. We selected the NASCAR pit stop as a best business practice to emulate. The idea was to place at the fingertips of our mechanics all the tools, equipment, parts, and information they needed to repair vehicles without leaving the pit. Our goal was to process 150 vehicles a month.

Equipment Flow

As we planned the corps’ reset program with the corps G-4, Army Forces Command, and Army Materiel Command (AMC), we realized that we would need

to use all maintenance sources available and continue to improve productivity. Another lesson learned in our Lean enterprise effort—to move the workload from one value-added step to another as directly and quickly as possible—had to be applied to the overall process. We also needed to control the flow of equipment into each repair source to maximize the use of each capability without creating a backlog of equipment at any one location.

The corps elected to move its equipment from the railhead directly to a staging area for distribution, using contractors and drivers who had returned from the theater earlier in the year with the 507th Corps Support Group. This removed from redeploying units the burden of organizing rail load and driver teams just as their Soldiers were returning from block leave. It also eliminated the need to move equipment to the unit area. However, it placed a tremendous workload on each recently redeployed unit to sort through and prepare almost all of its equipment for support maintenance.

The DOL played a central role in this plan. ITT provided oversight of the process with visibility of equipment from the time the ship departed port in Kuwait, through the east coast ports of debarkation, and into the gate at Fort Bragg. ITT also was responsible for coordinating the movement of equipment through its initial inspection in the staging area and distributing it to one of five sources of repair for reset. For the first time in the DOL reset program, ITT had a steady, predictable, metered flow of equipment feeding the production line.



Soldiers from the 82d Airborne Division compete in the tire-changing contest held outside the materiel maintenance division maintenance bays at Fort Bragg, North Carolina.

Results

The continued application of Lean Six Sigma has had a powerful effect on productivity and has yielded spectacular results. In November 2005, DOL reached its goal of 150 vehicles per month in the pit stop program.

Since the beginning of the field reset pit stop program, we have had the help of some remarkable partners. The national-level AMC Reset Program has had a significant impact. Because of this program, we seldom receive equipment that requires extensive shop work. The AMC National Maintenance Program and the Defense Logistics Agency also have ramped up their programs. We could not have tripled our production in 16 months without the major component and repair parts availability that we are experiencing now because of the increased output of those programs.

We also have expanded the program to meet increasing requirements by adding more pits with additional equipment and experienced mechanics. The total number of mechanics in the program has increased from 75 in July 2004 to 115 in November 2005. With this 53-percent increase in labor, we have elevated production by 200 percent, from 50 to 150 vehicles a month. We completed the reset of corps units in May 2006, a month ahead of schedule. It is clear that much of the success we have achieved to date has been brought about by a sustained commitment to process improvement using Lean Six Sigma.

Pit Stop Competition

It has not been all work along the way. ITT has brought its industry partner, Gould's Pumps, and its racing partner, the Fitz-Bradshaw racing team, into the DOL facility. We hosted a team of Soldiers from the 82d Airborne Division and 1st Corps Support Command in a pit stop high-mobility, multipurpose wheeled vehicle (humvee) tire-changing competition. The winning 82d Airborne team then challenged the crew from Fitz-Bradshaw Racing's Navy-sponsored car to match their time. I am proud to report that Army beat Navy. Following the competition, the Fitz-Bradshaw racing team hosted the Soldiers at their facilities in Mooresville, North Carolina, and at the race that followed at Lowe's Motor Speedway in Charlotte, North Carolina. The enthusiasm that these events brought to the program cannot be overstated.

Lean Six Sigma has helped make Fort Bragg's field reset program a success. Using the Lean Six Sigma concepts, we were able to improve our production process enough to triple our output. We returned the corps' equipment ahead of schedule, ensuring that they have what they need to train for future missions. **ALOG**

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Battlefield-Ready Civilians

BY KAREN B. KELLER-KAPPAUN

Civilian employees deploying to a combat zone must take certain steps to prepare themselves and their families for the deployment.

In the early morning hours of 5 October 2005, the main body of Headquarters, 3d Corps Support Command, boarded chartered buses for the first leg of their deployment to Iraq in support of Operation Iraqi Freedom. Among the group of more than 200 were 15 emergency-essential civilians (EECs) preparing to join 4 other civilians who had previously deployed with an advance party. Deploying to a combat zone presents specific challenges to civilian employees. This article, based on the experience of those civilians, should prove useful to Federal civilian employees who may deploy to combat zones in the future.

Civilian Guidelines

EECs are Department of Defense civilian employees who perform specific battle tasks during a mobilization. Although most deployed civilians hold positions designated as EEC, non-EEC employees may provide short-term wartime support on a temporary duty basis. Any civilian performing work in a combat zone, regardless of previous position designation, becomes an EEC for the period of his deployment and is therefore subject to all regulations governing the deployment of civilian personnel.

Generally speaking, deployment, or short-term assignment, of civilians to a combat zone should be considered only when—

- The specific skill set required for mission accomplishment is not readily available in the uniformed force.
- A civilian position cannot be converted to a military position without interrupting critical combat operations.

Unlike military personnel, deployed civilians are noncombatants and are not entitled to certain military benefits, such as tax-free earnings while serving in a combat zone. However, deployed civilians receive danger pay and foreign post differential as required by Department of State regulations. They also are issued, or reimbursed for, military uniforms, granted post exchange privileges, and authorized military medical care while serving in a temporary duty capacity in designated combat zones.

Before the Army's involvement in Operations Enduring Freedom and Iraqi Freedom, regulations on civilian deployment were vague because most civilian deployments had been to relatively secure long-term assignments at semipermanent military bases in Kosovo and the Balkans.

Because of its growing dependence on civilians to accomplish missions effectively, U.S. Army Europe (USAREUR) published guidance in 2005 governing the deployment of civilians. This guidance includes Army in Europe (AE) Regulation 690-47, Civilian Personnel Deployment and Redeployment, and AE Pamphlet 690-47-1, Civilian Deployment Handbook, which provide the most recent requirements for preparing for civilian deployment.

Preparation

Whether serving in EEC or non-EEC positions, civilians must ensure that their personal affairs at home station are in order and that specific predeployment and training requirements are met before they depart. They must complete a number of regulatory tasks, including medical examinations, equipment issue, and predeployment military training, including chemical warfare training, first aid, Soldier field survivor tasks, and a Geneva Conventions familiarization course. Specific predeployment requirements may differ from one command to another. Civilian employees serving in EEC positions should have previously completed all of these requirements. Non-EEC employees who are volunteering to deploy in an EEC capacity should begin basic EEC training requirements as soon as they are notified that deployment is imminent.

Training is the cornerstone of deployment preparedness. However, having the appropriate equipment plays an equally important role in preparing for deployment. Units should issue deploying civilians protective masks and hoods and protective overgarments for chemical agent exposure. Employees must use these items during chemical warfare training and include them on their deployment packing list. After their command issues a memorandum authorizing them to draw military uniforms and equipment, civilian employees should visit the central issue

facility to receive organizational clothing and individual equipment, including protective vests, sleeping bags, duffel bags, and Kevlar helmets. They also are required to draw a desert camouflage uniform and desert combat boots.

Deploying civilians are authorized up to \$400 reimbursement per fiscal year for expenditures for military clothing not issued by the central issue facility. This reimbursement covers purchases of t-shirts, socks, and other items bought at the post military clothing sales store that are needed to complete deployment outfitting.

Shortly before deployment, the community medical clinic conducts a predeployment medical examination for each deploying civilian. This medical examination will be used to determine any pre-existing conditions or medical issues that require attention before departure.

Commands will hold a predeployment processing (PDP) event 30 to 60 days before each deployment. PDPs provide a one-stop opportunity to finalize predeployment requirements. Representatives from the community legal office, medical clinic, civilian personnel office, and command will be on hand to assist with powers of attorney, wills, vehicle registration, immunizations, beneficiary forms, and last-minute training requirements. PDP attendance is mandatory.

Civilians deployed in support of Operation Iraqi Freedom are not authorized to carry weapons. Although deployed civilians are designated as noncombatants, service down range has its share of risk. Civilian employees are encouraged to update personal life insurance policies, legal authorization documents, and financial investments before they deploy. Federal beneficiary forms covering the Thrift Savings Plan, unpaid compensation, the retirement system, and Federal Employees' Group Life Insurance should be updated with a civilian personnel advisory center representative.

Civilian employees must register in the Civilian Tracking System and the Emergency Contact Data System before they deploy and should regularly update those systems with changes in location, contact information, or expected deployment dates. Their servicing civilian personnel advisory centers can provide assistance with either system.

Professional Development Opportunities

Deployed civilians have a unique opportunity to take advantage of their "captive" deployment time. Because the activities available during free time are limited, civilians are encouraged to participate in professional development training, such as the Supervisor Development Course, Manager Development Course, and Action Officer Development Course that are available on line through the Civilian Personnel Online Web site at <http://cpol.army.mil/>. Many universities have

special arrangements with U.S. forces overseas and offer distance education coursework for students interested in pursuing associate's, bachelor's, or master's degrees. The Army Distance Learning Program Web site, www.aimsrdl.atsc.army.mil/secured/accp_top.htm, offers training in specific occupational areas and can provide refresher and introductory training in occupational areas unrelated to a civilian's career code.

In any 6-month period, students may earn as many as 16 credit hours at participating colleges and universities through various online programs and up to 80 hours of Army classroom training and continuing education credits.

Career Management

A deployed civilian often performs slightly different tasks in a deployed environment than he does at home station. For this reason, it is important that the employee and his supervisor develop a clear set of performance standards for the job that the employee will be performing while deployed. A civilian employee who deploys should take advantage of the opportunity to let his deployment experience address his outstanding service. When writing accomplishments at the end of the rating period, he should highlight the time spent deployed and clearly identify any leadership abilities and extra responsibilities he assumed during the deployment.

Deployment also might become a ticket to future employment opportunities. The Department of Defense automated civilian resumé system, Resumix, should be updated with all deployment accomplishments and include points of contact outside of the employee's immediate chain of command that can be contacted to verify new skills and abilities. A good list of networking contacts is also helpful for future job searches.

R&R Opportunities

Special opportunities for rest and recuperation (R&R) travel may exist for civilians who deploy for a 1-year period. According to the current U.S. Central Command and USAREUR regulations on civilian deployment, the R&R program authorizes payment for all airline expenses for civilian employees to the location of their choice. Ticketing to the airport nearest the leave address is arranged in the theater of operations. However, the final decision about R&R eligibility lies with the theater commander. More information on R&R for civilians is available at the USAREUR Civilian Personnel Directorate Web site at www.per.hqusareur.army.mil/r1r/details.htm or from a unit resource management representative.

Redeployment

Once a deployment is concluded, and before they are transported back to home station, employees must complete a postdeployment questionnaire and have a



An emergency-essential civilian in uniform stands in a formation at a farewell ceremony before he deploys with a unit to Iraq.

tuberculin skin test. As part of postdeployment processing, employees are required to receive followup medical examinations and a reading of the tuberculin skin test within a specified period of time. Employees will be instructed on specific procedures before departing for their home stations.

Toward the end of their deployment, civilians should think about the upcoming redeployment and home station reintegration procedures. All deployed personnel are required to complete a postdeployment questionnaire that enables healthcare professionals to gauge their physical and mental health. Civilians should complete the questionnaires thoroughly and honestly since access to military medical treatment facilities at Government cost will be limited after they return from deployment. Medical conditions caused by deployment conditions should be well documented in the employees' military treatment facility records and post-deployment questionnaires before redeployment. Employees who feel that they have valid claims for continued medical compensation should speak directly with their servicing civilian personnel advisory center representatives.

Civilians and their family members are encouraged to use the family resources available to them in their communities. Army Community Services, chaplain's

offices, and military treatment facilities all employ professionals to assist returning employees with reintegration into their families. Information concerning civilian redeployment is available on the USAREUR Civilian Personnel Directorate Web site at www.per.hqusareur.army.mil/cpd/contingency_info/redeployment.htm

Civilian personnel deploying to a combat zone face a number of challenges that are different from those they face at home station. To prepare for these challenges, civilians must complete specific training and other preparations before they deploy. Knowing what they must do to prepare themselves and their families for deployment will help ease the deployment process.

ALOG

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Telepresence: Harnessing the Human-Computer-Machine Interface

BY DR. KEITH ALIBERTI AND THOMAS L. BRUEN

Editor's note: This is the second in a series of five articles on themes for future logistics innovation identified by the Army Logistics Innovation Agency's Futures Group. Each of the articles describes plausible future advances in technology and business processes that may significantly improve logistics effectiveness and efficiency. Together, they bring an advanced look at some amazing possibilities for Army logistics.

Telepresence can be defined as a human-computer-machine condition in which a user (a Soldier) receives sufficient information about a remote, real-world site (a battlefield) through a machine (a robot) so that the user *feels* physically present at the remote, real-world site. With telepresence, a user's physical presence (body) exists at one location (the *home* site) while his ability to act and interact with a remote, real-world environment occurs at one or more locations (the *remote* site or sites). Telepresence is achieved by using advanced sensors, communications, remote action, and feedback stimuli to allow personnel to project their presence around the world through remote sites, giving a user the ability to see, hear, touch, taste, and smell those sites. Soldiers using telepresence capabilities will be able to act and receive stimuli just as if they were present at the remote, real-world location.

Logistics Implications of Telepresence

Telepresence will enable sustained combat power in the theater of operations while minimizing human resource requirements. It is truly "the next best thing to being there." The vision for telepresence is: Fewer humans vulnerable to asymmetric attack, reduced requirements for consumables, and greater availability of continental United States (CONUS)-based expertise. Possible second-tier effects of telepresence include—

- Reduced sustainment requirements (food and water; clothing and individual equipment; personal items; religious, legal, and financial support; and medical services, including medical materiel) as a result of fewer personnel in the battlespace.
- Reduced requirements for airlift, sealift, billeting, and force protection.
- Leap-ahead capabilities in the areas of maintenance, depot operations, force reception, and theater distribution.

- Improved nuclear-biological-chemical detection and decontamination and explosive ordnance disposal.
- Enhanced telemedicine and emergency medical services, such as telesurgery for wounded Soldiers.
- Better mission rehearsal, improved route reconnaissance for convoys by remotely controlled systems, and more comprehensive collaborative planning.
- Improved training and education because of advances in virtual reality environments and perception capabilities.

Robots have been used for years by commercial industry to accomplish repetitive manufacturing tasks. With the use of advanced effectors (the equivalents of human limbs and hands), the complete telepresence-capable robotic system truly will become an enabler of logistics operations. Telepresence will allow certain logistics functions formerly performed by a human to be completed in a much more adaptive manner.

Some near-term telepresence efforts include allowing medical providers to see, hear, and touch patients in real time with the necessary visual, auditory, and tactile perception in order to conduct or assist in remote surgery (telemedicine). In many respects, telemedicine leads the way in the advancement of telepresence capabilities. While the technology still falls short of supporting telesurgery for Soldiers fighting in Iraq and Afghanistan, the Army Medical Command's Telemedicine and Advanced Technology Research Center successfully conducted a robotic telesurgery over the Internet at a conference in April 2005.

Effectively using technologies and advances from the telemedicine community could extend the use of telepresence to mechanics so that they could use robotic platforms to conduct high-risk battlefield recovery and maintenance. Telepresence also could be used to operate materials-handling equipment and conduct port discharge and depot repair operations. In those cases, operators would have greater control over processes without incurring additional safety or manpower burdens within the battlespace.

Telemaintenance, as envisioned for the deep future, may allow the Army's most experienced maintenance technician to participate from a CONUS-based depot in the repair of equipment on the battlefield. Conceivably, he would work as if truly present with a team of Soldiers on the ground in the theater of operations. Likewise, those

In the future, telepresence may be used in materials-handling, port-discharge, and depot-repair operations. Here, a home-site user remotely operates a robot to unload cargo at a remote site.

(Art by Eric Proctor of the Sensors and Electron Devices Directorate of the Army Research Laboratory.)



who designed the system—the scientist or engineer team from an Army research, development, and engineering center or contractor support team—could participate in the maintenance activity.

Achieving Full Telepresence Immersion

A *telepresence system* is required to accomplish telepresence. This system is composed of three essential subsystems (and their related technologies): the home site, the communications link, and the remote site. Telepresence technologies associated with these three subsystems are similar to technologies found in virtual reality except that, in telepresence, a user must have feedback stimuli from, and the ability to exercise control over, the remote site. The ultimate goal of a telepresence system is to produce a transparent link from human to machine that passes information so naturally between user and environment that the user achieves a complete sense of immersion in the remote-site environment. To accomplish this, sensory impressions obtained from the remote site and delivered to the home site must engage the human senses fully with sufficient breadth, volume, and quality. As an example, consider that you are at a home site viewing a video of a remote-site environment on a theater-sized screen. The video provides only a minor feature of the much larger real-world environment present at the remote site. If a majority of your total vision is subjected to the video image on a large, curved screen and the video image depicts natural human motions, then the visual element becomes perceptually real world. Engaging the other senses similarly and in a synchronous manner will enable you to progress toward the feeling of being fully immersed in the remote, real-world environment. The ideal situation occurs when high-quality, high-resolution, and consistent information is presented to all of your senses.

Telepresence requires a complete human-computer-machine interface that incorporates audio, visual, haptic (touch), olfactory (smell), and gustatory (taste) technologies with home site elements perceptually identical to remote, real-world elements. To date, the senses of sight and hearing have been the focus of intense research and have formed the core of virtual reality systems because these senses are the most important senses by which we receive information related to our surroundings. The contributions of smell, touch, and taste are not as great, and current technologies for reproducing smell and taste are difficult to implement. One might argue that, compared with the other senses, taste (and perhaps smell) play marginal roles in creating a full immersion experience. Nevertheless, technology progression eventually will enable all human senses to be engaged in the telepresence experience.

Aside from the human-computer-machine sensory interface, communication between the home and remote sites must be “real time” so the user feels that he is indeed

in the remote, real-world environment. Home or remote site latency detracts from the realism that telepresence systems seek to achieve. Any communications link may be used by a telepresence system. The specific type of link depends on distance, bandwidth requirements, latency tolerance, availability of services between sites, and so on. To achieve high fidelity immersion in military applications, direct, dedicated umbilical links between home and remote sites are desirable. Latency in communication between the various sensory elements also will erode the feeling of being fully immersed in the remote real-world environment. Current and future advances in processing power will reduce latency, which will provide users with more accurate and readily available telepresence systems for myriad applications.

Enabling Technologies for Telepresence Immersion

A number of enabling home-site interface technologies are required to realize telepresence fully. In some cases, these technologies are under study; in other cases, commercial off-the-shelf technologies are already available.

Visual technologies. Humans mainly interact with other humans through vision. Therefore, visual sensory elements must be mature. The typical binocular field of view (FOV) of a human is approximately 180 degrees horizontal (with approximately 120 degrees of binocular overlap) and 150 degrees vertical (limited by facial features such as cheeks, nose, and forehead). Current prototype telepresence systems use head-mounted displays (HMDs) to provide visual information to the user. HMDs are stereoscopic devices that can convert two-dimensional video images of remote-site environments into three-dimensional (3-D) visual images. Typical FOVs for HMDs are quite narrow—approximately 100 degrees horizontal and 60 degrees vertical—although full-immersion HMDs with FOVs of more than 180 degrees horizontal and 80 degrees vertical do exist. Full-immersion HMDs have been demonstrated in military environments, but they exhibited poor display resolution, limited FOV, and visual, position, and tracking latencies. Latency greatly affects the illusion of full immersion, and visual, position, and tracking latencies create visually induced motion sickness because the motions perceived in the real, remote-world environment are not reflected in the user’s body. Achieving near-zero visual latency is quite challenging because of the complexity of the real-world environment but may become possible with advances in quantum computation and quantum communication. (See “Quantum Computation and Communication” in the September–October issue of *Army Logistician*.) An alternative 3-D vision technology (holography) provides a way to create images without using lenses. Although this technology is very promising, moving holographic images are currently difficult to provide and therefore probably will not be developed until the 2010–2020 timeframe. Additional

vision technologies, such as 3-D computer displays and virtual retinal displays, are under study and have great potential.

Auditory technologies. In addition to the visual sensory element, full telepresence immersion requires authentic auditory reproduction of sound. The original sound field recorded at the remote site must be identical to the sound field reproduced at the home site. Today, audio reproduction is engineered with fidelity that exceeds the limits of human perception. Hearing, however, is inherently a *spatial* perception. The human auditory system detects sound waves with two ears (binaural hearing) to determine information about the 3-D location, distance, and size of sound sources. Therefore, the ultimate goal is to reproduce the spatial properties of sound as accurately as possible. Current prototype telepresence systems achieve accurate spatial reproduction through the use of high-quality stereo headphones. Multichannel audio systems such as 5.1 (6-channel) and 10.2 (14-channel) surround-sound systems improve spatial reproduction by increasing the number of channels around a user. Future telepresence systems will include headphones that incorporate virtual sound or multichannel surround-sound headphones, the capabilities of which exceed current 5.1 surround-sound headphones. Additional auditory technologies under study include sound transmission through the skull and HyperSonic Sound (HSS) technology. (HSS is intense focusing and channeling of sound over great distances without dispersing its quality.) These are not yet mainstream technologies, but they are on the horizon and are very promising.

Tactile technologies. The human sense of touch is conveyed to the human brain through the haptic sensory system. Haptic technologies seek to apply tactile sensations to a human's interaction with a computer using a haptic device such as a data glove equipped with sensors to sense the bending of the fingers and movements of the hand. The goal is not only to allow the user to feed information into a computer but to permit the user to receive information through a haptic interface. Using a data glove in virtual reality, for example, a user can pick up a virtual object such as a cup. A computer then senses the movement of the user's hand and moves the virtual cup on a display. This provides the user with the feel of the cup in his hand through tactile sensations sent by the computer.

Olfactory and gustatory technologies. Technologies to reproduce the human senses of smell (olfactory) and taste (gustatory) have, for the most part, been ignored compared with visual, audio, and haptic technologies. To appreciate the complexity of reproducing these sensory elements, keep in mind that humans have approximately 10 million sensory neurons for smell and approximately 10,000 taste buds that contain between 50 and 100 taste cells representing sweet, sour, bitter, salty, and umami

(the flavor that is characteristic of glutamates such as monosodium glutamate). Current electronic noses can recognize certain odors. These electronic noses, which are composed of arrays of electronic chemical sensors and pattern-recognition capabilities, are much simpler than their biological counterparts. Therefore, users are limited to a predetermined set of odors. Unlike electronic noses, gustatory technologies are quite complex. Currently, users experience taste through biological lipid and polymer membrane sensors. Full telepresence immersion will require maturation of olfactory and gustatory technologies.

Achieving Telepresence

In addition to advances in enabling technologies, telepresence requires advances in remote-site technology (robots) and communications link technology (to achieve near-zero communication latency).

Robots. Sensory elements received from the remote site will be obtained by effectors. An example of an effector is a human-like robot. Robots controlled by users from remote locations will carry out operations required in the field. Robots must be able to perform myriad tasks with the versatility of humans and, in some cases, with strength exceeding that of humans.

Advances in robot technologies have increased over the years, but robots remain very primitive. Research, for the most part, is confined to universities. Robots have the ability to see and hear but lack extensive haptic, olfactory, and gustatory sensory elements and are primarily purpose-built for specific tasks. Advances in telepresence will require advanced robots that can perform multiple tasks and have the ability to adapt.

Near-zero communication latency. Communication latency is perhaps one of the biggest detractors from the feeling of "being there here," or fully immersed in a remote environment. To demonstrate the effects of communication latency, consider the following example. Assume that you want to send a simple communications signal, such as a pulse of light, around the globe. Without the use of any communications networks, it would take 0.13 milliseconds for the pulse to make the trip. This time delay is referred to as a distance-induced latency. Humans can detect time delays of approximately 16 milliseconds and greater. Therefore, in this simple example, the communication latency would be negligible. Typically, however, communication between a source and a receiver involves the transfer of a large amount of data. As a result, distance-induced latencies must be coupled with latencies in processing speed (transmission-induced latencies, or throughput). Today, packet switching is the dominant means of transmitting communications. Packets of information are sent individually between nodes of a network in a way that optimizes bandwidth and minimizes latency.

Near-zero communication latency requires that, for the user to achieve full telepresence immersion, communication between a robot and the user occur in less than 16 milliseconds. Unfortunately, current high-bandwidth data transmissions (full motion video) have significant latency. This latency is both distance-induced and transmission-induced. This is sometimes evident, for example, when a news reporter presents a video report from a remote location halfway around the world. Latencies of a second are quite common and very noticeable. Although the distance-induced latency is very small, transmission-induced latencies built into the equipment are significant.

Future processor technologies undoubtedly will be faster than those today, and new communications paradigms will be developed. Advances in quantum computation could benefit true telepresence. In the near term, however, steps can be taken to decrease bandwidth requirements and reduce communication latency so that certain elements of telepresence can be realized. For instance, greater levels of interaction between unmanned systems can be facilitated by creating environment or terrain models in advance of operations. Representations of the physical environment can be mapped ahead of mission execution to help reduce bandwidth requirements. The remaining bandwidth then can be dedicated to representing dynamic features that will allow new levels of human-machine interface that otherwise would be infeasible. Enabling technologies for decreasing latency, such as data compression, increased digital modulation, and subdivided optical nodes, also can be implemented.

Certainly, near-zero communication latency affects global military logistics beyond its impact on telepresence. As Dr. Theodore Bially, the Director of the Defense Advanced Research Projects Agency Information Exploitation Office, said in 2004, "The fog of war will plague us as long as the information provided to any level of command is incomplete, inconsistent, delayed in time, difficult to manipulate or hard to visualize. To lift that fog we must provide each of our warfighters with total, accurate and up-to-the-minute battlefield situational information . . ." It is easy to see how telepresence could facilitate this task.

What can we expect in the deep future (2030)? In the deep future, sensory stimulation will completely bypass the human sensory organs, and the perceptual neurons in the brain will be stimulated directly. Sensory threshold filters will prevent overload of the human perceptual neurons. Full-immersion telepresence will be realized with completely noninvasive sensory stimulation directly to the brain. Sensory element information sent from a user to a robot will be accomplished using noninvasive brain-computer interfaces. Recent advances in brain-computer interfaces have demonstrated that noninvasive readings of brain activity can be harnessed

to perform primitive robotic motions. In the future, users will have the ability to control robots just by thinking. Finally, configurable, remotely assembling components (robot swarms) will have the ability to adapt to remote, real-world environments, thereby enhancing telepresence capabilities and applications.

Telepresence will become possible following the development and improvement of robots, near-zero latency communication capabilities, multisensor integration and fusion, and multirobot systems. Telepresence may be feasible in limited applications by 2015.

Research in various fields, such as computer graphics, computer vision, human-computer interaction, brain-computer-machine interaction, acoustics, networking, and databases, all support the telepresence theme. Work is underway in the areas of telepresence systems design and the architecture of physical spaces, multimodal sensing (including camera and computer vision, microphone arrays and acoustics, haptic sensors, and active badges), multimodal presentation and display systems, virtual and augmented reality, ambient intelligence, network infrastructure, and spatio-temporal databases. Current telepresence design and studies in the United States, the Netherlands, India, Japan, and the United Kingdom should mature significantly in the next 10 to 15 years.

Some network and communications hurdles exist in the use of telepresence for military applications. Telepresence devices use high-bandwidth fiber optics, which currently are not available to forward-deployed units. Until they are, short-range wireless and existing fiber optic networks could be used for communications in logistics applications such as materials-handling and depot operations. Full battlefield utility of telepresence may require quantum computation and communication advances or other paradigm-shifts to support and overcome current data transmission and bandwidth limitations. However, it is plausible to expect that prototype telepresence systems for logistics applications could be fielded in the near term.

ALOG

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Brigade and Battalion Staff Functions During Convoy Operations

BY LIEUTENANT COLONEL CHRISTOPHER J. WICKER

Logistics convoys offer an enemy low-risk opportunities to attack with relatively high odds of causing American casualties and destroying critically needed supplies. Logistics convoys are tempting targets for insurgents because they often have insufficient quantities of weapons and communications equipment, vehicles that are hard to maneuver, and Soldiers who are inadequately schooled in squad- and platoon-level dismounted tactics.

Successfully protecting logistics convoys requires a combined arms approach. A tactical convoy is not simply a platoon- or even a company-level mission; it is a brigade-level operation. Commanders at the battalion, brigade, and division levels have assets that can increase the survivability and lethality of logistics convoys. Unfortunately, it is usually company commanders who are tasked to resource and execute logistics convoys. Combat service support (CSS) unit commanders and their platoon-level convoy commanders try to execute assigned convoys, even though they do not have all of the assets they need. This article will examine what higher level commanders and staffs can do to help ensure successful convoy operations in combat.

Battalion Commander Responsibilities

To be successful, a battalion commander must ensure that everyone involved in an upcoming logistics convoy knows what “right” looks like. To do that, he must—

- Determine the numbers and types of weapons and the minimum quantities of ammunition needed by each Soldier in the convoy, the number of radios required and the appropriate nets to monitor, the number of Warlock (remote-detonation-jamming) or CREW (counter remote-controlled improvised explosive device warfare) systems available, and the medical capabilities needed.

- Specify the required training level of gunners, radio operators, combat lifesavers, and dismounted security teams and stipulate what each Soldier in the convoy must know about the convoy mission.

- Indicate the desired configuration of gun trucks in the convoy. To be effective, each gun truck must have a crew-served weapon with a 360-degree firing radius and provide armor protection for its gunner and crew. Communications equipment should permit the

crew to monitor multiple radio nets, and the driver and gunner must be able to communicate with each other and with other gun trucks, the convoy commander, and dismounted Soldiers. The gun trucks also must be capable of being driven off road to shield dismounted Soldiers or aid in evacuating casualties.

- Stipulate the generic configuration of the convoy, including the positioning of the convoy scout truck, the convoy commander’s vehicle, wreckers, spare “bobtails” (M931 trucks), gun trucks, communications assets, and electronic jammers. Convoy planning software can be used to help position Warlock and CREW devices and minimize their effect on communications.

- Observe and approve the battalion’s battle drills, including the use of pyrotechnics (signal, smoke, illumination, and marking devices).

- Prescribe the required content of convoy briefings.

- Specify the “not later than” (NLT) time for adding vehicles and Soldiers to a convoy. This prevents “mission creep” for the convoy commander.

- Approve the criteria that determine when a convoy is justified in missing its planned start time or when it is appropriate to abort a convoy mission altogether.

Company Commander Responsibilities

To help ensure the success of a convoy, a company commander must—

- Develop ways to track the training status of all Soldiers and the location of truck driver crews, combat lifesavers, medics, and convoy assets such as weapons, gun trucks, and radios.

- Train convoy commanders and noncommissioned officers to coordinate a convoy mission.

- Obtain the battalion commander’s approval of convoy battle drills and train all Soldiers and civilian passengers in those drills.

- Specify the protective gear that each Soldier must wear.

Staff Responsibilities

After the battalion and company commanders have clarified their intent, the brigade and battalion staffs must step up and provide the information and assets that convoys need to complete the mission. Here is a list of staff members and the tasks they should execute when a subordinate unit is conducting convoys.



A convoy commander with the 2-220 Field Artillery Battalion, Utah Army National Guard, gives a convoy mission briefing to Soldiers in Ramadi, Iraq.

Brigade S-3—

- Designate the brigade combat team's (BCT's) main supply route (MSR) security procedures and allocate units to this task.

- Include in the BCT standing operating procedure techniques for battle hand-off from a convoy in contact with the enemy to a BCT maneuver element.

- Track convoy movement through the BCT's battlespace, including convoys from organizations outside of the BCT.

- Allocate unmanned aerial vehicles to scan the route ahead of CSS convoys.

- Provide the brigade S-4 and support battalion support operations officer (SPO) with the brigade engineer's plan for clearing the route of improvised explosive devices (IEDs).

- Prepare and coordinate a recovery plan for search and recovery of personnel or convoys that are overdue, missing, or captured.

- Maintain a master route status chart that displays trafficability, civilian activity, congestion, and enemy activity along the MSR. An overall route condition color code is inadequate for convoy decisions because each of these factors requires different countermeasures.

- Designate a test-fire area for crew-served weapons and establish test-fire notification procedures for units at the forward operating base.

Brigade S-4 or executive officer—

- Chair a CSS synchronization meeting. Deconflict desired quantities, delivery time windows, and routes based on transportation assets available, road conditions, IED sweeps, tactical operations, and civilian activities.

- Compile the brigade logistics status (LOGSTAT) report and provide the SPO with a list of items and quantities needed by each supported battalion.

- Specify the NLT time for battalion S-4s and other supported units to request movement of personnel and supplies on scheduled convoys.

- Announce priorities for resupply of the supported units, by unit and commodity. This allows convoy commanders to adjust delivery plans when they encounter delays along the routes.

Brigade engineer—

- Coordinate IED sweeps and route-clearing activities with convoy operations.

Brigade S-6—

- Identify frequency modulation (FM) radio blackout areas in the brigade's area of operations.
- Designate retransmission assets to ensure 100-percent radio coverage of routes.

Customer battalion S-4—

- Know and report quantities of supplies on hand in the battalion.
- Know planned maneuver operations 24, 48, and 72 hours in advance.
- Forecast items and quantities on the LOGSTAT report based on expected consumption during upcoming operations 24 to 72 hours out.
- Coordinate with the battalion S-3 to identify restricted routes and routes that complement the maneuver plan.
- Specify desired delivery time windows for convoys to arrive in the battalion that allow resupply down to platoon level in support of the maneuver plan.
- Backbrief the convoy reception plan. The plan must ensure a rapid turnaround so that the convoy can proceed to its next destination. The plan must include an intelligence update and procedures to be followed by gate security personnel, ground guides, forklift operators, and security escorts.

Support battalion SPO—

- At the CSS synchronization meeting, propose convoy routes and delivery time windows from origin to each destination and deconflict routes and times with maneuver unit representatives. Routes contemplated must reflect truck availability versus required delivery times, road conditions, traffic congestion, enemy positions, friendly actions, the IED clearance schedule, and civilian activities.

- Ensure that delivery time windows at each destination consider storage capacity at destination, transfer times, maneuver NLT resupply times to support tactical operations, and all subsequent deliveries at other locations scheduled for that convoy.

- Discuss with the battalion commander the supply quantities, transportation assets, and delivery schedule for each day's convoys.

- Compile and provide a logistics synchronization matrix to all supported units. The matrix must specify quantities to be delivered to each unit and the delivery time window.

Support battalion S-2—

- Provide a pattern analysis of enemy actions along the primary and alternate routes over the previous 7

days and the previous 24 hours and identify danger areas.

- Contact the rear area operations center and the S-2 at customer locations for an updated intelligence picture.

- Present information obtained from the most recent convoy debriefing on the selected primary and alternate routes. Route information should address road conditions, traffic congestion, civilian and religious activities, location of friendly outposts, and observed changes to landmarks in the last week.

- Brief and show pictures of vehicles on the brigade's and destination battalion's "be on the lookout" (BOLO) lists.

- For optimal effectiveness, brief all convoy Soldiers personally instead of relaying information through the convoy commander or NCO in charge.

- Develop and continually update route strip maps that show the locations of landmarks, previous ambush zones, safe havens such as maneuver unit outposts, and other information of interest to drivers.

- Debrief the Soldiers of returning convoys. Develop a list of questions to use in obtaining information from tired and hungry Soldiers.

- Provide a daily intelligence summary to the brigade S-2 and designate named areas of interest based on observations of Soldiers in the convoys.

A tactical convoy is not simply a platoon- or even a company-level mission; it is a brigade-level operation. Commanders at the battalion, brigade, and division levels have assets that can increase the survivability and lethality of logistics convoys.

Support battalion S-3—

- Recommend to the battalion commander a basic convoy configuration (the sequence of convoy assets as they roll down the road).

- Propose standardized convoy battle drills and procedures for Soldiers who become separated or lost on the battlefield. After obtaining approval of the battalion commander, publish these battle drills and establish a training or verification plan to ensure that the drills are understood, rehearsed, and executed effectively.

- Ensure that the battalion's procedures for recovering isolated, missing, detained, or captured personnel are synchronized with the BCT's personnel recovery plan.

- Identify command-regulated items that are critical to convoy success, such as gun trucks and Warlock devices, and allocate and track them as needed for battalion missions.

- Assign weapon teams, additional squad automatic weapon gunners, Warlocks, and radios as needed to provide each convoy with the communications and firepower it needs to survive and counterattack.

- Develop and maintain a convoy planning and preparation checklist for each convoy to assist commanders in their “go, delay, or no go” decision.

- Document the locations of friendly maneuver units along the route, their radio frequencies, and their call signs. Contact the S-3s of these units and provide the expected transit time windows and the routes of the convoys moving through their battlespace.

- Determine and track the progress of task force operations that are scheduled to occur before and during the delivery time window that could affect the planned convoy route or assist the convoy with firepower or security.

- Propose to the BCT S-3 a plan for unmanned aerial vehicles or helicopters to perform reconnaissance ahead of the convoy.

- Coordinate for fixed-wing air support to be in the area.

- Specify events that convoys must report to the tactical operations center, such as convoy departure, maintenance halts, and passes through checkpoints.

- Continuously track the location of the battalion’s convoys along the routes.

- Specify priorities of work for returning convoys, such as refueling, vehicle maintenance, S-2 debriefing, weapons maintenance, vehicle parking, and “chow.”

- Attend the S-2 debriefing of the returning convoy.

Support battalion S-4—

- Provide, or direct the temporary loan or cross-leveling of, radios, tow bars, ammunition, weapon mounts, and electronic jammers as needed.

Radios in CSS units typically are mounted in vehicles. Dismounted operations require manpack radios, and swapping out radio installation kits between vehicles consumes too much time when a cargo truck is deadlined. Therefore, the battalion communications noncommissioned officer (NCO) and the S-4 must know the availability of all radios, manpacks, installation kits, and spare antennas that could be used to communicate. (“Manpack” is the common name for the AN/PRC-119A/D/F radio that is configured for a Soldier to carry.)

Tow bars are vital in a convoy. Each truck must be able to connect to a towing vehicle rapidly when under fire. Waiting for a tow bar to arrive from the rear of the convoy is not a good option. Tow bars are class IX (repair parts) items; they should be obtained in

sufficient quantities to ensure their availability to convoy drivers as needed.

After the battalion commander defines the minimum amount of ammunition and pyrotechnics needed for a convoy, the battalion S-4 must work with the unit supply sergeants to ensure that Soldiers in the convoy have sufficient rounds for all of their weapons. They also must ensure that all authorized ring mounts are actually on hand and installed and that gun-mount assemblies have all of the components required to make them functional for all types of weapon systems. Availability of weapon mounts is typically the biggest limiting factor in determining the number of gun trucks a battalion can put on the road.

Because of the operating tempo and enemy activity, all of the staff preparatory tasks above may not be completed for every convoy. For example, aerial reconnaissance may not be available for a particular convoy. The decision to proceed with a convoy that has not been prepared fully rests with the battalion commander and the company commander charged with executing the convoy. The battalion S-3 is responsible for providing the battalion commander with the status of the preparatory events that have occurred and those that have not. The company commander must obtain the battalion commander’s approval of any convoy abort criteria ahead of time to avoid confusion and premature execution. The battalion command sergeant major plays a vital role in assessing the preparation and rehearsals for convoy missions and raising a red flag if things are not going well.

Assessing Battle Drills

Every deployed and returning unit has a list of battle drills that worked in a particular situation. For example, what works on the open terrain between Samarra and Tikrit would be completely impracticable on Baghdad’s urban terrain. The need to be aggressive and the ability to take the fight to the enemy are constants in all effective battle drills. Merely buttoning up and running away may minimize casualties, but, in the long run, leaving attackers alone will encourage them more and ultimately result in increased friendly casualties.

Commanders must decide which battle drills to execute in order to move their convoys successfully over the terrain or road conditions they face. Five basic principles provide a framework for evaluating which battle drills are suitable for a particular mission. Various tactical situations will drive their relative importance for each mission. An effective convoy battle drill is one that will, for a specific situation—

1. Minimize friendly casualties.
2. Maximize enemy casualties.
3. Not create new enemies.
4. Leave no abandoned equipment.
5. Allow the convoy to accomplish its mission.



A Soldier from the 626th Brigade Support Battalion, 101st Airborne Division (Air Assault), prepares to drive a heavy, expanded-mobility tactical truck in a convoy leaving Forward Operating Base Remagen, Iraq.

So which battle drills apply best to a particular mission? Some factors that influence the effectiveness of a particular battle drill are the following—

- How many vehicles and Soldiers are in the convoy?
- How many mounted and hand-carried automatic weapons are on hand?
- Does the terrain allow both cargo trucks and gun trucks to drive off the paved surface?
- Can convoy Soldiers communicate while dismounted?
- Is the terrain flat and open, rolling hills, or urban?
- How critical is it to the receiving unit that the supplies arrive on schedule?
- Where along the route can the convoy call for help, and where are the communications dead spots?
- How proficient are the Soldiers in their various battle drills?
- How able are the leaders and Soldiers to recognize which battle drill they should execute in a particular situation?

As this list reveals, a convoy may have to execute three or four different battle drills to react to IED and small arms fire, depending on the conditions along its route.

Soldiers in a convoy must have a clear vision of the hazards they may encounter along the convoy route. The convoy commander must ensure that the Soldiers on the convoy know which battle drills will be applied and when each will be in effect. The commanders and their staffs must make sure that the Soldiers on the convoy have the knowledge and equipment they need to be successful. A coordinated brigade operation in which everyone is prepared to do his job offers the Soldiers in the convoy the best chance of success. **ALOG**

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Save the Best for Last

BY MAJOR JULIAN H. BOND, CAARNG

During a transfer of authority, the outgoing and incoming units must ensure that the customers they support continue to receive a quality product throughout the transition.

When one unit replaces another in a theater of operations, the units must conduct a transfer of authority (TOA) to ensure that the incoming unit is integrated seamlessly into the battle command structure and is prepared to assume the mission. The TOA is essential in ensuring that mission continuity and customer support are not affected by the change of mission control.

The requirements of a typical TOA include not only assuming control of the mission but also completing an organization equipment inventory with subsequent property transactions, completing a number of base support and training requirements, and settling Soldiers into what will be their home away from home for the next year.

Regardless of planning, closely coordinated integration, and a positive relationship between units, TOAs can cause stress and anxiety for both the outgoing and incoming units' leaders and Soldiers. Consequently, units are most vulnerable to accidents and enemy threats during this period of transition. The TOA process is normally a 10-day process that encompasses not only handing over a mission set but also transferring an entire unit's property—an action that would take 30 to 45 days for an active unit to complete in garrison. The outgoing unit also must complete mandatory redeployment activities that include clearing various accounts, attending personnel briefings, packing, maintaining life support functions, completing personnel evaluations and awards, and arranging for the redeployment of personnel and equipment to home station. However, the most important mission for the outgoing unit is to “save the best for last”: it must ensure that the transfer of the mission is seamless without a break in customer service.

Recently, the 541st Transportation Company (TC) (Petroleum, Oils, and Lubricants [POL]) from Fort Campbell, Kentucky, conducted a relief in place and TOA with its replacement unit, the 756th TC (POL) (-), a National Guard unit from Lancaster, California. The TOA process, which took place in Taji, Iraq, was a model of success.

The 541st and 756th completed their TOA with minimal stress or anxiety. The companies quickly and

professionally accomplished a seamless integration of outgoing and incoming units. The four basic principles used to accomplish this successful TOA were—

- Proactive communication. “Make the time.”
- Established plan. “Stick to it.”
- Immediate immersion. “Be fast and furious.”
- Quality product to the end. “Save the best for last.”

Proactive Communication

The leaders of the two companies began communicating 90 days before the 756th's projected movement into theater. Personnel assessments, including potential personnel and training strengths and weaknesses, were reviewed to prepare both units for the upcoming integration.

So that the 756th TC could adequately prepare for the upcoming mission, the leaders of the 541st provided the 756th with specific proficiencies that would be required in theater. Areas discussed included driving proficiency (measured in miles driven and the drivers' ability to operate both loaded and unloaded vehicles), weapons proficiency, and training that would be needed in order to serve commanders of combat logistics patrols (CLPs). Based on the 541st's input, the 756th TC expanded their predeployment training to include—

- Fifty thousand miles of driver training in a desert environment at Dona Ana, New Mexico.
- Crew-served weapons qualification for 39 percent of the unit's personnel.
- Vehicle familiarization while pulling tankers loaded with product.
- Convoy operations (for staff sergeants and above).

Established Plan

After an assessment by the 756th TC's commander, the 541st leaders developed and implemented a detailed training plan that incorporated—

- CLP trainup.
- Company headquarters and truckmaster operations.
- Life support integration (personnel, supply, and Soldier-care functions).

- Mandatory detail training (life support operations, force protection company, dining facility security, battalion and brigade support, and morale, welfare, and recreation crew).

- Maintenance –10 and –20 operations.
- Forward operating base (FOB) standing operating procedures (SOPs).
- Other specific battalion, brigade, and FOB policies and procedures.

Following a detailed training plan allowed both units to stay focused and provided little room for distractions. To ensure that the plan was synchronized, an advance party that included the 756th commander, operations officer, truckmaster, and supply sergeant arrived at the FOB 3 days before the main body of the company.

Immediate Immersion

The 541st provided on-the-spot assistance with instruction, unit SOP familiarization, and corrections (when needed) from the first day of arrival of the 756th. The 541st had moved out of the company barracks, work, and common areas before the 756th arrived. This set the conditions for the 756th to assume the mission and made the transition easier. Highlights of the “fast and furious” immersion included adjustment to the high operating tempo with reduced rest, leader planning and risk analysis, and constant direction and guidance by the 541st.

. . . the most important mission for the outgoing unit is to “save the best for last”: it must ensure that the transfer of the mission is seamless without a break in customer service.

Immersion was conducted in three phases. Phase I began with the 756th shadowing the 541st, or conducting a “right seat ride,” in all facets of company operations. The right-seat-ride concept started with daily operations, including leadership responsibilities, life support, maintenance, mandatory FOB details, and mission preparation and execution. The 756th’s convoy commanders were allowed to make mistakes on real missions, from mission preparation to mission execution; however, the 541st’s key leaders made immediate corrections. This phase lasted 3 days. Phase II was the “left seat ride,” in which the 756th assumed operations and the 541st observed. During this phase, 756th personnel overcame their anxiety and took over operations with on-the-spot consulting by dedicated 541st transition trainers. This phase lasted 4 days. Phase III was independent operations

with monitoring. The 756th began operating on its own, and the 541st personnel were available if needed for support. The 756th’s Soldiers were able to reinforce the three C’s, a concept developed by Colonel Gustave Perna, the commander of the 4th Sustainment Brigade, 3d Corps Support Command: confidence in themselves, confidence in their equipment, and confidence in their leaders. This phase lasted 3 days.

Quality Product to the End

Outgoing units often provide a mixture of personnel to conduct the relief in place and TOA training, but key leaders usually are absent from the training to prepare for redeployment. The 756th was fortunate that, under the “save the best for last” concept, the 541st provided a team of their key leaders, skilled operators, and gifted trainers for every aspect of the trainup. The same 541st personnel accompanied each mission element of the 756th TC on all CLPs during the right-seat-ride and left-seat-ride phases of the TOA. The 541st Soldiers served as coaches, observer-controllers, mentors, and consultants and, when necessary, rendered immediate on-the-spot corrections. This concept was carried throughout the full spectrum of the TOA. The 541st TC’s TOA training ensured that all 756th mission platoons were trained to the same standard. The 541st also was prepared to keep the training teams in place past the TOA (while the remainder of the unit redeployed) to ensure that the 756th was ready to assume the mission.

The success of the TOA was demonstrated when the 541st redeployed on time and the 756th stepped in to provide seamless customer support with the same level of professionalism that the 541st had provided. The 541st TC’s Soldiers can look back on their deployment as a total success because success is not measured by how you start but by how you finish. Their training plan to save the best for last—ensuring total mission success before departing—is a true testament to the professionalism of the unit.

ALOG

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Securing Shelters to 5-Ton Cargo Trucks

BY COLONEL NEAL H. BRALLEY, USA (RET.)

Only the authorized method should be used to secure storage and equipment shelters to 5-ton cargo trucks.

During a recent visit to observe training at the Joint Multinational Readiness Center in Hohenfels, Germany, I noted that many shelters were incorrectly secured to military 5-ton tactical cargo vehicles. The units were using many types of tiedowns to secure their shelters. “Why is the type of tiedown used important?” you ask. That is a fair question; after all, the items had made their way to the training area without incident. However, there is only one correct way to secure shelters, such as the S-280C/G electrical equipment shelter, to 5-ton cargo vehicles.

Tiedown Requirements

The correct tiedown method is explained in several publications—

- Military Traffic Management Command Transportation Engineering Agency (MTMCTEA) Pamphlet 55-20, Tiedown Handbook for Truck Movements.
- Technical Manual (TM) 10-5411-207-14, Operator’s, Unit, Direct Support, and General Support Maintenance Manual for Shelter, Electrical Equipment S-280C/G.
- TM 11-5411-216-14&P, Operator, Unit, Direct Support (DS), and General Support (GS) Maintenance Manual for Electronic Equipment Storage Shelters: S-744/TSM-191 and S-745/TSM-191.

Each publication calls for the use of a steel, multiple-leg sling assembly, national stock number (NSN) 3940-00-805-5533. This item costs \$540. (Please note that the previous NSN for this item was 3940-00-846-9858. This NSN may still appear in some documents; however, only the new NSN should be used when procuring the sling assembly.) This sling assembly is used to lift the shelter onto and off a 5-ton cargo truck and to secure the shelter to the vehicle. It comes with all of the hardware needed for both tasks (including the plate and eyebolt assembly, illustrated at right). For

Shelters should be mounted to 5-ton trucks using the method illustrated at right. (Drawing from TM 10-5411-207-14)

many shelters, the sling assembly is the only basic issue item that comes with them.

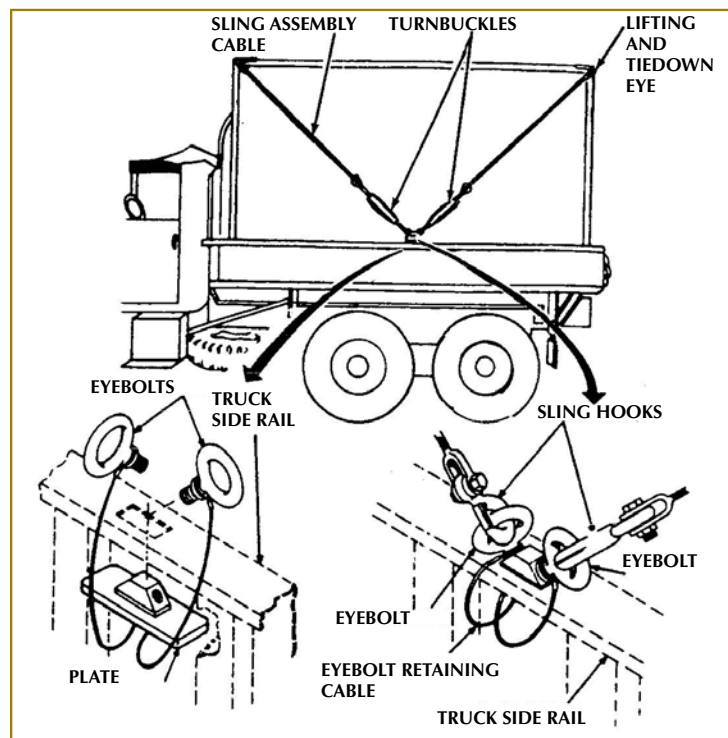
Correctly Securing a Shelter

Think back for a moment to Sir Isaac Newton and his first law of motion, often stated as—

An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction *unless acted upon by an unbalanced force.*

The sling leg assembly’s tension is an important unbalanced force that will keep the shelter on the back of the truck and will not permit it to shift rearward or forward under rapid acceleration or deceleration.

Although empty shelters weigh approximately 1,400 pounds, they may contain a payload weight of up to 5,000 pounds, resulting in a total shelter weight of





This collage shows tiedowns that were improperly used to attach shelters to trucks.

6,400 pounds. You should never use nylon cargo straps to secure a shelter to a 5-ton cargo truck because the shelter and its contents are too heavy. Nylon straps may stretch; steel doesn't stretch as much. The illustration at left depicts what "right" looks like when securing a shelter.

When securing a shelter to a 5-ton cargo truck, you must ensure that the tension of the tiedowns will keep the shelter in place. Place the turnbuckles low, near the bed of the truck—not at the top of the shelter—so you can reach them. This enables you to ensure that the tiedowns are tight and have the proper tension. Proper tension is applied to each sling leg by hand-tightening the turnbuckle until tight, then turning it an additional half turn using a bar or wrench inserted into the turnbuckle's opening.

The photographs above depict incorrect assembly. Each photograph shows an actual vehicle in use by a unit in the field. Use these illustrations to learn to recognize what is incorrect so that you can make the necessary changes and get the correct materials to protect your equipment, cargo, and Soldiers. In this instance, "right" does not include the use of other wire rope assemblies, alternate tiedown points on the cargo truck, various combinations of shackles, or the use of nylon cargo straps.

We cannot change the first law of motion that Sir Isaac Newton identified many years ago. However, we can secure our loads safely to protect both our Soldiers and cargo from damage. Reading the appropriate equipment technical manuals and reviewing MTMCTEA Pamphlet 55-20 will help you prepare to secure your heavy shelters correctly and safely on 5-ton cargo vehicles, regardless of driving conditions. Drivers, noncommissioned officers, and commanders have many responsibilities while conducting vehicle operations. Properly securing and checking their loads will remove one important item—shifting loads—from their list of things to worry about. **ALOG**

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Designer Materials

BY DR. KEITH ALIBERTI AND THOMAS L. BRUEN

Advances in materials science hold the promise of revolutionary improvements in supportability, maintainability, reliability, and deployability.

Editor's note: This is the third in a series of five articles on future logistics innovations identified by the Army Logistics Innovation Agency's Futures Group. The second article in the series—on telepresence—begins on page 22 of this issue. The final two articles in the series will appear in the January-February 2007 issue of Army Logistician.

Imagine a world where materials are engineered from the “ground up,” atom by atom, rather than from the “top down.” Imagine having the ability to create entirely new types of materials and to tailor the properties of existing materials, thereby minimizing sustainment requirements and reducing demand. Advances in *designer materials* will allow attainment of these capabilities, thereby revolutionizing future logistics.

Designer materials encompass that realm of materials science that is concerned with the design, development, and optimization of materials to reduce wear, friction, corrosion, radiation, oxidation, and fatigue. The Joint Logistics (Distribution) Joint Integrating Concept describes the need for the Future Force to have increased speed and agility. Advances in metallic alloys, composites, ceramics, electro-optic and photonic materials, and polymers promise to provide those improvements. Ultralightweight, amorphous, and multifunctional materials will reduce the weight and increase the performance of aircraft and ground vehicles and therefore greatly minimize the logistics burden of warfighters in the field. The new and exciting field of nanoscale technology, including molecular manufacturing, will yield materials that dramatically improve the reliability and durability of equipment, supplies, and infrastructure.

In this article, we discuss designer materials and their properties in an effort to inform the logistics community of the exciting possibilities designer materials offer for the future of Army logistics. We also present some basic concepts of nanoscale technology and nanoscale materials. Logisticians in today's Army will need an understanding of these concepts so they can advocate and plan for the introduction of these new materials into the Future Force. Familiarity with the implications of advances in the various fields of materials science will enable logisticians to communicate

their requirements to the research, development, test, and evaluation community.

Nanotechnology and Nanomaterials

The National Nanotechnology Initiative describes nanoscale technology as “the understanding and control of matter at dimensions of roughly 1 to 100 nanometers, where unique phenomena enable novel applications.” [A nanometer is 10^{-9} meter, or one-billionth of a meter.] Scientists and engineers employing nanoscale technologies seek to build materials from the ground up, atom by atom. To appreciate the marvels of emerging nanoscale technologies, consider the human hair. A piece of hair is approximately 50,000 nanometers thick; this is equivalent to the length of 500,000 atoms placed side by side. Couple the small size of nanoscale particles with the fact that these particles cannot be seen with the unaided eye, and we can begin to appreciate the complex task of manipulating nanoscale particles to design advanced materials.

Scientific and technological advances in nanoscale technologies provide the underpinnings of designer materials by allowing the deliberate manipulation and manufacture of nanoscale structures. Materials designed at the nanoscale level exhibit properties that do not exist in their macroscale counterparts. [“Macroscale” refers to matter greater than 100 nanometers in size.]

Take carbon as an example. The carbon in a lead pencil is a soft material. However, reconfiguring carbon on the molecular scale to form cylindrical carbon molecules (carbon nanotubes) yields one of the strongest materials known to mankind (stronger than steel, yet six times lighter). Carbon nanotubes also can be fabricated in the form of concentric cylinders, known as multiwalled carbon nanotubes, that exhibit dynamic properties. Imagine a nanoscale carbon cylinder within another nanoscale carbon cylinder of slightly larger radius. Such a configuration creates a telescoping property in which the inner tube can slide within the outer tube almost without friction; the result is ultralow-friction nanoscale linear bearings. These carbon nanotubes may constitute near-perfect, wear-free surfaces and offer an example of molecular nanoscale technology with potentially significant logistics benefits. They represent precise manipulation of atoms to manufacture useful materials with *functional capabilities*.

At the nanoscale, scientists and engineers manipulate matter at the molecular level to produce materials and systems with significantly improved properties. (Art by Eric Proctor of the Sensors and Electron Devices Directorate of the Army Research Laboratory.)



Emerging nanoscale technologies for the manipulation and manufacture of novel advanced materials are quite remarkable. Rodney Brooks, Director of the Artificial Intelligence Laboratory at the Massachusetts Institute of Technology, observed, “Our thirty-year goal is to have such exquisite control over the genetics of living systems that instead of growing a tree, cutting it down, and building a table out of it, we will ultimately be able to grow the table.”

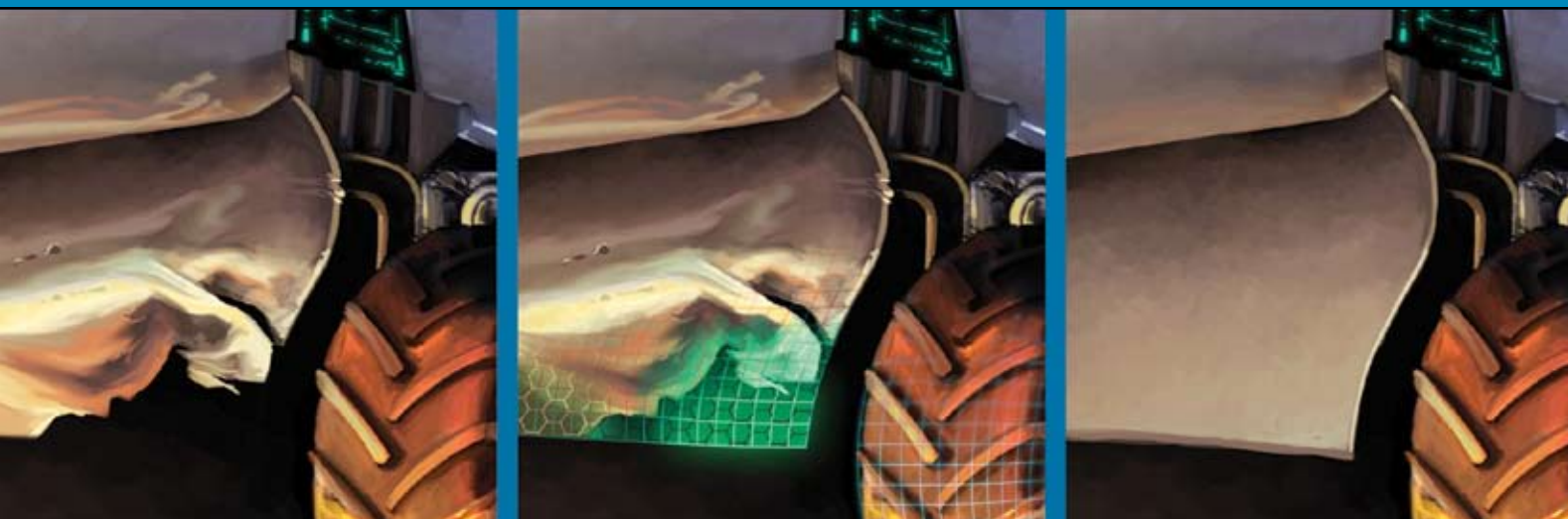
Perhaps even more remarkable, however, is the fact that molecules can self-assemble without external guidance. Molecular self-assembly is a process that occurs in nature by which a material can spontaneously build itself (biological self-assembly). The construction of cell membranes is a common example. Self-assembly also can occur in the laboratory. Scientists and engineers have succeeded recently in imitating biologically self-assembled systems by “encoding” molecules to self-assemble into larger molecular assemblies (nanoscale materials) with desired shapes and properties. Once scientists and engineers gain adequate control over the scale and speed of molecularly self-assembled materials, they will set the stage for molecular manufacturing: the effective and economically viable tailoring of the properties and attributes of materials. Think of the possibilities for solving many of the logistics challenges of the future. The molecular manufacturing of supplies and equipment at or near the point of need in the battlespace may become a real possibility. This would eliminate much of the demand for distribution across hazardous terrain or airspace.

Multifunctional Materials

While nanoscale technologies have the promise to revolutionize materials of the future, materials with multifunctional abilities undoubtedly will affect almost every military activity from communications to sensing to power generation. As military systems and missions become more complex, the ability of materials to adapt to their environment—to be dynamic in both shape and function—will become critical. Multi-functional materials—specifically engineered materials that can behave both structurally and functionally (for example, actuating, or putting into action; functioning electrically, magnetically, or thermally; or performing self-diagnosis and self-healing actions)—will offer extraordinary capabilities for military logistics.

Smart, or intelligent, materials form a class of multifunctional materials that have intrinsic information-processing capabilities, such as sensing, actuating, and controlling. The ultimate goal of using smart materials is to provide materials that can respond autonomously and intelligently to dynamically changing environmental conditions in the best way possible. This requires materials (and structures) that can respond to stimuli in an appropriate time interval and return to their normal state once the stimuli are removed. For example, future military mobile bridges constructed of smart materials will be able to sense strain, alter their structure when subjected to heavy loads, and provide self-diagnosis and self-repair in response to any damages incurred. Some advanced smart materials with intrinsic intelligence include shape-memory materials and active polymers.

These artist's conceptions show self-repairing materials used in a vehicle (below) and a bridge (at right). New composite materials with self-repairing capabilities will decrease parts supply and maintenance requirements. (Art by Eric Proctor of the Sensors and Electron Devices Directorate of the Army Research Laboratory.)



Shape-Memory Materials

Shape-memory materials (SMMs) can sense magnetic, electrical, thermal, and mechanical changes and respond to those stimuli. SMMs also can be tuned, or adjusted, to respond to predetermined changes in position, strain, shape, stiffness, damping (reducing excess vibrations), natural frequency of vibration, and even friction. SMMs include alloys, ceramics, polymers, and gels and can be fabricated into wires, fibers, thin films, and other forms that allow for numerous applications.

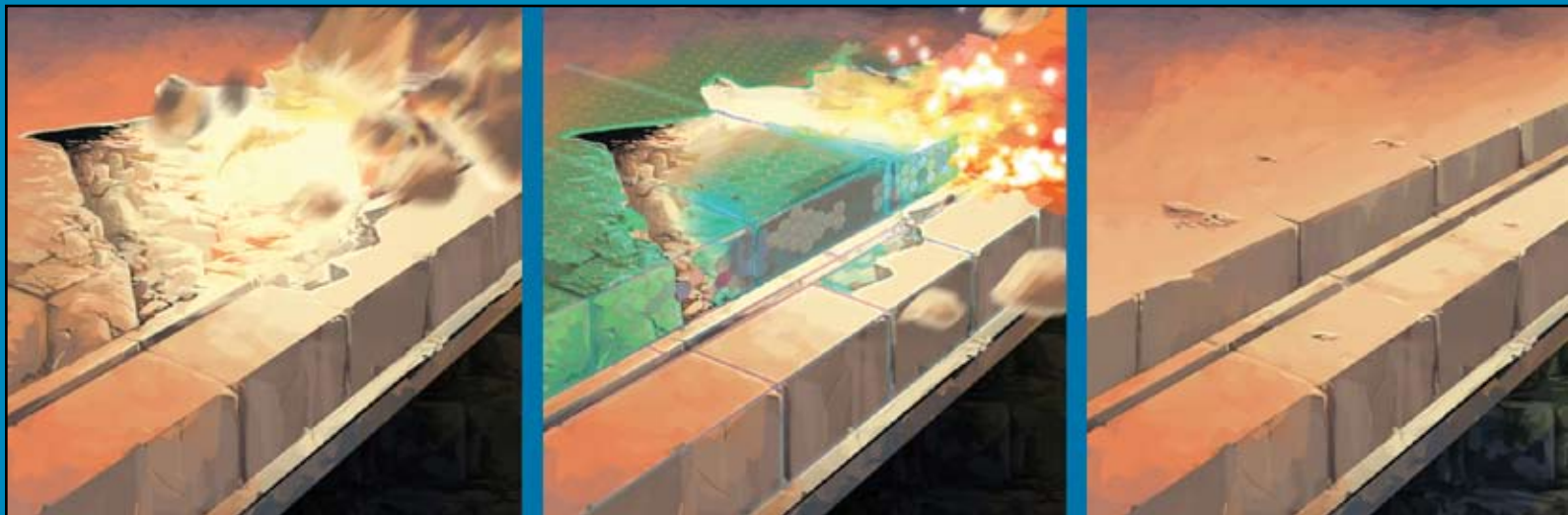
Certain SMMs, such as shape-memory alloys (SMAs), exhibit the “shape-memory effect.” Temperature-dependent SMAs, for example, have a certain shape above a particular temperature (called the transformation temperature), but they can be deformed easily below that temperature. Returning the material to its original temperature after heating will return the material to its original shape. In a sense, the material “remembers” its shape before deformation. This shape change is a result of a change in the crystal structure of the material and is called the shape-memory effect. SMAs are also pseudo-elastic, have a high damping capacity and good chemical resistance, and are biocompatible. As a result, they are attracting a great deal of attention for use in smart and functional materials and are very attractive for use in microelectromechanical systems (MEMS).

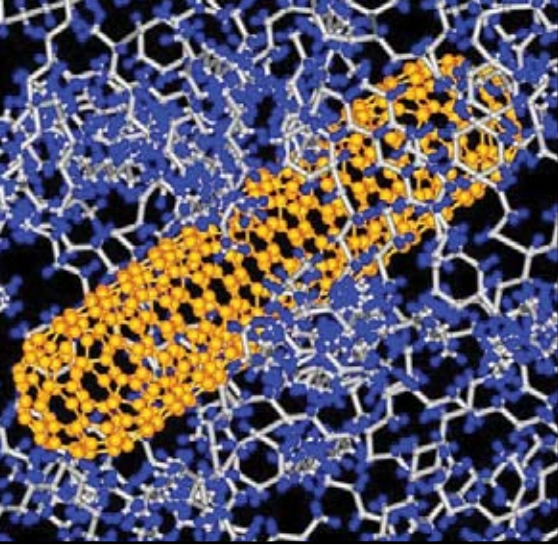
MEMS combine advanced electronics with mechanical systems at the microscale (10^{-6} meter, or one-millionth of a meter) to sense and control changing conditions within larger systems. MEMS is an enabling technology that facilitates the development of smart products and augments the computational ability of

microelectronics with the perception and control capabilities of microsensors and microactuators. MEMS devices, which already are being developed to monitor environmental factors to determine the health and shelf life of equipment and supplies (such as medical supplies), can use SMAs and other nanoscale improvements to increase their own effectiveness, versatility, and durability.

The most prominent SMA is nickel-titanium (NiTi). NiTi not only exhibits the shape-memory effect but also has very good mechanical properties, is fairly easy to process, and demonstrates excellent corrosion and fatigue resistance. Because of these attributes, NiTi is used for medical implants, smart materials, and smart structure systems with amazing success. One particular feature of NiTi, which has plagued its use in applications, is its slow response time to changes in temperature. Recently, however, NiTi has been used in robotics applications to mimic smooth, human-like motions; it may be usable in robots that require human physiological characteristics. Thin-film NiTi has been shown to yield very fast actuation response times and is finding increased use as a core technology for some MEMS applications, including micropumps, microvalves, microsprings, and micropositioners.

In addition to SMAs, shape-memory ceramics (SMCs) and shape-memory polymers (SMPs) are being applied in a number of areas not suitable for SMAs. SMCs can transition under both temperature and stress and have additional attributes such as improved toughening and plasticity, making them particularly attractive for uses calling for increased reliability and structural integrity. Perhaps the biggest drawbacks to using SMCs are the presence of microcracks, which





Shown at left is a polymer/single-walled carbon nanotube composite. Carbon nanotubes are stronger than steel but six times lighter.

are inherent in some ceramic materials, and a limited ability to recover from deformation (in other words, they can recover from only a low level of strain).

SMPs have recently gained much attention because of their ability to regain their original shape after severe deformation. Rubber and plastic are examples of polymer materials. The fact that polymers exhibit shape memory at all is quite amazing considering the very large deformations they undergo at certain temperatures. A rubber bushing (an insulating lining), for example, is rubbery and pliable at high temperatures, yet it becomes glassy and stiff when cooled to low temperatures. If an ordinary piece of rubber is bent at high temperature and its temperature then is lowered, the deformation of the rubber can be frozen in a glassy state. Reheating the rubber usually will not allow it to completely return to its normal shape. In contrast, SMPs can recover all of their residual deformation after undergoing such a process; strains of more than 400 percent can be recovered in most SMPs. A car bumper made out of an SMP, for example, can be shaped at high temperatures and then cooled to room temperature for installation on a car. If the bumper is dented, then one simply would have to heat the bumper to return it to its original shape.

Active Polymers

Certain polymers, known as electroactive polymers, undergo shape changes when subjected to an applied voltage, so they are distinguished from SMPs. Applying a voltage to an electroactive polymer causes it to undergo a deformation in one direction, while reversing the voltage polarity causes it to reverse its deformation. This motion can be done repetitively, and the response time is fairly quick. These materials are finding applications in the field of robotics as “artificial muscles.” They also are being used in supercapacitors and superbatteries, transistors, chemical and biological sensors, molecular electronics, photovoltaics, and corrosion protection.

The use of electroactive polymers as anticorrosion coatings is particularly attractive, considering that the majority of the Department of Defense’s (DOD’s)

military assets are subjected to environments in which corrosion causes deterioration. A 2001 study indicated that direct costs of corrosion for military systems and infrastructure are \$10 billion to \$20 billion annually. Corrosion was found to be one of the largest components of life-cycle costs for military weapon systems; corrosion also substantially reduces readiness by increasing equipment downtime. Recent studies on the use of electroactive polymers for corrosion prevention are quite promising. In this application, a conducting electroactive polymer film is produced directly on the surface of a metal through a procedure known as “anodic oxidation.” Conventional metal coatings, such as paint, form a temporary barrier to the environment and slow the corrosion of metals. Conductive polymers, on the other hand, do not create physical barriers but actually react with metals to create a layer of pure iron oxide on the metal surface that halts corrosion. In field tests, these coatings have been shown to be 3 to 10 times more effective than conventional coatings. They may play a substantial role in corrosion mitigation for future military systems.

Research on SMMs is ongoing, and many applications are yet to be discovered. The development and design of new SMMs to meet demanding applications with strict tolerance requirements are crucial. SMMs are not without shortcomings, but widespread use undoubtedly will increase in the future if low-cost SMMs become available, design and modeling complexity issues are overcome, pretuning of SMMs to respond to exacting environmental changes is achieved, and better understanding of material properties and behaviors is gained. For military applications, SMMs that can withstand extreme deformations, extreme temperature variations, and enormous stresses are highly desirable. The main applications of SMMs include actuation, memory, energy storage, sensing, switching, vibration control, and surface coatings. The ultimate goal for these materials is to offer complete end-to-end design of *composite* SMMs to help meet the future demands of our military.

New Composite Materials

New composite materials will yield significant advances for future material designs and functions. A composite material is an engineered material consisting of two or more constituent materials. The constituent materials consist of a matrix material (similar to glue) and a reinforcement material. The custom blending of these distinct components yields a composite with improved properties that allows the composite to outperform its constituents. One particularly useful property of composites is their high strength-to-weight ratio, which allows lightweight materials to be designed that reduce the weight of military platforms and thus increase fuel efficiency. Composites can be molded into

complex shapes to further reduce weight (for example, by eliminating fasteners). Composites also resist corrosion, thereby reducing maintenance requirements.

While composites have been around for a number of years, advances in nanoscale and wireless technologies will create incredible opportunities to develop composite multifunctional materials at reduced costs. Composites will allow for the design of materials and structures based on the desired functionality of the materials. This may help remove constraints imposed by a material's intrinsic properties. The ability to embed sensors, actuators, and nanoscale particles into composites will permit creation of materials with built-in health monitoring and control (self-diagnosis and self-repair), surveillance, and stealth-like functions.

The ability to control, organize, and integrate nanoscale particles into composite materials will offer tremendous potential for applications. Polymer-based composite materials with embedded chemical microcapsules, for example, have been shown to self-repair after cracking. In the future, composite materials embedded with microscale and nanoscale capsules that sense thermal, mechanical, and electrical stresses will wirelessly trigger additional embedded microscale and nanoscale capsules to initiate self-repair with near-instantaneous response. Recent estimates indicate that increased research efforts in composite materials will achieve an average 20- to 25-percent improvement in strength, toughness, stiffness, density, environmental resistance, and high-temperature capabilities in these materials by 2020. This, in turn, will lead to enhanced mobility, maneuverability, survivability, and transportability of DOD systems.

Logistics Implications

The application of designer materials within the Army likely will have enormous logistics benefits. Equipment readiness will increase in real terms as component parts achieve enhanced reliability. Development of lubrication-free bearings for quiet, efficient, high-performance electric motor drives on vehicles and aircraft will increase maintainability and reduce the need to stock and transport lubricants in the battlespace. The use of surface coatings will contribute to increased maintainability and reduced downtime by reducing friction and wear, increasing reliability, and creating superior resistance to corrosion. Material developments will reduce the weight and volume of equipment and systems, enhance mobility and durability, and reduce friction.

Low-power, highly reliable electronic and integrated circuits will be designed for logistics command and control decision support systems and their communications backbones. The use of advanced, novel materials to support efforts like telepresence will serve to remove

Soldiers from the battlespace yet let them participate fully in ongoing operations. (See the article beginning on page 22.) Advanced manufacturing and fabrication capabilities will allow for deployment of molecular replication equipment to support onsite production of consumables (such as food, water, and fuels) in a theater of operations.

Nanoscale technology will permit the creation of materials with structurally superior shear strength, tensile strength, and compression characteristics. These and other novel characteristics will yield increased reliability of parts, thereby reducing sustainment and distribution requirements. Designer materials also may enhance human performance by augmenting human skills, attributes, or competencies. Human-embedded nanoscale materials and machines, for example, may revolutionize medicines and therapies designed to replace or increase performance.

Future advances in materials science will yield maintenance-free, highly durable materials capable of enduring harsh battlespace and other environmental conditions. Ultrahigh temperature ceramic materials that can withstand extremely high temperatures (4,000 degrees Fahrenheit) have been developed in the laboratory, and strong, electrically and thermally conductive carbon nanotube-based materials currently exist. Revolutionary advances in newer and better materials will lead to new structures, vehicles, armor, munitions, and equipment. These advances will greatly affect supportability, maintainability, reliability, and deployability, leading to reductions in logistics footprint and life-cycle costs as well as increased effectiveness for sustained combat.

So when you hear the expression, "don't sweat the small stuff," think again. Because of the small stuff resulting from designer materials, logisticians in the future may have to do less sweating about the big stuff needed to support the Soldier. **ALOG**

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Making the Most of New Batteries

BY PERRY A. CUSHMAN

The 2d Infantry Division found that adopting advanced-technology batteries was more than a matter of simply installing the batteries in its vehicles. Division maintainers also learned that they needed a support plan if they were going to realize the benefits of the new technology.

Since September 2005, the 2d Infantry Division in Korea has experienced a remarkable turnaround in vehicle battery maintenance. Changes in the division's battery maintenance program have saved nearly \$400,000—a cost saving of 80 percent compared to the previous fiscal year. Battery usage has dropped by 75 percent during the same period. More important has been the increase in the division's equipment readiness posture that has resulted from this program.

These improvements can be attributed to the investment the 2d Infantry Division has made in new battery technology. In an effort to decrease battery use and increase readiness rates, the division began replacing 6TN batteries, which use the older flooded cell lead-acid technology, with "HAWKER" batteries, which incorporate the newer absorbed-glass-mat (AGM) battery technology. [Flooded cell (wet), absorbed glass mat, and gelled are the three major types of battery construction. An AGM battery incorporates boron-silicate glass mats between its plates. It is sealed and therefore maintenance free.]

The division's maintenance leaders invested \$1.5 million to purchase nearly 5,400 AGM HAWKER batteries and convert critical combat fleets to the maintenance-free AGM technology. However, what the leaders did not realize at first was that the HAWKER battery had to be treated as a component of an overall battery plan. They learned that they also should have invested in additional support equipment—specifically, PulseTech smart battery chargers and PulseTech 490PT battery analyzers—and in a training package to create an overall battery maintenance program.

New Ways of Maintenance

Initially, the conversion to HAWKER batteries was painful because the division's Soldiers were not trained on the AGM technology and therefore did not understand how their standard maintenance procedures actually created battery problems rather than prevented or eliminated them. However, with training, they eventually caught on.

The division's maintenance leaders contacted the Army Materiel Command (AMC) Logistics Support Element (LSE) for the 2d Infantry Division for assistance. Logistics assistance representatives (LARs) from the Tank-automotive and Armaments Life Cycle Management Command (TACOM) and the chief of the LSE investigated and found that several thousand of the division's new HAWKER batteries had voltage readings below 8 volts; more than half showed readings below 5 volts. All of these batteries were less than 2 years old, had been installed in vehicles for less than 30 days, and apparently were dead when installed. Unit maintenance personnel had been trying, with little success, to charge the "dead" HAWKER batteries since they were received.

After further investigation, it was determined that the HAWKER battery has a shelf life of 30 months. If taken off the shelf before the 30-month limit and properly charged before installation, the battery will fully recover and provide 54 months of use. The batteries that the division had issued to its units had been on the shelf for nearly 24 months when they were installed in vehicles, so they were not actually dead. Based on what they had found, the senior TACOM LAR requested assistance on fault isolation and problem solution from TACOM's Team Power in Warren, Michigan. TACOM responded by sending a detailed description of the HAWKER battery technology.

After studying all that he had been provided, the senior TACOM LAR for the division briefed the division G-4's maintenance officer and the LSE chief on his finding that the division's HAWKER batteries were not, in fact, dead. The problem was that the majority of batteries had simply reached a state of discharge so that they were actually in hibernation. By investing in smart battery chargers and battery analyzers, the division would be able to recover thousands of the HAWKER batteries issued to its units and installed in combat and tactical vehicles. Together with G-4 maintenance personnel, the LSE chief determined that the minimum requirement for smart battery chargers (national stock number 6130-01-500-3401) was one

In an effort to decrease battery use and increase readiness rates, the division began replacing 6TN batteries, which use the older flooded-cell lead-acid technology, with "HAWKER" batteries, which incorporate the newer absorbed-glass-mat (AGM) battery technology.

for each maintenance activity. An equal number of battery analyzers (national stock number 6130-01-510-9594) also would be required.

AMC LSE personnel then suggested that the 2d Infantry Division request the assistance of the AMC Battery Office in obtaining a portion of the required charging equipment. The LSE chief contacted Rafael Casanova at the AMC Battery Office, who offered to provide 100 PulseTech smart chargers and PulseTech 490PT analyzers to the division. The analyzers and chargers were received and distributed to each of the division's maintenance activities.

That solved the hardware problems, but one critical problem remained: Division Soldiers still needed training on AGM battery technology, battery recovery, and sustainment maintenance procedures. The LSE chief and the commander of Army Field Support Base Far East briefed the training requirement to General Benjamin S. Griffin, the AMC commanding general, during his visit to Korea in January 2006. At that time, the TACOM commander took the requirement back to TACOM as an issue. TACOM offered to have a PulseTech factory training technician travel to Korea and provide the required battery training to division personnel. This training was scheduled, and the technician taught battery maintenance to more than 75 mechanics, 9 battery shop local nationals, and 7 TACOM LARs.

After all personnel were trained, the 2d Infantry Division saw an immediate reduction in battery-related problems. During the first 2 months, the division recovered nearly 2,000 batteries that previously were thought to be unserviceable. The estimated saving to the division since this process was implemented is more than \$750,000 in cost avoidance. The overall program has been a total success. This success story filtered to other units on the Korean peninsula. As a result, the PulseTech factory technician returned to

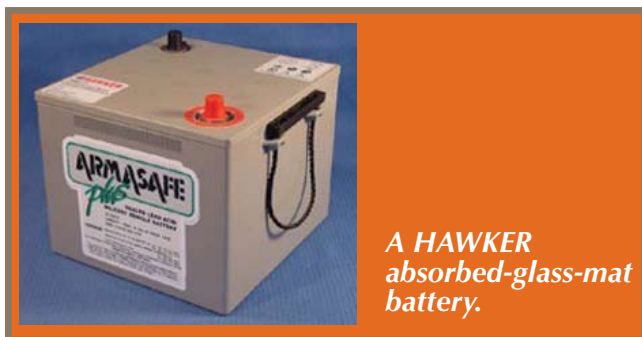
Korea and trained the battery maintenance personnel at the Materiel Support Center Korea and Army Prepositioned Stocks 4 sites. It also was determined that, to accommodate the division's rotation of mechanics, training should be provided at least annually; semiannual training, when possible, would be even more effective.

HAWKER Battery Advantages

The HAWKER battery is like no other battery the military has ever used. While its cost is nearly three times that of a conventional 6TN flooded cell battery, its potential life cycle is five times longer. The HAWKER battery is a deep cycle battery with remarkable recovery capabilities. [A deep cycle battery provides a steady current over a long period of time. A typical automobile battery, by contrast, provides a very large amount of current for a short time.] The division's experience has shown that the HAWKER battery can be recovered to full charge with no internal damage from a discharged rate as low as 0 volts. Most dead or discharged batteries have tested at between 2 and 5 volts. Experience has shown that the only HAWKER batteries that could not be recovered and fully charged were those that recorded a "Bad Cell—Replace" result when analyzed. All other batteries were recovered, recharged, and put back into service at no monetary cost to the unit. The only cost of this recovery process was time.

A fully discharged, or hibernating, battery was found to take as long as 3 days to fully charge. A battery is at all times in one of two states, charging or discharging. The HAWKER battery is half discharged when it reads 12.2 volts and is fully charged at 12.8 volts. A battery with less than 12 volts is nearly dead. This was a big problem for Soldiers and mechanics, who expected a battery with 12 volts to be fully charged (which is the case with the 6TN flooded cell battery).

The HAWKER battery is also "maintenance free." Most of the division's leaders thought this meant "Place them and forget them"; the batteries would not need maintenance for 54 months. The 54-month figure is the advertised life expectancy of AGM batteries. The term "maintenance free" refers to the fact that operators do not have to check or replace the electrolyte, which they do in preventive maintenance checks and services for other batteries. The HAWKER's battery terminals also are made of tin over brass rather than lead and therefore resist corrosion, which eliminates



The 2d Infantry Division has found that the AGM technology embodied in the HAWKER battery is far superior to the flooded cell battery and has a life cycle nearly five times longer.

the requirement to grease the terminals. Eliminating the grease also greatly reduces the dirt buildup in the battery box. About the only problem with the HAWKER battery is that it can be overcharged, in which case it will then “vent,” or boil. This will cause the acid in the absorbed glass mats to vent out of the battery and eventually short the cells, which will result in the “Bad Cell—Replace” message when the battery is analyzed. The only requirement the operator has once the battery is fully charged and installed is to keep the battery clean and charged and the terminals tight.

The 2d Infantry Division has found that the AGM technology embodied in the HAWKER battery is far superior to the flooded cell battery and has a life cycle nearly five times longer. The HAWKER batteries have a shelf life of 30 months and must be fully charged to 12.8 volts before they are installed and used. Units using the HAWKER batteries must be trained on AGM technology and must have the proper tools and test equipment to maintain the batteries. PulseTech provides a variety of chargers, including solar chargers and analyzers, that are approved by TACOM and must be used. The current equipment fielded to the

2d Infantry Division is the approved smart charging equipment that is included in the new Standard Army Tool Set. The division has the absolute minimum number of required smart chargers, but maintenance sections also should have one PulseTech 490PT analyzer for every four mechanics.

Currently, the HAWKER battery has an initial cost that is three to four times the cost of the older flooded cell battery technology. However, the HAWKER is more environmentally friendly, lasts five times longer, and can be transported safely by air since it is a completely sealed battery. As more of the Army converts to the AGM-type battery and the Defense Logistics Agency is able to make larger buys, its price is expected to come down. I recommend that the AGM-technology battery be the one type of battery the Army uses and that AGM technology be expanded to include all battery applications. **ALOG**

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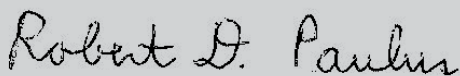
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Robert D. Paulus, 5 September 2006.

ALOG NEWS

(continued from page 1)

ARMY ESTABLISHES NEW CONTINGENCY CONTRACTING UNITS

In a move toward transition of the Army's contingency contracting mission from the Army Contracting Agency to the Army Materiel Command, the Army issued activation orders on 28 July to establish two contingency contracting battalions (CCBs) and 14 contingency contracting teams (CCTs) under AMC's new Army Sustainment Command at Rock Island Arsenal, Illinois. The 72 Soldiers assigned to the battalions and teams represent 30 percent of the Army's contingency contracting force structure. The units will align with AMC's existing Army field support brigades (AFSBs) located around the world.

"By consolidating the contingency contracting mission into AMC, we can provide a full range of contracted combat support and combat service support needed by our deployed forces," said Lieutenant General William E. Mortensen, AMC's deputy commanding general. Combatant commanders also will have a single source to turn to for their acquisition, logistics, and technology needs, he added.

Additional CCTs, one additional CCB, and four contracting support brigades (CSBs) are planned. Each CSB will be commanded by a colonel who will be dual-hatted as the principal assistant responsible for contracting for one of four Army Contracting Agency operations outside of the United States including Europe, Korea, Southwest Asia, and the Americas. The CSB commander will be responsible for executing ACA's contracting mission to support local installations and the needs of their assigned Army service component command and other customers. When deployed, however, the CSB commander will command all of the deployed contingency contracting teams and battalions in a theater and will join with the AFSB to ensure seamless contracting support to the combatant commander.

INSTALLATION MANAGEMENT COMMAND ACTIVATED

In its continuing efforts to reorganize its commands and specified headquarters to obtain the most efficient command and control structures possible,

the Army has activated a new command—the Installation Management Command. The command is accountable to the Chief of Staff of the Army for garrison support of mission activities and serves as the Army's single authority and primary provider of base support services.

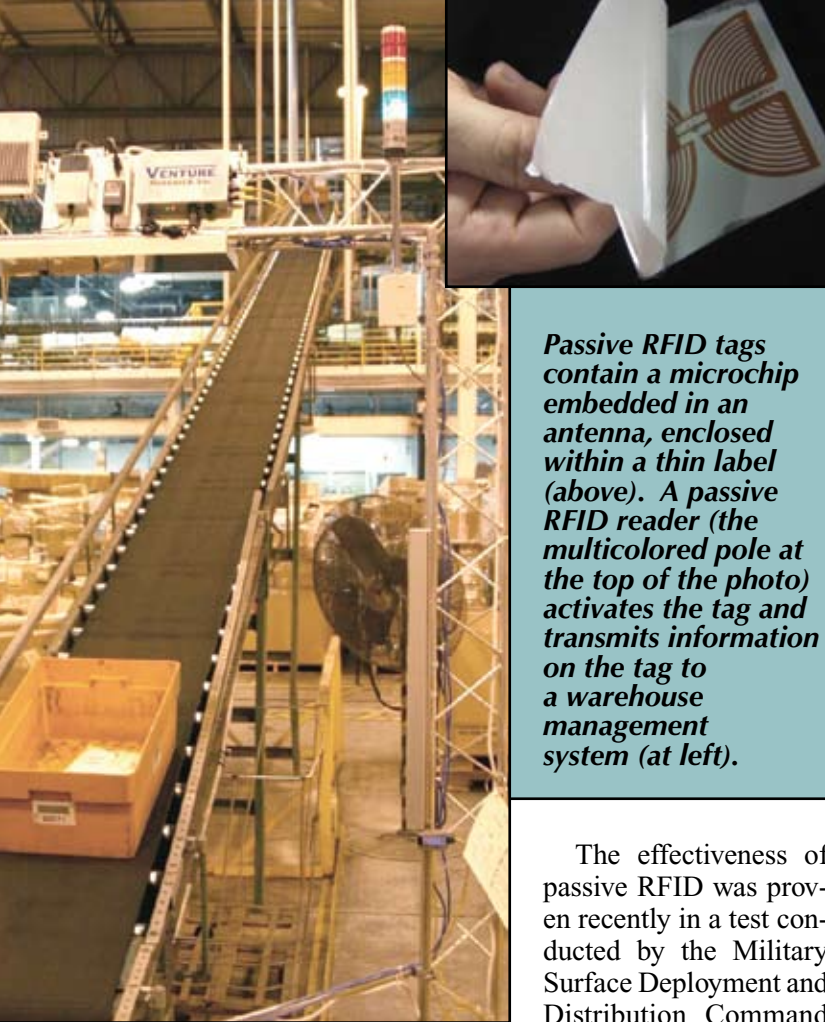
The Installation Management Command comprises four previously separate installation management organizations: components of the Office of the Assistant Chief of Staff for Installation Management, the Installation Management Agency, the Army Environmental Center, and the Army Community and Family Support Center. The Army Environmental Center and the Army Community and Family Support Center remain separate activities, but they are now subordinate to the new command. The commander of the Installation Management Command also will hold the position of Assistant Chief of Staff for Installation Management on the Army Staff.

The four former Installation Management Agency regions in the United States have been consolidated into two—one at Fort Sam Houston, Texas, and the other at Fort Eustis, Virginia. Most of the new command will relocate to Fort Sam Houston; Army staff functions will remain at the Pentagon.

DDC EXPANDS PASSIVE RFID CAPABILITIES

As part of the Department of Defense (DOD) distribution system transformation, the Defense Logistics Agency's Defense Distribution Center (DDC) has installed more than 300 passive radio frequency identification (RFID) portals among the 19 Defense distribution depots in the continental United States. The installed portals support both generation 1 and generation 2 passive RFID tags. This installation brings these depots into compliance with DOD policy, which requires that DOD distribution centers be equipped to receive passive RFID tags as suppliers begin tagging their products in accordance with DOD acquisition regulations. Passive RFID portals will be installed at depots outside the continental United States in 2007. The installation of passive RFID equipment throughout DDC is being conducted by ODIN Technologies of Dulles, Virginia, under a \$14.6-million contract awarded in May.

A passive RFID tag uses radio frequencies to transmit information up to 12 feet. An active RFID tag has a range of up to 300 feet. This difference in range is because the active tag operates off its own battery.



Passive RFID tags contain a microchip embedded in an antenna, enclosed within a thin label (above). A passive RFID reader (the multicolored pole at the top of the photo) activates the tag and transmits information on the tag to a warehouse management system (at left).

The effectiveness of passive RFID was proven recently in a test conducted by the Military Surface Deployment and Distribution Command (SDDC) at the Port of Norfolk, Virginia. Forty-eight containers were inventoried by hand using written notes. It took almost 12 minutes to inventory each container and another 10 minutes to enter the data into a spreadsheet; 2 mistakes were identified. During the handheld scanner test, it took less than 3 minutes to scan the RFID tags on each container, resulting in 100-percent successful reads at distances of 3, 6, 9, and 12 feet with containers at ground level. With containers stacked two high, tag reads were successful 100 percent of the time at distances of 3 and 6 feet.

DOD RFID SUMMIT SCHEDULED

The Assistant Deputy Under Secretary of Defense for Supply Chain Integration is sponsoring the fourth Department of Defense (DOD) RFID (radio frequency identification) Summit on 3 and 4 April at the Hilton Washington in Washington, D.C. The summit will provide information on the DOD RFID implementation plan, timeline, and lessons learned and will showcase RFID technology providers. Program and registration information is available on the Web at www.dodrfidsummit.com/index.html.

DLA SETS UP DEPLOYABLE DEPOT OPERATION FOR DISASTER RELIEF

The Defense Logistics Agency's (DLA's) Defense Distribution Center (DDC) has created a team that can deploy in response to natural disasters in the continental United States and set up a distribution operation in support of disaster relief. The team, known as the Defense Distribution Deployable Center (DDXX), has the distribution skills and equipment needed to receive, store, issue, ship, and maintain in-transit visibility of relief supplies.

According to Army Brigadier General Michael J. Lally, the DDC Commander, "DDXX allows the Department of Defense [DOD] to better serve the U.S. community during a natural disaster. DDXX can be deployed in response to requests from Federal or state agencies . . . [that] have been approved by DOD through the United States Northern Command."

When they are not deployed, the 66 DDXX personnel are based largely at Defense Distribution Depot Red River, Texas, and Defense Distribution Depot San Joaquin, California, with a few members located at DDC headquarters at New Cumberland, Pennsylvania.

RED RIVER ARMY DEPOT, FORT HOOD UNIT WIN 2006 DOD MAINTENANCE AWARDS

The Department of Defense (DOD) named two Army winners of the 2006 Secretary of Defense Maintenance Awards. The awards are presented annually to recognize outstanding achievements in military equipment and weapon systems maintenance at the depot and field levels.

Red River Army Depot, Texas, received DOD's highest award for depot-level maintenance—the 2006 Secretary of Defense Robert T. Mason Depot Maintenance Excellence Award—for its successful high-mobility, multipurpose wheeled vehicle (humvee) recapitalization program. Through that program, the depot streamlined the humvee overhaul and remanufacturing processes in support of Soldiers fighting in the Global War on Terrorism. (See related story on page 2.) The award is named in honor of Robert T. Mason, a former Assistant Deputy Secretary of Defense for Maintenance Policy, Programs, and Resources, who championed organic depot maintenance for more than 30 years.

The 297th Transportation Company at Fort Hood, Texas, won a field-level award in the medium unit category. Units from all services compete for the

During a mock deployment exercise at Defense Distribution Depot Red River, Texas, DDXX personnel erect a tent to house the operations center.



awards that are presented annually to two outstanding units in each of three categories (small, medium, and large). One overall winner from these categories will receive the Phoenix Trophy, DOD's highest award for field-level maintenance of weapon systems and equipment. All awards will be presented at the 2006 DOD Maintenance Symposium and Exhibition on 25 October in Reno, Nevada.

BUSINESS TRANSFORMATION PROCESS TRANSFORMED

The Secretary of the Army has terminated the Army Business Initiative Council after 5 years of operation. The council was established in June 2001 to find ways to improve Army business practices by soliciting ideas from the field. Its functions have been assumed by a Senior Review Group for Business Transformation, which is co-chaired by the Assistant Secretary of the Army for Financial Management and Comptroller and the Deputy Under Secretary of the Army for Business Transformation [DUSA (BT)]. The latter position was established last March.

Soldiers and Army civilians may continue to submit business transformation initiatives through their organization's Lean Six Sigma process. The Office of the DUSA (BT) has created a Web-based Business Transformation Knowledge Center that provides resources and a venue for communication to support business transformation in the field. The knowledge center can be accessed at www.army.mil/armybtkc/index.htm. Among its features is a Lean Six Sigma discussion forum, which can be accessed through the knowledge center's DUSA (BT) portal.

ARMY CIVILIAN CORPS ESTABLISHED

Recognizing the commitment of Army civilians to support the Army's missions around the world, Secretary of the Army Francis J. Harvey and Chief of Staff of the Army General Peter J. Schoomaker announced the establishment of the Army Civilian Corps in June.

The Civilian Corps' purpose is to unify the Army civilian service and embody the commitment of civilians who serve as an integral part of the Army team.

The corps was established as a result of a study conducted by the Army Training and Leadership Development Panel from August 2001 to February 2003. This panel also established the Civilian Advisory Board in November 2004.

The memorandum announcing the establishment of the corps and the Army Civilian Corps Creed, which was released at the same time, are available on the Internet at http://acpol.army.mil/employment/about_civcorp.htm.

MATERIEL MAINTENANCE POLICY REGULATION UPDATED

A "rapid action revision" of Army Regulation 750-1, Army Materiel Maintenance Policy, dated 27 June 2006, establishes the commander of the Army Materiel Command as the single authority for special repair authorizations. The revision also provides policy for cleaning equipment; clarifies policy for determining maintenance expenditure limit replacement prices and establishes a one-time waiver ceiling; and provides instructions for the Depot Maintenance Award Program. This revision adds these changes to a major revision of the Army materiel maintenance policy that was published in July 2005.

AMC ORGANIZATIONS WIN SHINGO PRIZE

Four Army Materiel Command (AMC) organizations received 2006 Shingo Prize for Excellence in Manufacturing Public Sector Awards for implementing Lean systems in support of the manufacturing, repair, overhaul, and maintenance of warfighter equipment.

The awards were presented in September at the 2d Annual Shingo Prize Public Sector Conference in Las Vegas, Nevada.

AMC award recipients were as follows—

- Gold: The Joint Manufacturing and Technology Center at Rock Island Arsenal, Illinois, for work on the forward repair system.

- Silver: Letterkenny Army Depot at Chambersburg, Pennsylvania, for work on the high-mobility, multipurpose wheeled vehicle.

- Silver: Red River Army Depot at Texarkana, Texas, for work on the high-mobility, multipurpose wheeled vehicle.

- Bronze: Tobyhanna Army Depot at Tobyhanna, Pennsylvania, for work on the AN/TPS-75 radar system.

Established in 1988, the Shingo Prize promotes awareness of Lean manufacturing concepts and recognizes excellence in manufacturing. The Shingo Public Sector Prize was established in 2005 to recognize government industrial organizations such as the Army arsenals and depots that won the 2006 awards. The Shingo Prize is named Shigeo Shingo, a Japanese industrial engineer who became one of the world's leading experts on improving manufacturing processes.

General Benjamin S. Griffin, AMC Commanding General said, "I am very proud of our folks in AMC whose extraordinary efforts are providing our warfighters with the highest quality equipment, ahead of schedule and at a reduced cost. The Shingo Award recognizes this extraordinary performance by our arsenal and depot workforce—for it is the workers on the shop floor who are using Lean and Six Sigma techniques to enable us to better meet the needs of our men and women serving on point for our nation around the world, fighting the global war on terror."

On-site examiners evaluated the winning organizations on cost saving, leadership, empowerment, vision and strategy, innovation and development, partnering practices with suppliers and customers, environmental practices, quality and results, and consistent improvement in each of those areas. The Shingo Prize is managed by Utah State University's College of Business. (See related article on page 12.)

SOLDIERS TEST BODY VENTILATION SYSTEM

Some Soldiers stationed in Southwest Asia may soon have a way to keep cool while wearing body armor. Body Ventilation Systems (BVSs), produced by Global Secure Corporation, will be tested for 1 year by 2,000 Soldiers who serve as drivers, military



A Soldier adjusts the fit of the Body Ventilation System vest under his body armor.

police, and gunners in Iraq and Kuwait. The Army Rapid Equipping Force delivered the first 500 of these BVSs in July and anticipated issuing another 1,700 shortly thereafter.

The BVS, which weighs less than 5 pounds, consists of a ventilation unit (blower) and air distribution garment (vest). The vest can be worn under body armor. The ventilation unit draws ambient air through a filter into the vest and blows it out under the arms and in the neck area of the wearer. About the size of a rolled-up poncho, the ventilation unit fits into a small fanny pack that can be attached to a Soldier's load-carrying equipment. The BVS operates for approximately 8 hours on a rechargeable lithium battery that requires 4 to 5 hours to recharge.

Because of the extreme heat in Iraq and Kuwait, Soldiers were opening their body armor in order to cool off, leaving themselves vulnerable to attack. The BVS was developed to help reduce heat-related injuries and casualties. Earlier versions of the BVS were tested at the Joint Readiness Training Center at Fort Polk, Louisiana, and in Iraq in 2005. The response to these system tests was positive.

DEFENSE LOGISTICS 2006 CONFERENCE SCHEDULED

The Annual North American Logistics Conference, Defense Logistics 2006, will be held 27 to 30 November at the JW Marriott Hotel in Washington, D.C. Scheduled speakers include General Norton A. Schwartz, Commander, U.S. Transportation Command; Lieutenant General C.V. Christianson, Director for Logistics, J-4; and Lieutenant General Ann E. Dunwoody, Army Deputy Chief of Staff, G-4. Detailed conference information and registration information are available on the Internet at www.defenselog.com.

Writing for *Army Logistician*

If you are interested in submitting an article to *Army Logistician*, here are a few suggestions that may be helpful. Before you begin writing, review a past issue of *Army Logistician*; it will be your best guide. Keep your writing simple and straightforward (try reading it back to yourself); attribute all quotes; avoid footnotes (*Army Logistician* is not an academic journal); and identify all acronyms and technical terms. *Army Logistician's* readership is broad; do not assume that those reading your article are necessarily Soldiers or that they have background knowledge of your subject.

Do not worry too much about length; just tell your story, and we will work with you if length is a problem. However, if your article is more than 4,000 words, you can expect some cutting.

Do not submit your article in a layout format. A simple Word document is best. Do not embed photos, charts, or other graphics in your text. Any graphics you think will work well in illustrating your article should be submitted as separate files. Make sure that all graphics can be opened for editing by the *Army Logistician* staff.

Photos are a great asset for most articles, so we strongly encourage them. Photos may be in color or black and white. Photos submitted electronically must have a resolution of at least 300 dpi (.jpg or .tif). Photo prints may be submitted by mail. Please try to minimize use of PowerPoint charts; they usually do not reproduce well, and we seldom have the space to make them as large as they should be.

Army Logistician publishes only original articles, so please do not “market” your article. Ask your public affairs office for official clearance for open publication before submission to *Army Logistician*. A clearance statement from the public affairs office should accompany your submission. Exceptions to this requirement include historical articles and those that reflect a personal opinion or contain a personal suggestion. If you have questions about this requirement, please contact us at alog@lee.army.mil or (804) 765-4761 or DSN 539-4761.

Submit your article by email to alog@lee.army.mil or by mail to EDITOR ARMY LOGISTICIAN/ALMC/2401 QUARTERS RD/FT LEE VA 23801-1705. If you send your article by mail, please include a copy on floppy disk or CD if possible. We look forward to hearing from you.

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Coming in Future Issues—

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- **Logistics Modernization Program**
- **What to Pack: A Guide to Predeployment Planning**
- **Energy on Demand**
- **Prediction and Cooperation**
- **Optimizing Logistics**
- **Significant Issue Tracking System**
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