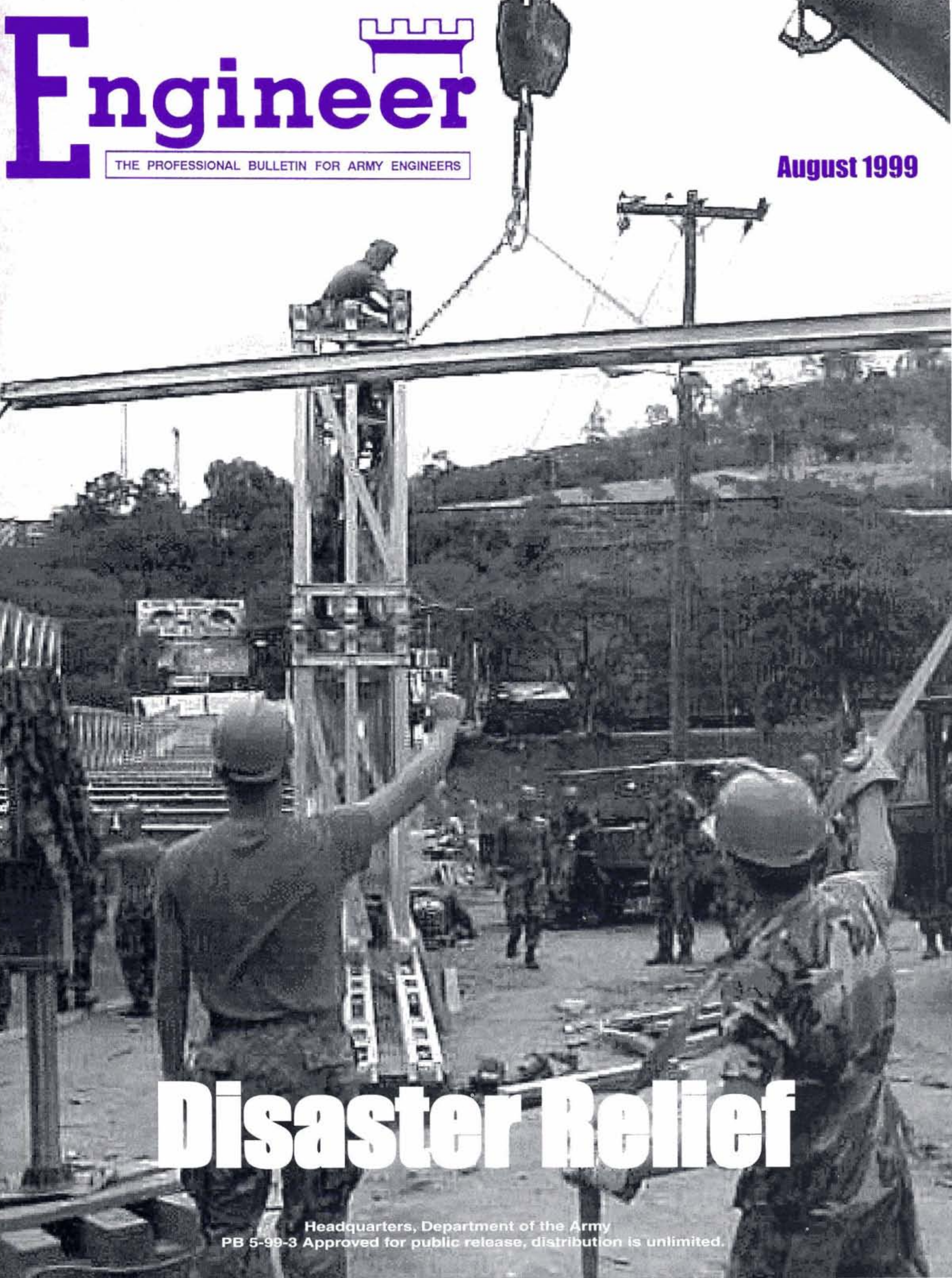
Engineer

THE PROFESSIONAL BULLETIN FOR ARMY ENGINEERS

August 1999



Disaster Relief

Headquarters, Department of the Army
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CLEAR THE WAY

By Major General Robert B. Flowers
Commandant, U.S. Army Engineer School

The ENFORCE Conference was a spectacular success this year. The tactical twilight tattoo presented by the 1st Engineer Brigade was the highlight of an event-filled week. On behalf of the entire Engineer Regiment, thank you for a job well done!

We are continuing to work on modernizing our engineer fleet of equipment and need the support of the entire regiment to ensure funding in the near term for the Grizzly, Wolverine, Digital Topographic Support System, Maneuver Control System-Engineer, and Engineer Bradley Fighting Vehicle.

The *Grizzly* provides the Army with a responsive, complex obstacle-reduction system to support our heavy divisions. This complex obstacle-breaching vehicle integrates advanced countermine and counterobstacle capabilities on the M1 tank chassis. The first unit equipped will be the 8th Engineer Battalion, 1st Cavalry Division, Fort Hood, Texas, in the 3rd quarter, FY04.

The *Wolverine Heavy Assault Bridge* gives modernized forces the capability to cross gaps up to 24 meters wide. It will keep pace with the maneuver force and replace the AVLB on a one-for-one basis, with four assigned to each mechanized engineer company. The Wolverine is the first system to have a fully embedded digital command and control capability. The first unit equipped will be the 528th Engineer Battalion, 4th Infantry Division, Fort Hood, Texas, in September 2000.

The *Digital Topographic Support System* provides the capability to achieve information dominance throughout the battlefield. It will provide commanders and their staffs with digital graphic overlays that support their information systems. Fielding for this system started in FY96 and will continue through FY01.

The *Maneuver Control System-Engineer* rapidly provides commanders and their staffs with more accurate decision aids and planning tools than is built into the current Maneuver Control System. Funding for this system will ensure that digitized engineer command and control systems support maneuver commanders.

Fielding of the *Engineer Bradley Fighting Vehicle* will allow mounted engineers to increase their survival from the start of breaching operations through final reduction of the obstacle. The increased lethality of the M2A2 over the M113A3 makes the Bradley a logical choice for the engineer squad vehicle (see article, page 18.)

We continue to modernize the infrastructure at Fort Leonard Wood. Most warehousing and industrial operations currently are located in 62 World War II wood buildings in a 60-acre area of the post. To replace those facilities, we have proposed that a business research park be constructed in the same area, which would encompass 250 acres. Fort Leonard Wood would provide a developer with a long-term lease of the land and access to the infrastructure to expand the current facility and construct the research park. Potential benefits to the Army include state-of-the-art warehousing and industrial operations facilities. These facilities would reduce manpower and operating costs, reduce infrastructure overhead costs through cost sharing with industry, and improve job opportunities for soldiers and their family members. We believe that economic development of this area will improve the overall quality of life for soldiers and their families stationed at Fort Leonard Wood.

I'm extremely proud of the Engineer Regiment's support to our nation. In addition to our forward deployed forces overseas, we currently have soldiers deployed to 80 countries around the world. Due to the diversity of our regimental mission, engineers are found at nearly every location. You can take great pride in knowing that these soldiers received their training at Fort Leonard Wood. Currently, numerous engineer units from Germany and Fort Leonard Wood are deploying to Albania and Macedonia in preparation for peacekeeping operations in Kosovo. I ask you to keep them in your prayers. Essayons!

Engineer

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Front Cover: *Soldiers help clean up Central America after Hurricane Mitch.*

Back Cover: *Historical example of the Army value "Integrity."*

FEATURES

DEPARTMENTS

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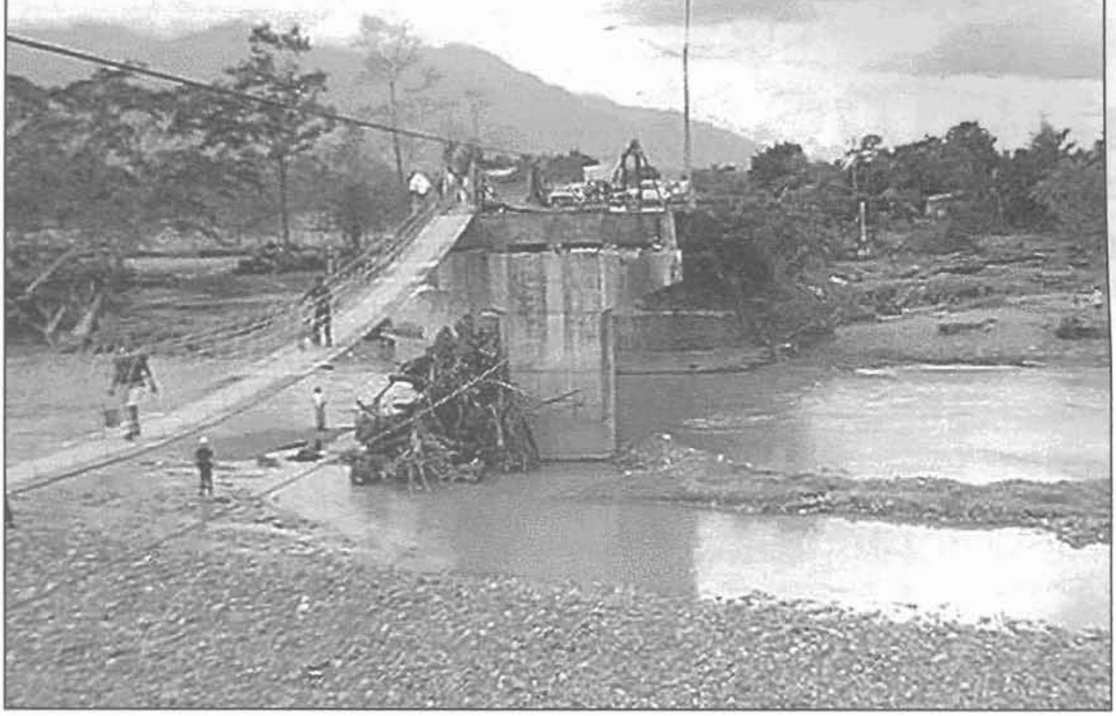


Joint Engineers in Disaster Relief: Hurricane Mitch Slams Central America

By Lieutenant Colonel Robert W. Nicholson

The damage and destruction that Hurricane Mitch wrought on Central America was of biblical proportions. The hurricane—called a 200-year-plus storm because it was the most devastating one to hit Central America in recorded history—was a category five event. Unlike most hurricanes, it did not render a swift, powerful blow to a contained area but spent a week meandering across the isthmus dumping huge amounts of rain. Very few infrastructures are engineered to withstand this type of event, much less those of underdeveloped countries in Central America. The grim figures below show the metrics of the disaster, but they cannot begin to describe the tragedy and trauma exacted.

This article is the story of the soldiers, sailors, airmen, and marines of Joint Task Force-Bravo (JTF-B), who participated in Operation Fuerte Apoyo (Strong Support). Together they survived the ravages of the hurricane firsthand and then exerted Herculean effort to save human lives and mitigate suffering. It is a story about a team, thrown together, that displayed the brotherhood of the Americas working together in a time of tragedy. Even though most of Central America was affected by the storm, the small country of Honduras—about the size of Tennessee and located in the center of the region—withstood the majority of the wrath of Hurricane Mitch. Therefore this article focuses on relief efforts in Honduras.

Hurricane Mitch Statistics	
Persons killed and/or missing	More than 10,000
Persons displaced	Nearly 3,000,000
Bridges destroyed	More than 300
Roads damaged	More than 1,000 kilometers
Estimated damage	$10 billion

Joint Task Force-Bravo

The Coronel Enrique Soto Cano Air Base, located approximately 75 kilometers north of the capital city of Tegucigalpa in the Department of Comayagua, is home to the Honduran Air Force Academy and JTF-B. Assigned to the U.S. Southern Command (USSOUTHCOM), JTF-B was organized in 1983 to assist in the national policy of deterring Nicaraguan aggression in Central America and to provide command and control over U.S. military units deployed to the joint

operations area. Over time, the organization and the mission have changed. Under the revised 1996 Operations Order Central Champs, JTF-B now conducts and supports the USSOUTHCOM commander's directed joint, combined, and interagency operations in the joint operations area to enhance regional cooperative security. Inclusive in this mission as the commander's strategic "gateway" to Central America (Belize, Guatemala, El Salvador, Nicaragua, Costa Rica, and Honduras) are these specific tasks:

- Maintain a C5-capable airfield.
- Conduct humanitarian assistance and disaster relief exercises (medical readiness training and engineering).
- Support Joint Chiefs of Staff joint/combined exercise training.
- Act as executive agent for humanitarian demining as well as counternarcotic operations.

When installations close and the United States' presence in Panama is removed (by 31 December 1999), JTF-B will be the only forward-deployed force in Central and South America. The organizational structure is the result of a downsizing operation to an eventual zero presence in Honduras, but it halted at 499 personnel in 1996. The resulting organization is "a mile wide and a foot deep."

The Hurricane

On 22 October 1998, the JTF-B commander alerted Situation Assessment Team-Alpha (SAT-A) to travel to the Pacific coast of Costa Rico to survey flood damage caused by heavy rains. Meanwhile, base weather personnel began watching Tropical Storm Mitch in the Caribbean off the northern coast of Honduras. National Weather Service predictions showed the storm increasing in strength and its path heading straight for Belize. Because the majority of Belize is at or near sea level, the JTF-B commander became concerned that a storm of this size would cause catastrophic damage. He put the team on hold and redirected its attention to Belize. The determination was made not to send the team's helicopters to Belize until after the storm had passed to avoid damage to the helicopters and the potential of the team becoming stranded.

As the hurricane began to develop and damage the northern coast of Honduras, the commander directed that a second situation assessment team (SAT–B) be formed to move north and perform surveys. The team left for the coast on 28 October. They made it as far as La Mesa International Airfield near San Pedro Sula, Honduras' second largest city, before the hurricane forced them to stop. The team was trapped in San Pedro Sula as the hurricane passed south of them and damaged roads, cutting them off from Soto Cano Air Base. Meanwhile the National Weather Service continued to predict the hurricane track into Belize. As the storm traveled across Honduras, it dumped as much as 84 inches of rain in five days.

Assessments continued throughout the first weeks after the storm, conducted mainly from UH-60 Black Hawk helicopters because floodwaters had not receded and roads were generally impassable. After the search-and-rescue effort trailed off, the JTF-B commander dedicated one helicopter daily to the engineers to conduct assessments and reconnaissance. This was critical to rapidly gain a picture of the overall situation; it greatly assisted in early determination for critical areas for engineer response.

Seabees from NMCB 7 finish a culvert/gabion crossing over the Rio Hombre at Rio Hondo.

Rehabilitation

After Soto Cano was out of danger and there was some idea of the extent of the damage to the country's infrastructure, the JTF-B's Directorate of Engineering began to coordinate with the Honduran government and SOUTHCOM for the U.S. forces' response. Tegucigalpa, located on the convergence of three major rivers, was hit particularly hard by the hurricane. Its downtown area was wiped out, and most government office buildings were flooded and lost all facilities, automation, and equipment. This situation, along with the death of the mayor in a helicopter crash, left the government in disarray. The JTF-B commander issued planning guidance and directed the JTF engineers to develop a methodology and concept to rehabilitate the country. The JTF-B commander's planning guidance for engineer operations was clear and simple: *Conduct initial rehabilitation of critical lines of communication and critical infrastructure nodes to conduct humanitarian assistance efforts and provide an initial assessment of critical municipal and national infrastructure.*

The concept of rehabilitation was to link the northern and southern ports with the capital along Centro Americano Carretera 5 (CA-5) to form the backbone of a relief supply route. Then branch roads linking the departmental capitals with the backbone route would be repaired. This plan was initially briefed to the commander of the Honduran Armed Forces and the Secretaria de Obras Publicas y Transporte (Secretary of Public Works and Transportation—or SECOPT). The plan was well received but not for the reasons on which it was predicated. The plan was based on connecting the national capitals with departmental capitals—or along political lines. It just so happened that this plan also supported the economic necessity and lines of communication for getting agricultural harvests (primarily coffee and fruit) to international markets. This event began a direct relationship between the SECOPT and the JTF-B engineers.

During the immediate aftermath of the hurricane, the Honduran government went through several reorganizations to maximize their limited resources and streamline command and control. SECOPT was reorganized and became the Secretaria de Obras Publicas, Transporte y Vivienda (Secretary of Public Works, Transportation, and Housing—or SOPTRAVI). JTF-B engineers coordinated through the Military Group–Honduras to meet with SOPTRAVI at its temporary office in a parking garage at the Tocontin Airport in Tegucigalpa. A complex process began to prioritize and assign projects based on the resources available and the capabilities of the various countries that volunteered to help. JTF-B engineers spent many hours negotiating with SOPTRAVI on where to employ U.S. engineers, the specific projects, and standards of construction.

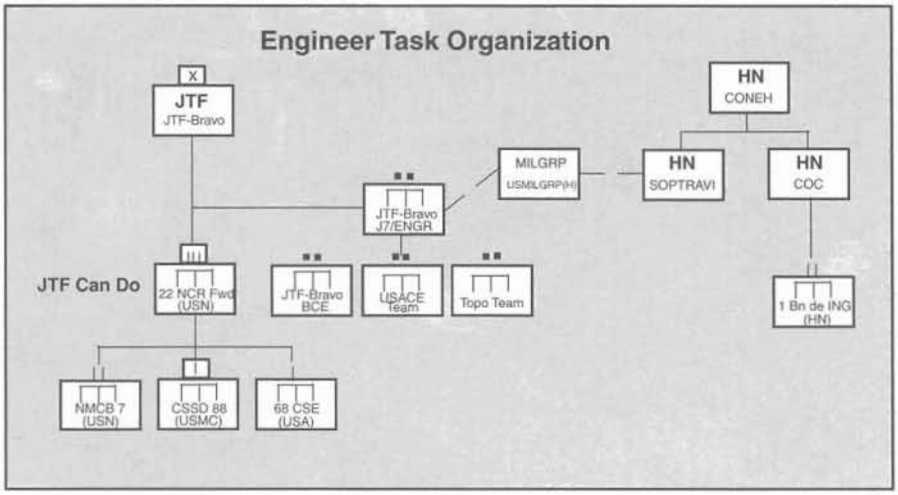
While coordinating with SOPTRAVI, SOUTHCOM was also preparing an engineer force package to support engineer operations in the four countries affected by the hurricane: Honduras, Nicaragua, Guatemala, and El Salvador. Based on the assessment already forwarded to SOUTHCOM from the joint operations area and the approved concept of operations, SOUTHCOM engineers devised a package that consisted of an engineer command and control headquarters, vertical and horizontal construction capabilities, and a bridging unit for each country. U.S. Atlantic Command was tasked to provide the units and further tasked the service components. The following units were selected to fill the requirements for Honduras:

- 22nd Naval Construction Regiment (FWD) as the overall engineer task force headquarters.

- Naval Mobile Construction Battalion 7 (NMCB 7) and the U.S. Army 68th Engineer Company (Combat Support Equipment [CSE)] as the vertical and horizontal construction capabilities.

- U.S. Marine Corps Combat Service Support Detachment 68 (CSSD 68) as the bridging asset.

The figure to the right shows the initial engineer task organization and line of coordination.



Engineer Projects

The final list of projects for JTF- B engineers includes four low-water crossings, five bridges, 135 kilometers of road work, and the repair of municipal utilities. The first priority was to link the coffee-producing regions west of Tegucigalpa to the capital and on to the ports. Two culvert crossing sites were constructed by NMCB 7 at Rio Hondo and Talanga. Not only was it important to reconnect this road for relief operations, it was also a major economic line of communication for the coffee harvest, which was ready for market. If the roads could not be opened, it would further compound the effects of the hurricane on the Honduran economy. Rio Hondo is where Honduran Route 15 (HN-15) crosses Rio del Hombre. This highway connects areas north, northwest, and west of the capital to the rest of the country. South of Talanga at a pueblo named San Juan de Flores, was a secondary route connecting Carratera 6 (CA-6) with HN-15 between Ojo de Agua and Talanga. This route helped relieve traffic off CA-6 while the bridge at Ojo de Agua was being shipped and installed. Constructed by NMCB 7, it consisted of a culvert crossing along the Rio Grande de Choluteca.

The third crossing was an ACROW bridge installed by CSSD 68 and the Honduran Primer Batallon de Ingenieria on CA-6 over the Rio Grande de Choluteca, which connected the coffee-growing region to the west of the capital. It was of major economic importance to get surviving crops to market.

The next priority was to reconnect the north coast highway from Puerto Castilla to Puerto Cortes. CA-13 runs along the northern coast of Honduras and connects an important fruit-growing region with the ports. Fruit exports are a major source of foreign income for Honduras. Three major cuts along this route were at Rio Bonito, Rio Perla, and Rio Congrejal. Unseasonable rains in December and January seriously hampered construction at these sites. In several instances, ongoing work was washed away by high, rapid currents. Rio Congrejal, which was constructed by NMCB 7, and Rio Perla, which was constructed by the 68th Engineer Company (CSE), were culvert crossings. Rio Bonito was a culvert causeway built by the 68th, but the CSSD 68 and Honduran engineers installed its 50-meter bridge.

Several important and difficult projects assigned throughout Honduras focused on commercial routes but were too difficult for the Honduran government to accomplish with its assets. The engineers of JTF-B assessed the projects and erected two bridges at Tegucigalpa and Ilama, repaired 35 kilometers of road in and around Morazan, and opened the port at Puerto Castilla.

In downtown Tegucigalpa, few bridges span the Rio Grande de Choluteca, which splits the city. The Molina Bridge was lost during the hurricane. A 50-meter, two-lane panel bridge originally was prescribed for the site, but it was not possible to locate four suitable points on which to rest a simple span bridge. Ultimately, CSSD 68 installed a 74-meter, two-lane, Class-40, triple-double ACROW bridge on footers specially designed to accept the weight of the bridge on existing structures.

The Ilama Bridge crosses the Rio Ulua and links the northern and southern parts of the country east of Lago de Yahoa. The only other route requires a five-hour detour. The available panel bridging could only span 74 meters in a single span, and the river current and limitations of the military engineers prohibited construction of an intermediate support. Therefore, the U.S. Army Corps of Engineers (USACE) located a suitable site upriver to construct a causeway and prepare a site for the bridge. A hydrologist and a civil engineer from USACE designed and supervised the 68th Engineer Company (CSE) in constructing the causeway and abutments and the CSSD 68 in constructing the bridge.

The road from Morazan to Yoro connects the Upper Valle de Aguan with the Valle de Sula (two important agricultural regions). Meandering up a narrow valley, a 7-kilometer section of the road was almost completely wiped out by raging currents. NMCB 7 and 68th Engineer Company (CSE) worked with local contractors at several sites along the road to make it passable to commercial traffic. These patches and crossings were very expedient and were not expected to last through the next rainy season. NMCB 7 also worked in and around Morazan on local mountain roads to clear mudslides and re-establish drainage. Despite their remote

Soldiers from the 68th CSE Company emplace a culvert at the village of Morazan.

location and the devastation of that region, the local people were always willing to help the Seabees and Army engineers in the area.

The main port facility for international shipment of fruit produced in the Valle de Aguan is Puerto Castilla. The port was heavily hit by high winds and sea surges. Two vessels were sunk on the docks: a Honduran Navy PT boat and a fishing trawler. These ships reduced the already limited dock capacity by half and made it necessary to load fruit shipments over the docks by hand. The reduced dock capability significantly decreased the throughput of commercial products and inhibited deployment of National Guard engineers en route to the area. U.S. Army divers from the 544th Engineer Team (Dive) of TF-10 (10th Transportation Battalion) worked for several weeks to salvage the vessels. They cut the PT boat into pieces and raised each piece separately with cranes. Using the same method, they raised the trawler in one piece, towed it to open water, and sank it. (See article on page 9.)

Lessons Learned

The lessons learned from this joint engineering operation were innumerable and many were not captured. Junior leaders—who faced and overcame difficulties in leadership, logistics, and engineering—learned most from this operation. Some of the major lessons learned at the joint level follow.

Engineer Command and Control

In an operation requiring significant engineer effort, the engineer command and control headquarters must be able to control all engineers in theater, design construction projects, perform construction management and quality assurance, and manage construction materials. The JTF-B Directorate of Engineering expected the 22nd Naval Construction Regiment (FWD) to be like a U.S. Army engineer construction group and command all engineers and their support elements and manage all construction in the joint operations area. Plans were made accordingly, and difficult projects were selected all through the Valle de Sula, western departments of Honduras, and the north coast. However, the 22nd only expected to build a 1,000-man base camp and perform repairs in and around Soto Cano. The unit selected the NMCB 7 headquarters as its "forward" command element and provided some augmentation. This arrangement overtaxed the 22nd's capability to command and control widely dispersed engineer missions. In particular, Seabees lack sufficient organic long-range communications to cover platoon-sized elements dispersed over a wide area. They are accustomed to receiving a mission then task organizing and cross attaching troops between companies to tailor a package for the mission.

Before deploying, the NMCB 7 and the air detachment commanders asked for specific missions and a definite engineer end state. JTF-B could not provide the 22nd with the information they needed because the situation was unclear at that time: assessments were incomplete, the Directorate of Engineering was still working with SOPTRAVI to define the U.S. role, and there were no designs for projects. Therefore the entire NMCB was deployed.

Because JTF-B expected to put the U.S. Marine Corps bridge company under the 22nd Naval Construction Regiment (FWD) for command, control, and support, they anticipated a unit of 80-90 marines. However, the SOUTHCOM operations order told units to plan to be self-sufficient when they arrived. Therefore the Marine Corps put together a package consisting of the bridge company; a reverse osmosis water-purification unit; and transportation, maintenance, communications, and other service support personnel. A total of 240 marines from the 2nd Landing Support Battalion at Camp Lejune became the Combat Service Support Detachment 68.

The Marine Corps' decision was fortuitous because the Seabees were recalled in mid-January and the CSSD 68 element was needed to command and control the remaining engineers—the Marine Corps Bridge Company and the 68th Engineer Company (CSE). Because it was a service support unit, CSSD 68 had no staff engineer section. The unit was augmented with an engineer major and captain from the JTF-B staff and a design team from USACE. The design team included a hydrologist, a structural engineer, a civil engineer, and a site manager.

Class IV Management

Engineers must be able to requisition, manage, transport, and handle their Class IV bills of materials, which are essential to joint engineer mission accomplishment. Without positive control, many missions would have failed, not been completed on time, or not started at all. During this deployment, engineers were in total control of ordering, acquisition, transportation, handling, and accounting for Class IV supplies. The Seabees' Class IV was shipped directly from their unit in Gulfport, Mississippi, to Soto Cano. All other Class IV was procured through purchase requests and contracts prepared by engineers. The Seabees and marines either used organic assets to line-haul the materials or contracted the line-haul from a local vendor. Either way the engineers had positive control over the bills of materials.

Naval Facilities (NAVFAC) and USACE Roles

These engineers played a critical role in providing assessments, designs, and project management and were key to the success of this operation. USACE responded early to requests for assessments but redeployed when the assessments were completed. Later, NAVFAC engineers, who augmented the 22nd Naval Construction Regiment (FWD), completed initial designs for expedient crossings and performed several assessments of public facilities. They delivered expeditionary designs based on minimal data. Their job was made difficult because little or no valid hydrologic data was available. When the NAVFAC engineers redeployed with the Seabees in mid-January, a design team was needed to assist in redesigning structures that had failed due to unseasonably heavy rains. A second USACE team that had the right skills was assigned and took ownership of the projects.

Working With the Host Nation

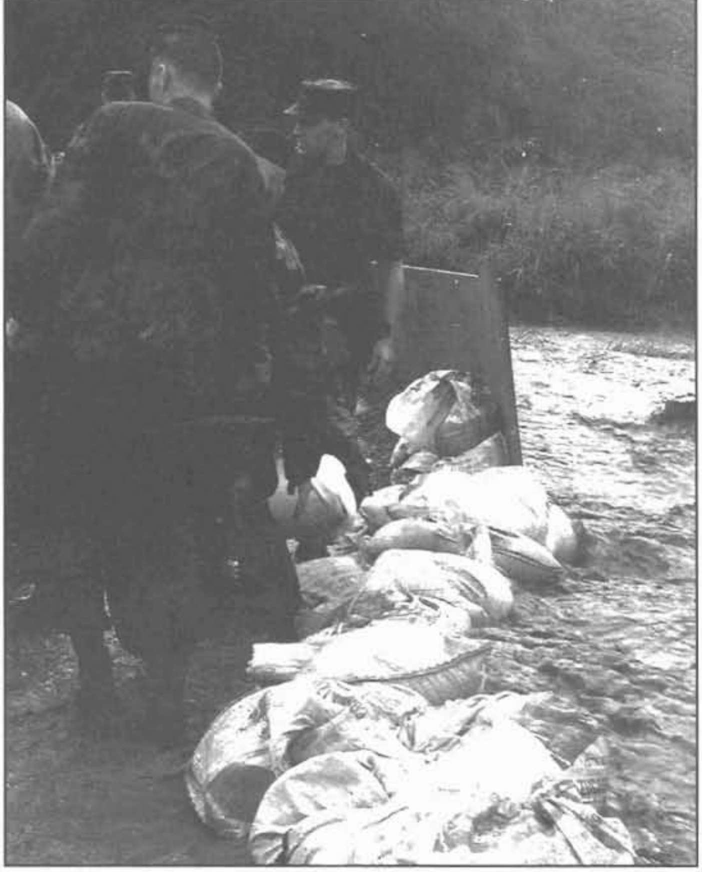
No two nations are the same. Even in Central America, *each country has its own customs, culture, history, and sensitivities.* To be successful with any of them, *country leaders must feel that they own the plan—because in reality they do.* The best JTF-B's Directorate of Engineering could do was articulate the capabilities of U.S. forces and recommend how they could best be used. There were many players in the relief effort: nongovernmental organizations, private volunteer organizations, and civilian and military personnel. *It is useful to know the big picture to determine where U.S. forces fit best. In disaster situations, especially where the government has been directly affected, it is important to be patient as they recover from the disaster. It is important to make clear what U.S. forces are willing and able to do and make sure they deliver. Always take minutes of meetings and record agreements, then translate them and provide the host nation government a copy. This confirms expectations and avoids misunderstandings.* In many cases, the Hondurans thought the U.S. temporary fixes would be permanent fixes. It was necessary to send written notification through the U.S. Embassy to the Honduran government to reiterate the expediency of the repairs and warn that they might not last through the rainy season.

The country's military groups and the civil-military operations office (JTF-B J5) played an invaluable role in coordinating engineer operations with the Honduran government, the local populace, and civilian contractors. All coordination with Honduras and other Central American countries was done through the military groups. They acted as an intermediary and helped convey the JTF-B story to the host nation and vice versa. They, along with the civil-military operations, coordinated with the Honduran military to provide security and engineers. Civil-military operations teams were assigned to every forward operating base and helped garner local support and labor for projects. The teams dealt directly with the local SOPTRAVI contractors on site to synchronize and support each project.

Panel Bridging

In this disaster, the Bailey bridge seemed to be a panacea for all bridging problems. The JTF-B engineer section was inundated with questions about this bridge from all sectors—government, civilian, military, foreign, and U.S. When word was put out that the Bailey bridge manual was available on the U.S. Army Engineer Center's home page, everyone became an instant Bailey bridge expert. There was a general misunderstanding of the capabilities and limitations of the bridge and exactly what it could do. Another misunderstanding was that commercially available panel bridges are of the same quality, the parts are interchangeable, and a single-single (single-width, single-story) bridge will fit any gap. In fact, each brand of bridging is different, and bridges must be specially designed for each gap. The Honduran government estimated that they had 700 meters of gap to bridge, so they ordered 700 meters of single-single panel bridging. However, river channel conditions made it impractical to build intermediate supports, so multistory, multiwidth bridges were designed. The original 700 meters of bridging was only enough to construct three bridges, and then only after ordering additional parts.

In the initial planning immediately after the hurricane, SOUTHCOM engineers researched the availability of Bailey bridging from war stocks. They found that most of the bridges were in poor condition and not ready for shipment. Thus, all the bridges emplaced by U.S. forces were commercially purchased panel bridges. Although their concept was similar to the Bailey bridge, marine engineers required a technical representative from the manufacturer to assist in the installation. In all instances, the panel bridges were placed adjacent to or as a detour away from the damaged bridge site. This allowed traffic to continue so the host



Soldiers and airmen construct a flood levee on Rio Conquigue.

nation could reconstruct permanent bridges. *The recommended solution is to keep a list of commercially available panel bridge points of contact, then custom order bridges to fit each site.*

Topographic Support

Early in the operation, the Directorate of Engineering determined a need for topographic surveys and terrain analyses. The topography of the country had altered due to significant land slides and river course changes. New topographic data was needed to determine the extent of the changes, to correct existing maps, and to determine watershed changes for hydrologic design.

When JTF-B was initially asked for their augmentation requirements, the Directorate of Engineering asked for a topographic survey detachment and a terrain analysis team. After several iterations of military occupational skills and grade changes, the commander of the 30th Engineer Battalion (Topographic) (Army) was consulted. Once he heard the requirements, he recommended and deployed a composite team of surveyors and terrain analysts. The surveyors surveyed bridge and crossing sites and river channels for JTF-B and assisted USACE and U.S. Geological Survey teams in surveying serious landslides. The surveyors also trained Hondurans to use newly acquired state-of-the-art topographic survey equipment.

The terrain analysts did not fare as well. An analysis of imagery before and after Hurricane Mitch could show areas of damage and changes in topography and watersheds. Even though U.S. Army Space Command offered to get the most recent post-Mitch data, baud rates and a disrupted postal system prevented getting the data to the terrain team. They did, however, produce several useful products for both JTF-B and the Honduran government. A landslide in the heart of the capital blocked the Rio de Choluteca and backed water into the city. The resulting topographic survey and terrain analysis allowed geotechnical experts to determine the extent of the slide, predict further slippage, and design remedial solutions. *The lesson learned is to keep data on the joint operations area as current as possible because the means to get new data may not be available or timely.*

Lastly, in dealing with civilians and other governmental agencies, the use of military grids is not widely accepted outside tactical units. However, when geolocating sites, using latitude and longitude was universally understood.

Real-World Training

This episode in Honduras was tragic to the people, the economy, and the country. But it provided an excellent training ground for all service engineers. No amount of training can prepare a unit, organization, or country for a disaster of the magnitude of Hurricane Mitch. Every unit that participated increased their training readiness. Young leaders were placed in remote locations and were required to act on their own with minimal guidance. Faced with issues of force protection, caring for their troops, and constantly dealing with local officials and contractors, they gained real-world experience rarely available at combat training centers. The engineering problems that the officers and NCOs encountered could not be taught in the classroom. Each problem required a unique solution, and in all cases decisions were made on the spot.

All parties involved made mistakes, but the service engineers demonstrated an incredible amount of ingenuity, flexibility, and teamwork. Jointness at the individual level was never an issue. Soldiers, sailors, airmen, and marines all saw the destruction of the countries and worked together to ensure that projects were completed.

Lieutenant Colonel Nicholson is the Director of Engineering, JTF-Bravo, Soto Cano Air Base, Honduras. Previous command assignments include: A/13th Engineer Battalion, 42nd Engineer Company, Berlin Brigade and Operations Wing, Australian School of Military Engineering. LTC Nicholson is a graduate of CGSC and is enrolled in the Army War College Distance Education.

U.S. ARMY DIVERS IN OPERATIONS OTHER THAN WAR

By Captain Daniel Coffey

The U.S. Army is performing more and more operations other than war (OOTW). These missions provide opportunities for the United States to help other countries in times of need and bolster its foreign policy at the same time. The U.S. Army Diving Company recently participated in Operation Fuerte Apoyo (Strong Support)—providing disaster relief in Central America after Hurricane Mitch. One mission during the deployment was to salvage two sunken vessels that blocked much of a pier that is vital to the Honduran economy. The mission is one example of how U.S. Army divers can help during OOTW. Some of the lessons we learned may be useful to units involved in other operations.

Diving Units

The U.S. Army "Deep Sea" diving community is comprised of six separately deployable detachments. The main body of five detachments is based at Fort Eustis, Virginia, and structured as the U.S. Army Diving Company "Provisional." The remaining detachment is in Hawaii. The U.S. Army divers' mission is to provide engineer diving support to major commands, task forces, government agencies, and sister services throughout the world. Their capabilities encompass everything from underwater construction/repair and salvage operations to inland waterway mobility and countermobility operations. More specifically, diving units conduct the following operations:

- Ship salvage
- Underwater obstacle reduction and removal
- Hydrographic surveys
- Channel and harbor inspections
- Pipeline placement and inspections
- Ship husbandry (maintenance and inspections)
- Water bottom sampling
- Lock and dam inspections and repair
- Bridge inspections and repair
- Port construction and rehabilitation
- Civilian contract quality control
- Personnel, vehicles, and equipment search, salvage, and recovery
- Near- and far-shore reconnaissance in support of river-crossing operations
- Emergency medical recompression treatment

Deployment

On 25 November 1998, the 7th Transportation Group was notified to organize Task Force 10 to participate in Hurricane Mitch relief operations. The task force included line haul units, cargo watercraft, and cargo transfer units. Its primary mission was to transport equipment, supplies, and personnel throughout Central America. The 544th Diving Detachment was also organized under Task Force 10 and was instructed to deploy with the assets needed to accomplish all possible diving missions.

The Mission

Task Force 10 deployed to Central America on 9 December. The first 45 days were spent performing ship husbandry and hydrographic surveys. About mid-January, we were given the mission to survey two sunken Honduran navy vessels in Puerto Castilla, Honduras, for possible salvage. One was a patrol (PT) boat, and the other was a fishing trawler seized during drug raids. These vessels, each more than 100 feet long, were blocking about half of the pier where much of the country's fruit shipments were loaded. After surveying the area, we estimated that we could accomplish the mission in about 21 days once we were on site.

A crane lifts the bow of the PT boat onto the pier at Puerto Castilla.

Logistically, a great deal of coordination was required. The first challenge was to find a suitable place to land our vessel to off-load equipment. We needed a ramp and would need U.S. Army engineer support from units already in country to help build it. However, moving heavy equipment through Honduras was virtually impossible because of bridge and road conditions.

We found an area that looked as if it had been used years ago as a landing ramp. Construction materials were scattered, but with proper equipment, we could reconstruct it. The port had heavy equipment on site that we could use, and the head of the Port Authority arranged for personnel to help us. We completed the ramp in one day. *This drove home the lesson to use resources that are on hand whenever possible.*

The main body of divers arrived on 24 January, and we began working the following day. We split the mission into two phases—one to recover the PT boat and the other to remove the fishing trawler.

The PT boat was too badly damaged to use again. However, the vessel represented one-fifth of the Honduran navy's fleet, so they needed to salvage the engines and weapons to use on other vessels. Our plan was to use two 40-foot cranes with cable slings to lift the boat until water and the ship's weight caused it to break into sections. Then we could lift the pieces out with the cranes.

During our first lift attempt, about 30-35 feet of the bow ripped off and was removed. We tried to make the vessel more accessible by pulling it closer to shore, but the vessel was too heavy. We had to cut the remainder of the boat into pieces by hand, which was a very time-intensive process.

Removing the PT boat took the crew almost 21 days, but the second crew worked concurrently to take out the fishing boat. The vessel was in 40 feet of water with a large hole in its port side. We planned to patch the hole underwater, then raise the boat to the surface with the cranes. It was a difficult and dangerous process. We rigged the vessel for lifting and tried to raise it, but it would not budge. Every option we tried was unsuccessful, so we ordered two 150-ton cranes from Fort Eustis. A week after these cranes arrived, we removed the vessel. After pumping water out (see photo on page 9), we towed the vessel to deeper water and sank it.

Never underestimate the time or resources it will take to complete a mission. Our original estimate of 21 days was based on a best-case scenario—that we could recover both vessels with the two 40-ton cranes in the area. But underestimating the equipment caused us to require about 49 days to complete the mission.

Over and over, we saw how important it is to use assets on hand. We used the host nation's military as well as U.S. assets in the area. The Honduran navy had a base a mile from the work site, and their divers were eager to help. Their knowledge of the vessels and expertise were extremely useful during the recovery effort. When crowds became a problem, they stationed an armed guard on-site.

U.S. National Guard units in the area provided bulldozer winch support during one phase of the operation. At times the U.S. National Guard, the Honduran military, and the 544th Diving Detachment worked together to remove the sunken vessels.

We learned from government and military representatives on site that our operation had the attention of the country's top naval general and the Honduran president. The mission also warranted an on-site visit by General Reimer, Chief of Staff of the U.S. Army. *Never underestimate the importance of your OOTW mission. Something routine in the United States may be monumental in underdeveloped countries.*

Operating in a foreign country presents unique challenges, and one of them is the language barrier. *In OOTW, it is imperative that you communicate well with the host nation. To do this, someone in the unit must speak the host nation's language fluently.*

A Valuable Asset

The U.S Army has one of the most unique and least-known assets in the military—deep-sea divers. Engineer diving units have capabilities that facilitate the successful completion of numerous missions, including OOTW. Operations other than war present tremendous opportunities to work with and help countries in need. Although these operations involve unique and challenging problems, the lessons learned and the impact the work has on the country make it an incredibly rewarding experience.

The Army needs more divers! If you are a specialist (E4) or below and are interested in an exciting career change, contact the Army Liaison Office at the Naval Diving and Salvage Training Center, Panama City, Florida. The telephone number is (850) 235-5261; the web site is *http://members.aol.com/alondstc/diverapp.htm.*

Captain Coffey is attending the Engineer Officer Advanced Course before reporting for duty in Hawaii. Previous assignments include the 544th Engineer Team (Dive), Fort Eustis, Virginia.

BRIDGE RECONSTRUCTION:
POLISH ENGINEERS PROVIDE ASSISTANCE AFTER 1,000-YEAR FLOOD

By Colonel Zenon Zamiar, Major Tomasz Ciszewski, and Lieutenant Colonel Zbigniew Kamyk

The following article by staff at the Tadeusz Kosciuszko Military Academy, Wroclaw, Poland, describes the unexpected 1,000-year flood that inundated southern Poland in July 1997. The authors detail the flood's ruthless destruction of thousands of kilometers (km) of roads and numerous bridges that existed in the watershed. Polish engineers reacted quickly and lent military assistance to the immobilized countryside. The authors describe the engineers' experiences during reconstruction of the area's bridge infrastructure and explain the technical and organizational challenges they faced as well as the solutions employed. Lessons learned concerning the capabilities of small engineer bridging units are emphasized.

The 1,000-Year Flood

Prolonged and abundant rainfalls in July 1997 caused freshets within the southern part of Poland. Two flood waves that overflowed riverbeds and damaged or destroyed many bridges and road sections were especially severe. Based on the range of this disaster, it has been named the "Millennium Flood."

Destruction of Roads and Bridges

From the beginning of the flood to the end of July, the following main and local roads and bridges were excluded from traffic:

- 480 bridges, including 219 main road bridges and 261 local road bridges.
- 791 road sections, including 232 main road sections and 559 local road sections, with a total length of 3,172 km.

The greatest damage occurred in mountainous regions where roads are adjacent to rivers and streams. Many small bridges were built over rivers that run along main, local, and private roads to connect the roads to households. This parallel system of roads and rivers was the basic cause of the enormous devastation and damage to roads and bridges. The great mass and speed of the flood waves caused most of the destruction. Design flow values previously provided as permissible for bridges within Kotlina Klodzka, a mountainous valley in southwest Poland, were exceeded many times. Additionally, debris carried by flowing water plugged bridge clearances and increased stream speeds (velocities). As a result, the destroying force of water was intensified and caused stream bottoms to erode, especially at bridge supports.

In order to evaluate the kinds and causes of damage to bridges, engineers first must analyze the mechanisms that caused the damage. During the first phase of flood-destructive operations on bridge objects, we noted undermining and settlement of the bridge supports, and many of them finally collapsed (Figure 1). When that happened, the bridge spans broke, fell, and were destroyed. Fallen bridges and their support elements then barricaded the water beds, leading to increased stream speeds and the creation of new main water streams. The next result was undermining of stream banks and bridge access embankments, which caused the crowns on roads located along rivers to be washed away. We noted that

Figure 1. Lifted spans after the bridge broke due to undermining of its pillar. Note the significant settlement (approximately 1 meter) of the pillar and its dislocation (Radochów town - Baila Ladecka River).

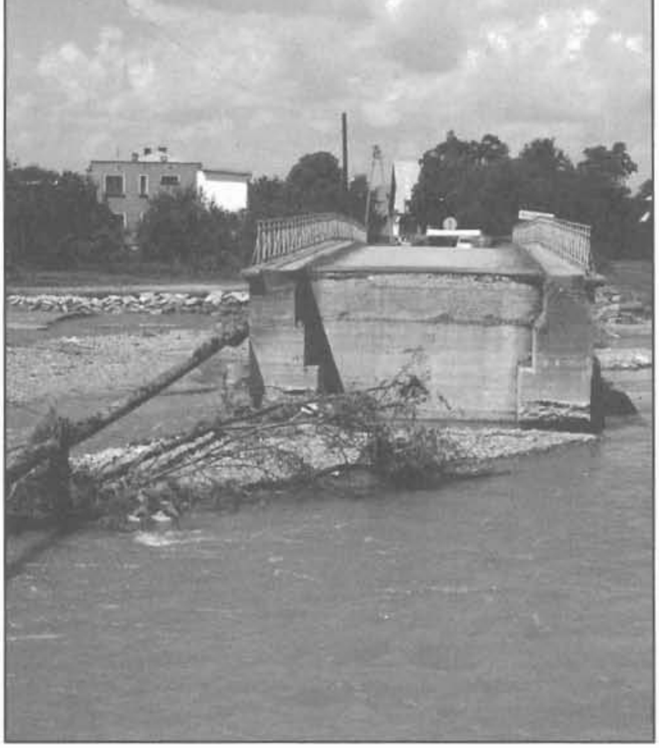


Figure 2. A washed out embankment behind a bridgehead. A 60-meter section of the access road was destroyed (Bystrzyca Dolna town - Bystrzyca River).

undermining of bridge supports caused the destruction of load-carrying members of all types of bridges except footbridges. Often, when bridge members withstood the water pressure, their access embankments were destroyed (Figure 2). At some locations new water beds were created (as at Radochów and Wilkanów). In many places, water mass created new, temporary riverbeds, which caused significant damage to areas along their routes. Bridge supports located in meanders of rivers and locations where bridges limited the natural stream width were especially exposed to undermining.

One example illustrating the elemental force of water is the 30-meter steel framework construction footbridge in Radochów. This footbridge was broken and moved a distance of 500 meters by floodwater. Water carried it over a broken bridge that lay in its way. *Destruction mechanism analyses show that proper protection of bridge supports against undermining is the most effective method of preventing damage. Bridge-support durability should be considered the main factor in designing and building bridges, because it determines the bridges' resistance to the destructive force of flood waves.*

Preparation for Eliminating Flood Consequences

For the temporary reconstruction of flood-damaged objects, the following units, specially trained for that purpose, were involved: military engineering units, military communication units, and civilian road- and bridge-building companies.

On 9 July 1997, as soon as falling water levels allowed, engineers started to identify and assess the damage and eliminate consequences of the flood. Due to persistently high water levels in rivers, impassable road sections, and the loss of communication with field units, it was difficult to assess the damage to roads and bridge structures.

During the first stage, immediately after the flood crest passed, the army assigned priority to the quick restoration of traffic along main transport routes. This was done by temporary reconstruction of the structures. By cooperating closely with civilian road services and municipal authorities, the army started to open passages in disrupted links. During the first stage, damaged bridges along main transport routes and national and local road sections were selected for repair.

Following the governor's request for assistance in repairing bridges and roads, a mobile team of military experts on transportation went to the zones affected by the disaster. Their task was to identify and evaluate the damage and indicate the technical and technological/organizational variants of their reconstruction. The goals of their reconnaissance were to determine the feasibility of using local materials, determine the military technical measures required, and assess field conditions (such as the condition of access roads and the possibility of deploying troops to the area of reconstruction).

The bridge reconstruction method chosen was largely determined by the following criteria:

- Degree of destruction.
- Significance and transportation requirements of the line the bridge was built on.
- Length of time the bridge will be in use.
- Available materials and structures.
- Capabilities of the engineering troops.
- Length of time assigned for reconstruction.

The basic requirements for bridges to be reconstructed included the following: limiting outline height (minimum 4.5 meters), roadway width (minimum 4.2 meters), and horizontal outline width where track spans were used (minimum 3.4 meters). Engineer experts adjusted the time of use of temporary bridges to match the characteristics of the road traffic, the obstacle type, and the anticipated time needed to replace temporary bridge structures with permanent structures.

The bridge reconstruction method selected was determined by the working requirements (people, materials, machinery, and engineering devices). Due to organizational conditions, engineers divided the entire work cycle into preparation and execution periods.

Preparation work included the following tasks:

- Engineer reconnaissance of bridge construction sites, places to prepare the materials and bridge structures, and supply paths.

- Removal of damaged spans and supports from the river bottom.
- Preparation and transport of structures and materials to the building site.
- Preparation of access roads and supply paths for materials and equipment.
- Preparation of building sites.
- Development of the work-mechanization measures and other devices needed to reconstruct the bridges.
- Preparation of design documentation.

The principal actions needed to execute temporary bridge reconstruction included the following tasks:

- Staking out the bridge axis.
- Constructing indirect and bank supports.
- Assembling the span structure and placing it on the supports.
- Constructing bridge entrances.
- Commissioning bridge use to local authorities and the road administration.

After determining the scope of the damage, engineers refined the concept of using military resources to eliminate flood consequences on the road network.

Bridge Reconstruction

To accelerate the pace of bridge reconstruction and quickly restore traffic continuity along main routes, engineers adapted the use of folding bridges (similar to Bailey bridges) and assault bridge structures for civilian traffic. The use of pontoon bridges was not possible in this mountainous area due to low water levels after the flood crests.

The DMS-65 folding road bridge, in the form of a free-supported beam, was the principal structure used to reconstruct destroyed bridge structures. Its theoretical span depended on land conditions. Essential components of the DMS-65 are spatial and flat elements of the main girder, transverse beams, the platform slab, and bolts to link particular segments of the structure.

Technical Characteristics of a DMS-65 Bridge

This bridge is meant for quick and multiple construction or reconstruction of destroyed high-water bridges. Using its components, it is possible to build single- or multiple-span bridges, with spans ranging from 3.0 to 45.0 m, and the change modulus 3.0 m in length. Due to the narrow width of water courses in Kotlina Klodzka, engineers reconstructed the bridges using single-span structures. A two-span continuous system was used only at Pilce (Figure 3).

The width of the roadway placed below or above is 4.2 meters, with a widening to 6.2 meters. The static system of the spans is assumed to be free-supported or continuous. The maximum span length under a load of 600 kilo-Newton (kN) (67.446 U.S. tons) is 39 meters for free-supported spans, 39 meters for outer continuous spans, and 45 meters for middle continuous spans. The maximum span length under a load of 800 kN (89.928 U.S. tons) is 33 meters for free-supported spans, 33 meters for outer continuous spans, and 39 meters for middle continuous spans. Bridge supports may be permanent (concrete), temporary, or floating.

Within three days, the army built a DMS-65 collapsible temporary bridge next to the destroyed bridge at Roztoki (Miedzylesie Commune, Figure 4, page 14). The road the bridge is built on is an important transport route from Warsaw to Prague and Vienna. Numerous local businesses and thousands of motorists use this road every day. Similar structures were built at Gajnik and Goworów.

The structure at Roztoki has the character of a temporary bridge but will function until a permanent bridge is built. A permanent bridge is planned at Roztoki as a gift for flood victims. Local societies will use the bridges at Gajnik and Goworów for the next few years. The bridge at Gajnik has steel pipe abutments and a retaining wall. This solution should make the supports resistant to future washout and make it prospectively possible for a future permanent bridge to be supported on them. *To make the roadway level with the bridge formation line for smooth passage, it was necessary to lower the bridge bearings below the surface level and apply an intermediate slab in the form of a 3-meter entry span.*

Figure 3. A bypass bridge made of DMS-65 structure elements with a continuous beam of 33 meters + 33 meters in length and access spans of 3 meters in length. The remaining parts of a destroyed bridge of 59 meters in length (Pilce town on the Nysa Klodzka River) are shown in the foreground.

Figure 4. Free-supported spans in a DMS-65 structure in the basic arrangement. It has a 21-meter span with 6-meter entry spans stretching Lc = 7 meters (Roztoki - Miedzylesie Commune on the Nysa Klodzka River).

Technical Operating Characteristics of BLG and SMT-1 Assault Bridges

BLG and SMT-1 bridge spans are track structures that are laid directly on an obstacle (see table below). They are principally used for single-span bridge construction. These bridges allow pedestrians and wheeled and tracked vehicles to pass the obstacle. The structures should be supported on strong subsoil and protected from washout or slide. The length of support on reinforced banks is at least 0.50 m.

To increase vehicle and pedestrian safety, engineers increased the limited width and free space left between the tracks and installed handrails. An unquestionable advantage of these adaptive solutions is that both assembly and disassembly can be performed quite quickly (Figures 5 and 6, page 15). These adaptations made it possible to perform the repair quickly and to restore the span's military functions.

Engineers used a BLG span discarded by the army to build a bridge at Kletno. They built up the intertrack space using steel plates that were welded to track edges and supported on steel crossbars that were welded to track structures. In addition, the engineers made channel-bar steel curbs and angle-bar handrails (Figure 5c, page 15). While the reduced width of the span (3.20 m) fails to meet the requirements for tracked bridges, the ability to build the bridge quickly was a decisive factor in using this method.

In other places, temporary reconstruction was performed or low-water bridges were built in cooperation with local authorities using local materials.

Conclusions

The following conclusions are based on experience gained during the 1997 flood:

- The order in which destroyed roads and bridges were to be reconstructed depended on how quickly the water level fell and how significant the bridges and roads were for transportation. The priority was for temporary (immediate) reconstruction using local materials and military resources.
- Where lasting damage was revealed but did not yet threaten bridge stability, officials allowed traffic to cross the structures under certain limitations until comprehensive reconstruction was performed.
- Where bridge structures had been totally destroyed by the flood and required comprehensive reconstruction, engineers recommended a detailed analysis and assessment of the disaster causes. Conclusions drawn from the analyses and assessments were used to help avoid repeating the same or similar mistakes when reconstructing or building bridges.
- Where bridges were destroyed, engineers made road detours for the shortest access to dwellings and business places. Engineers also constructed temporary bridges made of wood or used collapsible steel structures stored in so-called "transport reserves" of the State. These temporary measures should work until permanent bridges are built.
- Assault and folding bridges may have wide applications outside of the military community, especially when

Technical Operating Characteristics of BLG and SMT-1 Spans

Parameters	Armored Vehicle-Launched Bridge (BLG-67)	Wheeled Vehicle Assault Bridge (SMT-1)
Width of land obstacles to be passed	Up to 19 m	6 to 10 m
Number of directions	One-way traffic	One-way traffic
Load-bearing capacity	150 kN (16.86 t) for wheeled vehicles and 500 kN (56.21 t) for tracked vehicles	110 kN (12.36 t) for wheeled vehicles
Span length	20 m	10.5 m
Span width	3.25 m (BLG-67M2 - 3.43 m)	3.30 m
Number of tracks	2	2
Track width	1.15 m (BLG-67M2 - 1.24 m)	1.20 m
Distance between tracks	0.95 m	0.90 m
Span weight	60 kN (6.74 t) (BLG-67M2 - 70 kN or 7.87 t)	29 kN (3.26 t)

BLG-67M2=New model.
kN = kilo-Newton. 1 kip = 4.448 kN; 1 U.S. ton = 8.896 kN.

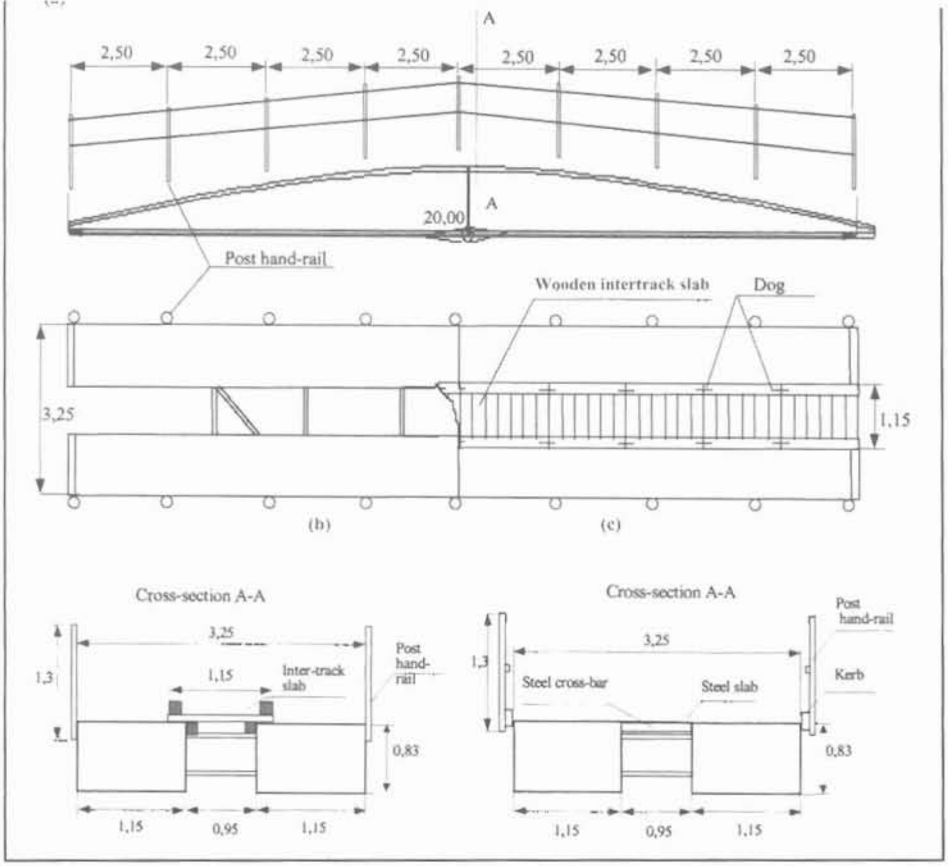


Figure 5. A scheme for building up a BLG span: (a) and (b) use wooden intertrack slabs, and (c) uses steel intertrack slabs.

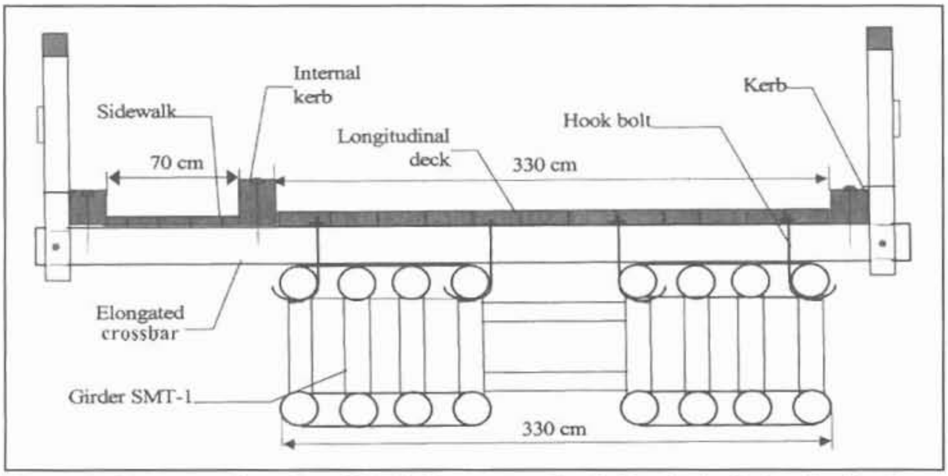


Figure 6. Cross section of an SMT bridge span. The bridge is built longitudinally with a wooden deck on crossbars.

repairing damage from disasters or accidents, and have enormous benefits to society.

Engineers generally should design new bridges with longer spans than those used in the past. They should properly protect riverbanks and bridge supports against washout (undermining). Additionally, civilian and military authorities should prepare detailed plans for their cooperation when working to prevent flood damage and when cleaning up after a flood or other disaster.

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Lieutenant Colonel Kamyk is head of the Bridges and Crossing Division of the Military Engineer Faculty, Thaddeus Kosciusko Military Academy, Wroclaw, Poland. He served as a planning officer for the Anti-Flood Combined Command during the 1997 flood.

Joint Engineers Build a Temporary Parking Apron

By Lieutenant Kevin J. Bartoe, USN

The ability to transform a field of thick vegetation into a solid helicopter parking apron is one thing that makes military engineers so valuable. Joint engineer forces make the impossible possible by completing engineering missions while under fire or in peacetime. With the continuing resource challenges we face, joint engineering operations are demonstrating their value by making the best use of all resources.

Naval Mobile Construction Battalion 4 (NMCB 4) was tasked with a deployment for training to construct a 290,000-square-foot expeditionary parking apron on the U.S. Army K-16 Airfield in Seoul, Korea. The apron would be built using AM-2 matting. Originally designed as a rapid runway repair tool, the 2-foot by 12-foot aluminum-magnesium panels have preformed grooves that lock together and form a staggered grid pattern. The ends are locked in place with a thin locking bar, which is also aluminum. The apron at K-16 Airfield would provide temporary parking for 16 UH-60 Black Hawk helicopters while the existing asphalt apron was replaced with a new concrete apron. Funding for the project was to be provided by the Republic of Korea Funded Construction program. The customer for the parking apron was 1/52 Aviation Battalion, 17th Aviation Brigade.

Photo by JO1 J.C. Musser

The 7.1-acre, 11,900-piece apron is put together like a gigantic puzzle by hand, crowbar and sledgehammer.

Planning

The construction tasking called for clearing and grubbing a 7.1-acre site adjacent to the existing 9,900-foot runway. The K-16 Airfield is controlled and operated by the Republic of Korea Air Force, which required thorough access control procedures and reporting on the project's progress. After clearing the site, a 6- to 8-inch lift of fill material from an adjacent in situ fill pile would be placed, compacted, and graded to finish elevation. Then, 11,900 sheets of AM-2 matting would be placed on the 204-foot by 1,360-foot area. Access to the existing airfield taxiway would be maintained by constructing a culvert system across a 10-foot-deep, 25-foot-wide drainage ditch. Additionally, an access road for fuel support vehicles would be constructed.

For the project's horizontal tasking, NMCB 4 assembled a 24-person detail of equipment operators, construction mechanics, an engineering aide, and others. Twenty marines from 9th Engineering Support Battalion, Okinawa, Japan, provided additional labor and AM-2 technical expertise.

Obtaining equipment for the project was an open issue as the Seabee advance party deployed on 22 October 1998. Funds to draw equipment from theater war reserve were still in the approval process. To get the project started, four pieces of equipment were moved from the Seabee camp in Pohang, Korea, to K-16 Airfield. The Seabee advance party worked with the limited equipment fleet for 30 days and accomplished 90 percent of the clearing and subbase rough grade.

Funding for the project was ultimately provided from the Eighth U.S. Army commanding general's "flex" funds. These funds enabled the unit to draw on Air Force war reserves of civil engineer support equipment at Suwon Air Base. Maintained by the U.S. Air Force 607th Material Maintenance Squadron Detachment 2, the fleet consists of more than 400 pieces of equipment ranging from flight-line support gear to troop movers.

Executing the Project

With the entire vehicle fleet on site by 20 November, it was time to move full speed ahead on the project. The mixed-service equipment suite included two bulldozers, two motor graders, three front-end loaders, two vibratory rollers, five dump trucks, one wheeled excavator, and troop support vehicles for the 44 personnel assigned to the task.

The clearing and grubbing operations concluded after removing 7,000 cubic yards of spoil and vegetation. The clay-rich subbase material was rough graded to a 1-percent slope and compacted. Then, 5,200 cubic yards—more than 800 truckloads—of select fill material were placed. Conveniently, the fill site was less than one-quarter mile from the project, which made haul times short. By 27 November, the rough grading was 90 percent complete and the fill placement was 30 percent complete. The marines arrived on 28-29 November and began placing AM-2 matting on 1 December.


Photo by JO1 J.C. Musser

A crew of NMCB 4 Seabees prepares to build a roadway to the airstrip over an existing gully.

Matting, Matting, and More Matting…

The placement system for AM-2 matting is designed to be simple and straightforward. However, each panel weighs 144 pounds and each pallet of 20 panels weighs almost 3,000 pounds. Placing the matting is highly labor intensive and requires a hardworking crew to successfully complete the task.

Marines from the 9th Engineering Support Battalion began with a goal of placing 10,000 square feet of matting each day. After two days on the job, they averaged 20,000 square feet of matting per day and peaked at 31,416 square feet during one 9-hour day. As Seabee equipment operators placed the fill material and completed related site work, they shifted crews to the matting task as well. The entire 285,600-square-foot main parking apron was completed by 16 December, just 14 working days after work began.

Clean Up and Wrap Up

The final work elements of the project were wrapped up by 21 December. This included constructing a culvert crossing for the 10-foot-deep drainage ditch; finishing the fuel access road, which included a soil stabilization operation; cleaning the matting; and final grading the fill site. Follow-on work for the Army Directorate of Public Works included painting parking and taxi lines and installing aircraft mooring points.

Seabee equipment operators and construction mechanics washed and inspected the equipment and returned it to Suwon Air Base. The total cost of repairing 15 pieces of construction equipment was less than $15,000, one-half of the original $30,000 estimate. Total equipment operating time was 1,200 hours and 1,500 miles worth of troop training.

Working Together

This project provided high-quality training for everyone involved. Navy Seabees received construction training similar to what they would receive in a contingency environment. Marine Corps engineers practiced AM-2 matting installation, which is one of their major requirements in support of marine air/ground task force operations. Air Force and Army personnel demonstrated outstanding support and contributed vital resources to the project. Under the leadership of U.S. Forces, Korea, engineers worked together in a joint environment and accomplished the task on schedule. From junior Seabees or marines up to the officer in charge and the staff at U.S. Forces, Korea, it was clear that each of the four services plays a vital role in the Korean theater. Engineers must be prepared to work together in peacetime taskings as well as in contingency operations.

Lieutenant Bartoe is the Deployment for Training Officer in Charge, U.S. Naval Mobile Construction Battalion 4, Port Hueneme, California. Previous assignments include Public Works Officer, Naval Hospital, and Assistant Officer in Charge of Construction, Marine Corps Base, Camp Lejeune, North Carolina. Lieutenant Bartoe holds a degree in civil engineering from Virginia Tech.

The Engineer Bradley Fighting Vehicle

By Chester A. Kojro

This is the third in a series of articles concerning a possible replacement for the M113A3 armored personnel carrier (APC) for mechanized combat engineers. The November 1998 issue of Engineer presented preliminary observations from the field. In March 1999, Engineer published a white paper stating why engineers need the Bradley Fighting Vehicle (BFV). This article describes the U.S. Army Engineer School's efforts to field the Engineer Bradley Fighting Vehicle (E-BFV) to replace the APC.

Engineers support the maneuver brigade commander's scheme of maneuver as part of the brigade combat team in the close fight. They also fight as infantry, and mechanized engineers fight as mechanized infantry. Engineers and infantry have always been linked: they have marched, ridden, and fought together with the same equipment. In World War II, both used armored halftracks; and during the Cold War, both used APCs. In the future, both will use the yet-to-be-defined Future Infantry Vehicle. It is only now that engineers are equipped with a distinctly less-capable vehicle than the infantry soldiers they accompany and support.

The Problem

The M113A3 APC is an excellent armored carrier and will remain a fully capable "battlefield taxi" throughout the foreseeable future. However, it does not belong in the forward edge of the combat team. The APC cannot defend itself on today's mechanized battlefield, much less on future battlefields to be faced by the Force XXI Conservative Heavy Division and Army After Next. Engineers cannot keep up with the tank and mechanized battalions they support. Engineers are readily identifiable on the battlefield and, because they lack a defensive capability, are often singled out for destruction by enemy forces.

Like tanks, mechanized Infantry Fighting Vehicles have modern, lethal cannons and missiles with full-solution fire control; stabilized thermal sights; and an armor-protected, shoot-on-the-move capability in all weather and visibility. They also have survivability enhancements that protect the crew after the hull is penetrated. Meanwhile, accompanying engineers in their APCs must expose themselves to fire to manhandle a single, flex-mounted .50-caliber machine gun. They have nothing but their eyes for fire control and cannot expect to penetrate and defeat enemy armored fighting vehicles even if they are lucky enough to score a few hits.

Engineers carry a lot of equipment and materiel—mines, explosive demolitions, barrier materials, and special tools—as well as specialized obstacle-breaching systems, such as mine-clearing line charges (MICLICs). The current "solution" is for engineer squad APCs to pull cargo trailers, which creates more problems. The added weight overtaxes engines and drive trains, and maintenance problems multiply. APCs are less agile with trailers attached because the trailers may jackknife and flip, especially when traveling cross-country. In addition, trailers block the APC's rear ramp, making it difficult to exit a damaged or burning vehicle.

The Solution

The solution to these problems is the Engineer Bradley Fighting Vehicle. Table 1, page 19, shows major milestones in the effort to field such a vehicle.

Table 1

Engineer Bradley Fighting Vehicle History	
Mid-1980s	Under the Armored Family of Vehicles (AFV) program, engineers pursued the Sapper Vehicle (SV), a variant of the yet-to-be-defined Infantry Future Fighting Vehicle. Under this program, all vehicles were to have a turreted cannon. The SV was to have a dozer blade, backhoe, hydraulic auger, and hydraulic power tools.
1988	Many of the tools and systems were incompatible and were trimmed from the SV. The turret was replaced with a commander's weapon station. The backhoe was removed because it would tie the vehicle to the work site rather than to an overwatching position. The AFV program was downsized, reorganized, renamed, and finally disappeared due to lack of funding, but the conceptual SV remained.
Late 1980s	The Canadian Special Engineer Vehicle (SEV)—an M113 with a dozer blade, hydraulic auger, and hydraulic tools—was considered. The blade had a flotation backing that allowed it to float and serve as a trim vane, so the vehicle could swim like a conventional APC. As with the SV, hydraulics to power the blade and auger reduced interior volume needed for the engineer squad's equipment, so interest in the SEV never developed.
1994	The Engineer School developed a mission need statement for an Engineer Squad Armored Carrier. The focus was on the need to maneuver (and survive) alongside Infantry Fighting Vehicles and tanks and the need for a large cargo capacity. Analyses pointed to a stretched APC or a turretless Bradley. In the stretched M113A3, the hull was cut and an extra 3-foot section inserted. The APC also had an extra (sixth) road wheel and an uprated engine. The turretless Bradley allowed extra space, but the turret ring's gaping hole had to be replaced with a new top deck with a commander's weapon station and crew/cargo hatches. Hull wiring that previously ran through the turret slip rings required rerouting, and new positions for radios and controls had to be developed.
December 1995	The stretched APC was the preferred solution of the two and was so briefed to the Army Vice Chief of Staff. But it was still a defenseless vehicle, even though the trailer was eliminated.
1997	MG Gill, Engineer School Commandant, directed that an operational concept be prepared for the Bradley Engineer Squad Vehicle, including an assessment of DTLOMS.
July 1997	The operational concept was submitted to TRADOC.
January 1998	The operational concept was endorsed by TRADOC, but implementation was deferred pending a more detailed assessment of resource impacts. According to the concept, BFVs would replace all engineer APCs in divisional battalions of active component (AC) divisions and Army National Guard (ARNG) enhanced brigades and in engineer companies of Armored Cavalry Regiments (ACR). Engineer corps mechanized battalions and ARNG divisional battalions were not included because they were to be reorganized under the Army's Force XXI effort. The total requirement was estimated to be 1,005 vehicles. Eliminating squad trailers would result in a need for additional cargo vehicles and drivers.
Summer 1998	No decision was made at HQDA, and attention shifted to the Army's Heavy Force Modernization Plan. Engineer School representatives to the working group for the plan raised the E-BFV issue, but a decision was deferred because the requirement was unfunded.
October 1998	MG Flowers, Engineer School commandant, directed that a white paper be written stating why engineers need the E-BFV (see *Engineer*, March 1999).
December 1998	TRADOC directed the Bradley proponent, the Infantry School, to prepare a recommendation on the feasibility of an E-BFV.
May 1999	TRADOC approved the infantry/engineer assessment and the E-BFV operational concept, which has changed considerably since the 1997 concept.

Advantages

Engineers mounted in E-BFVs would gain the following:

- Survivability through lethality (defensive fire from the tube-launched, optically-tracked, wire-guided missile [TOW] and 25-millimeter cannon).
- Improved situational awareness (armor-protected turret with enhanced optics and forward-looking infrared).
- A common signature (to prevent the enemy from specifically targeting engineers and to reduce fratricide)
- Improved cross-country mobility (for example, crossing gaps).
- Logistics and maintenance commonality with the brigade combat team.

Considerations

Some of the logic concerning which Bradley Fighting Vehicle model is needed follows:

The original M2A0 model is obsolete, and existing M2A0s are unsuitable. Practically everything on them has been upgraded or modernized, so there is little maintenance commonality with later models. Their age and mileage would make them a readiness nightmare.

No M2A1s remain, since they have all been upgraded to M2A2 or higher.

During Operation Desert Storm, needed improvements to the M2A2 were identified, which resulted in the M2A2 ODS (Operation Desert Storm). Improvements include an eye-safe laser range finder, a Global Positioning System/digital compass, missile countermeasures, enhanced driver's thermal viewer, internal restowage, and mounting provisions for Battlefield Command Identification System. The M2A2 ODS is the current frontline infantry vehicle. When upgraded with a "digital applique," it will be compatible with Force XXI digital requirements.

As AC infantry units receive the M2A2 ODS, their M2A2s are being cascaded to ARNG infantry battalions. Diverting these vehicles to AC engineer battalions would derail ARNG modernization, to which the Army is fully committed.

The M2A2 is suitable for today's engineer, but it needs upgrades to be compatible with the digitized applique required under Force XXI. This would create a sort of M2A2 "hybrid" that would be "almost an ODS" but not quite. It would cost about the same initially and less in the long run to select the M2A2 ODS configuration for engineers.

Under Conservative Heavy Division redesign, tank and infantry battalions are smaller by one line company each. Excess M2A2 and M2A2 ODS models are being turned in and will be rebuilt to the yet-to-be-fielded M2A3 configuration. The M2A3 will be fully digitized and will be interoperable with the M2A2 ODS (w/applique). Only a limited number of M2A3s will be fielded, and none are available for engineers. Retaining the division's excess M2A2 and M2A2 ODS models for engineer use is not acceptable since it would derail the M2A3 fielding schedule. (One engineer battalion equivalent—about 30 BFVs—had been retained at 4th Infantry Division at Fort Hood, Texas, but this was a temporary exception.)

Given all of these considerations and constraints, the agreed-upon plan is to use excess M2A0 BFVs and upgrade them to the M2A2 ODS configuration. Except for removing the internal TOW racks, the E-BFV will be identical to the infantry M2A2 ODS. Once the digital applique is fielded, the E-BFV will be operationally compatible with the digitized brigade combat team of Force XXI.

Table 2 shows the breakdown for the 668 Bradleys required for conversion under the Heavy Force Modernization Plan.

Table 2

Bradleys Required for E-BFV Conversion			
Type of Unit	Number of Units	Quantity Per Unit	Total Requirement
AC Divisional Engineer Battalions	18	29	522
AC Armored Cavalry Regiment Engineer Company	1	13	13
Pre-positioned Battalion Sets	3	29	87
National Training Center	1	20	20
Engineer School	1	22	22
Infantry School	1	4	4
Total			668

Table 3

DTLOMS Impacts of the Engineer Bradley Fighting Vehicle	
Doctrine	Field and training manuals will be revised to reflect added engineer capability. These include FM 5-10, *Combat Engineer Platoon*; FM 5-71-2, *Armored Task Force Engineer Combat Operations*; FM 5-71-3, *Brigade Engineer Combat Operations (Armored)*; FM 5-71-100, *Division Engineer Combat Operations*; MTP 5-335 series, *Engineer Topographic Units*; FM 71-1, *Tank and Mechanized Infantry Company Team*; FM 71-2, *The Tank and Mechanized Infantry Battalion Task Force*; and 71-3, *The Armored and Mechanized Infantry Brigade*. Tactics, techniques, and procedures (TTPs) also will be revised.
Training	The Engineer School will adjust training for 12B10 One-Station Unit Training, 12B30 Basic Noncommissioned Officer Course, Career Management Field 12 Advanced Noncommissioned Officer Course, Engineer Officer Basic Course, and Engineer Officer Advanced Course. Engineer NETT will be raised and resourced.
Leader Development	Engineer master gunners and engineer Bradley Leader Course graduates will be assigned an additional skill identifier and tracked accordingly.
Organization	M113A3 APCs will be replaced one-for-one. There will be no change to engineer platoon, company, and battalion structure, and no personnel or vehicles will be added to the engineer battalion. Forward support maintenance will need six additional mechanics per engineer battalion (18 mechanics per division with three engineer battalions).
Materiel	The E-BFV is essentially identical to the Infantry's M2A2 ODS Bradley, with only minor changes to the internal stowage configuration.
Soldier	Engineer units will be more capable. They will be more survivable through improved lethality, situational awareness, and armored protection.

Impacts

Due to other changes associated with Conservative Heavy Division redesign (independent of the E-BFV issue), acquiring the E-BFV will not significantly impact equipment and personnel at the battalion level. All positions will be satisfied through redistribution of available personnel, and no added vehicles are needed. At the division level, there is an increase of six mechanics per engineer battalion or 18 per division. So the six AC divisions require an additional 108 mechanics.

Training will be impacted based on the increase in firepower (25-millimeter cannon and TOW) and sophistication of the fighting vehicle overall. New equipment training teams (NETT) will provide initial training. Engineers will conduct semiannual gunnery using common tables I through VIII and engineer-specific tables XI and XII. Engineers will also conduct one combined arms live-fire exercise and two field training exercises annually. All training for the TOW will be conducted using simulators and training devices rather than live missiles. Each engineer battalion will have one set of training aids, devices, simulators, and simulations, which consists of Conduct-of-Fire Trainer, Precision Gunnery System, and Through-Sight Video.

Engineer master gunners will be trained at the U.S. Army Infantry Center's Bradley Master Gunner Course. Engineer leaders initially will be trained at the Infantry Center's Bradley Leader Course until an engineer-specific course is taught at the Maneuver Support Center at Fort Leonard Wood, Missouri. Course scheduling will depend on the E-BFV fielding schedule. During initial low-rate fielding (less than 60 per year), training will continue at Fort Benning, Georgia. Engineer-specific training will begin at Fort Leonard Wood as fielding expands to two or more battalions (60 vehicles) per year.

Table 3 shows how transitioning to the E-BFV will impact DTLOMS.

The Result

While specific milestones have not been determined at this time, Engineer School personnel are hopeful that E-BFV fielding may begin as soon as 2004. With this vehicle, engineers will shoot, move, and communicate as fully capable members of the brigade combat team of the Force XXI Conservative Heavy Division design. They will be in line with the infantry for further transitions to follow-on combat systems such as the Future Infantry Vehicle and Future Combat Vehicle of the next two decades. With comparable equipment, engineers will finally return to their position alongside the infantry as they enter the close fight at the tip of the brigade combat team.

Mr. Kojro is a materiel engineering development analyst at the Engineer School and a lieutenant colonel in the Army Reserve. He holds a degree from the University of Illinois, Chicago, and is a CGSC graduate.

SapperNET: Creating an Engineer-Relevant Common Picture

By Captain Timothy T. Sellers and Major Dionysios Anninos

The Chief of Staff of the Army's *Vision 2010* instructs us to "leverage technology" and "foster innovation and experimentation." That's exactly what the 3rd Infantry Division engineers accomplished with the creation of SapperNET, a fully automated, web-based tactical reporting system. Using Warfighter preparatory exercises as a test bed, we experimented with databases and Hypertext Markup Language (HTML) interfaces to establish a system that was a combat multiplier during 3rd Infantry Division's Warfighter exercise.

The more comprehensive and complex solutions offered by Force XXI take time to fully test, and there is no way to predict when these solutions will be implemented at the division level. By leveraging existing technology, the Engineer Brigade developed an interim solution for its information needs today. SapperNET uses existing hardware, an open architecture, and commercial off-the-shelf software to provide timely, accurate data for creating the engineer-relevant common picture (ERCP).

SapperNET Evolution

We began with the central idea of creating the ERCP. An elusive problem, it not only involved creating the information product but also distributing it across the battlefield. Early ideas focused more on the product and less on its dissemination. The idea of a terrain summary that looked much like the intelligence summary (INTSUM) went a long way toward providing a common picture, but it lacked the level of detail required to ensure relevance to the end user. Further, the terrain summary would be created without dynamic input from the individuals most knowledgeable of the terrain. At best, it would provide a text-based summary with a simple cartoon to illustrate broad mobility concepts.

Maneuver Control System/Phoenix (MCS/P) offered another method of establishing a common picture. A UNIX-based program running on high-end Sun workstations, it could assimilate information from other MCS/P terminals and autoplot that information on a digitized map. Its downfall, however, was the requirement for high-cost hardware and proprietary software that could only communicate with other MCS/P systems. Further, it required extensive contractor support and was highly inflexible. In the end, these issues proved to be insurmountable in creating a system that would work today.

We had an idea for using a central database to synthesize information and ease distribution so that information could be shared in real time. An HTML interface would allow dynamic input from end users, while giving nonengineer customers the ability to tailor information to their individual needs. Using commercial off-the-shelf software and existing automation assets, we created a fully automated information solution for division engineers. This solution provided the detail, relevance, and flexibility lacking in previous systems. In short, by using a common laptop with open-architecture software, SapperNET provided an interim information solution for Force XXI objectives.

Lessons Learned

Early versions of SapperNET were primitive. They amounted to ad hoc use of the tactical local area network (TACLAN) to help disseminate engineer information reports from the engineer tactical command post (ETAC). Far from being interactive, information was reported to ETAC through FM or mobile subscriber equipment (MSE) voice, typed into report data tables using Microsoft Excel, and then saved in HTML format. The HTML files were transferred to a web server located at the engineer main command post (EMAIN). Battle staff personnel at each command post could then use the "refresh" feature of their web browser to see the most recent information. The process was extremely labor intensive for the web master, who also served as the battle captain in the ETAC.

Despite its initial drawbacks, we could see the inherent potential in using web technology to share our engineer information. The dividends SapperNET provided in the form of reduced FM voice traffic and timely, accurate information proved the validity of our concept. All engineer elements, to include the 10th, 11th, and 317th Engineer Battalions and the Engineer Brigade distributed command posts—ETAC, EMAIN, and engineer rear command post (EREAR)—enjoyed the same ERCP. In addition, the 36th Engineer Group, a Corps asset, could share in the benefits of SapperNET's products.

We recognized, however, that SapperNET must evolve to overcome its drawbacks. Our goal was to develop a reporting and information distribution system that would:

- Support quick and easy reporting.
- Support one-time submission of information.
- Permit easy updating of reports without resubmission.
- Reduce FM and MSE voice transmissions.
- Provide instantaneous ERCP data to all engineer command posts.
- Provide an easy planning tool for nonengineer customers to facilitate battlespace mobility.

It was evident that we needed a self-sufficient, dynamic web page to achieve these objectives.

Incremental Software Development

We began by defining how and what relevant information should be shared across the division. In a conscious effort to not recreate our standard report formats, we based the database structure on existing field standard operating procedure reports. If we stuck to this format, we could make the existing system more efficient without adding more reporting requirements for subordinate units. In short, this would put us in a favorable "fallback" position should we have to revert to the old way of doing business.

The next challenge was to design the interface. Users needed the capability to view and edit information. More specifically, we wanted to provide the capability to tailor information to individual unit's needs. Using the Internet, we found a shareware program called *BaseRunner.* A common gateway interface application, BaseRunner allows users to input data through HTML forms using drop-down menus. It automatically places a date/time stamp on input and allows formatting of output into data tables.

BaseRunner, however, only reads from "flat" database tables. In other words, it limits the user's ability to query SapperNET's database and thus tailor this information. It also forced us to store the same information in multiple data tables. We tested this version of SapperNET during Command Post Exercise (CPX) 99-02 in December 1998. It resulted in an even greater decrease in FM and MSE voice traffic. SapperNET received more than 200 obstacle reports and more than 50 breach lane reports throughout the four-day exercise. ERCP was now shared instantaneously across the battlefield. The division embraced our efforts, and the potential for a web-based information system was evident.

The next step was to provide users the capability to query SapperNET's database. Again, we searched the Internet and found a program called *ODBIC*, which draws its data directly from any open database, such as Microsoft Access, Microsoft Excel, or Oracle. It also supports the use of Structured Query Language. This capability allows users to control what information is extracted from the database and allowed us to efficiently store information in the SapperNET database.

This version of SapperNET, using both ODBIC and BaseRunner, was tested during CPX 99-03 in January 1999. By then, radio-telephone operators were spending more time on the computer than on the radio. All engineer operational and logistical reports were sent on SapperNET. Commanders were free to use the FM without first clearing the net.

The final version of SapperNET—running completely on ODBIC—was tested during the 3rd Infantry Division Warfighter Exercise in February 1999 with amazing results. During the five-day exercise, 488 obstacles, more than 50 breach lanes, and 136 main supply route waypoints were reported (Figure 1). More than 170 users accessed SapperNET with more than 25,000 hits on the web page (Figure 2). In one instance, SapperNET provided maneuver commanders with timely information that directly contributed to executing 15 Air Volcano situational obstacles and a division-level counterattack into the enemies' flanks. This effort resulted in the

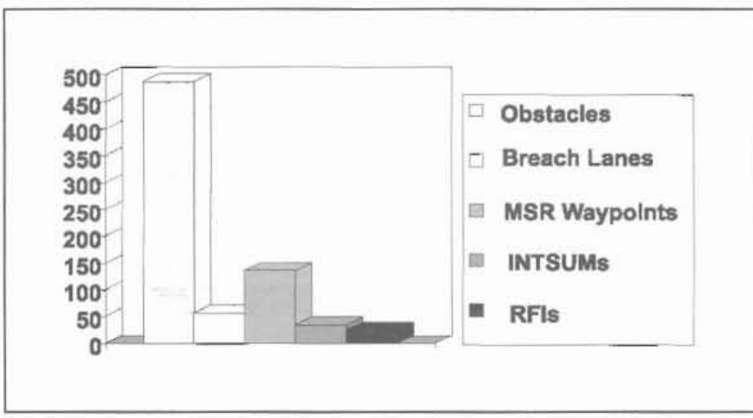

Figure 1. Number and Kinds of Reports

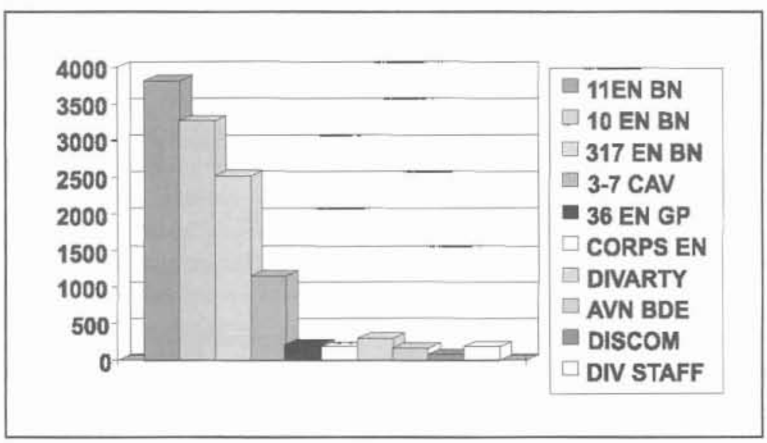

Figure 2. Web Page Hits

division destroying three regiments while preventing any penetration into the division's rear area.

Throughout the exercise, SapperNET achieved an instantaneous, accurate ERCP, while greatly reducing traffic on FM and MSE command nets. SapperNET provided an obstacle search tool for our nonengineer customers. Using this tool, a planner can specify an area and SapperNET will report all obstacles and obstacle breaches in the area. This valuable tool eliminated the need for nonengineer command posts to track all obstacles in the division area. The result was significantly fewer incidents of fratricide and elimination of the need for engineer officer liaisons at these headquarters. In short, the entire engineer community and the division possessed the ERCP. Possession was not limited by who did or did not have Advanced Warfighting Experiment Appliqué.

SapperNET Features

SapperNET's web interface uses forms and tables to gather user inputs and format the output. Output tables show obstacle data, breach lanes, main supply routes, combat power, unit locations, countermobility, and survivability status. In addition to tabular data, it also provides a request-for-information (RFI) board, a terrain analysis page, and an engineer intelligence summary page.

PowerPoint slides in HTML format are used to brief division leaders on the status of engineer forces, and all operations orders, warning orders, and fragmentary orders are posted in HTML format (see Figure 3).

One of SapperNET's most often used features is the obstacle locator. Nonengineer units found this particularly useful in planning their movements in the battlespace. The locator allows users to define an area of the battlefield within which to search for obstacles and breach lanes. Entering coordinates for the northeast and southwest corners of a figurative box returns the desired results and provides a useful planning tool (see Figure 4, page 25). This process takes responsibility of data selection out of the hands of the data provider and into the hands of the data user.

Advantages

SapperNET's biggest advantage is near real-time information. During CPX 99-01, ETAC tracked the battle within two hours of "ground truth"; EMAIN was within four hours; and EREAR was about six hours behind. By CPX 99-03, SapperNET brought all command posts within one hour of ground truth. Used extensively by maneuver and combat service support units, SapperNET contributed immensely to situational awareness, resulting in almost no losses to known obstacles.

Another advantage of SapperNET is its ease of use. Anyone who has ever surfed the worldwide web can access and navigate SapperNET. Operator training for radio-telephone operators and battle captains took just 90 minutes.

SapperNET costs almost nothing and is extremely portable. It uses available hardware (some units access SapperNET using a 486 laptop with 8 megabytes of RAM) and maximizes the use of freeware/shareware so that the only expense is the license for ODBIC ($39 for a single license or $79 for unlimited licenses). A Dell Inspiron laptop with a Pentium II, 233 MHz processor, 64 megabytes of RAM, and a 3.5-gigabyte hard drive served as the web server. Finally, SapperNET is optimized for low bandwidth with no graphics; the entire application is less than 3 megabytes in size.

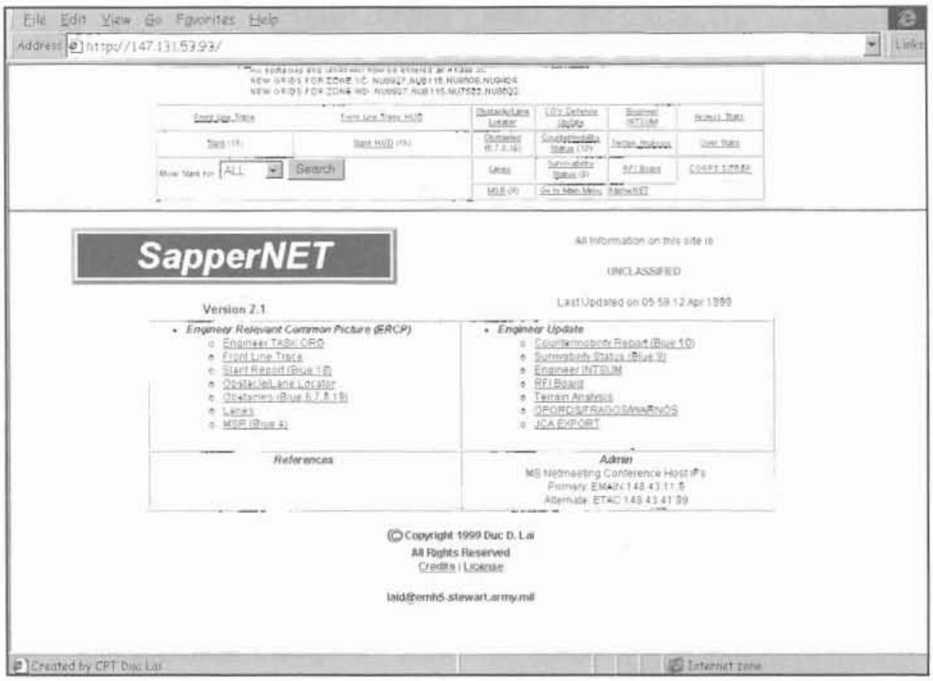

Figure 3. SapperNET Home Page

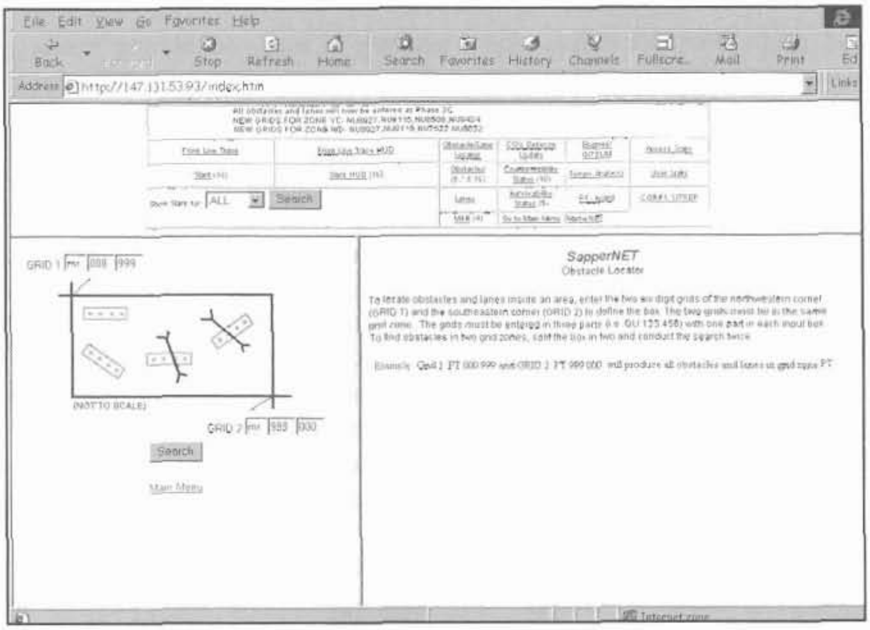

Figure 4. Obstacle Locator Box

Still another advantage of SapperNET is its open architecture, which allows us to quickly develop and implement new capabilities after each after-action report. The obstacle search tool was just such a development. Changes like this and many others allow the information management system to adapt to the needs of the organization.

Finally, SapperNET exists on the TACLAN with the same classification as the MSE network—Secret High. Physically separated from the rest of the world, its security is as reliable as the MSE network.

Challenges

The main challenge of SapperNET is its dependence on MSE. The data channels are carried over the same airwaves as the voice channels for digital nonsecure voice terminals and MSRTs. Therefore, if the MSE network goes down so does TACLAN and SapperNET. One way we avoided prolonged downtime was by distributing the network. Duplicating the web server at both the EMAIN and ETAC allowed a redundant capability. These systematic backups of the database, transferred through the network to the alternate server, provided an alternative in the event of communication outages.

Another challenge of using MSE is low bandwidth. Using the Tactical Packet-Switching Network with a maximum throughput of 9.6 kilobytes per second results in slow-loading web pages. However, even with slow-loading web pages, sending a combat engineer slant report over SapperNET is faster than sending it over FM or digital nonsecure voice terminal. With the advent of the Signal Corps' high-speed multiplexing network at 256 kbps, SapperNET's performance improved tremendously.

SapperNET currently does not have the ability to provide graphical representations of the battlefield. For example, it cannot autoplot obstacles and breach lanes on a digitized map of the terrain. However, this capability is not far off. We are currently working a joint effort with the Engineer School to import SapperNET data into TerraBase II to autoplot the ERCP onto a digital map. Additionally, SapperNET will become the data source for XVIII Airborne Corps' Joint Countermine Application—a Global Command and Control System application being developed by the Corps engineer section to provide ERCP on a digital map.

A Viable Solution

SapperNET is a proven, cost-effective, and viable interim solution to manage and distribute the information necessary to provide the engineer-relevant common picture. Additionally, its low-cost, open-architecture design allows a high level of flexibility that can be adapted to almost any tactical unit. Recently, the XVIII Airborne Corps engineer section adopted SapperNET as the Corps engineer reporting and information distribution system. Once again, SapperNET was easily modified to accommodate Corps and light engineer-specific reports.

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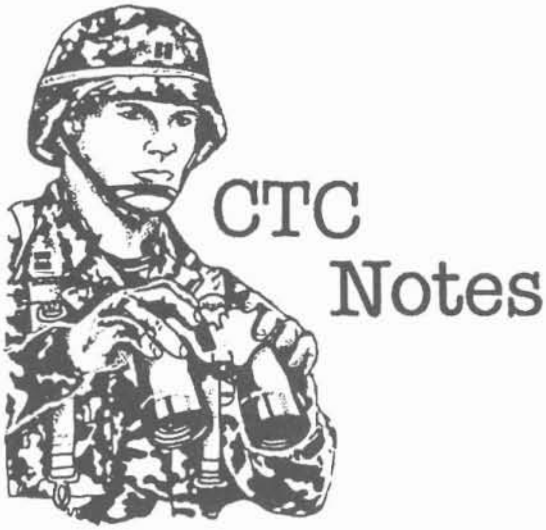
Major Anninos is the S3 of the Engineer Brigade, 3d Infantry Division, Fort Stewart, Georgia. A graduate of the Command and General Staff Course, he holds master's degrees in systems engineering and transportation engineering from the University of Pennsylvania.



Battle Command Training Program (BCTP)

Integrating Smoke in the Mobility/Survivability BOS

By Lieutenant Colonel Ron Light and Major John Kulifay

If you are an "old soldier," you may recall a time when engineers were not fully integrated in the combined arms team. Engineers often had to "fight" to be heard, to secure a seat at the planning table, and so on. Due largely to the efforts of the combat training centers, I believe that this has changed. For example, during Warfighter exercises conducted by the Battle Command Training Program (BCTP), engineers are integrated in all stages of the military decision-making process and across the depth of the division zone. Brigade and division commanders seek the advice and counsel of their engineers. Thus, we are now a relevant, potent force on the battlefield.

However, engineers are only part of the mobility/survivability battlefield operating system (BOS). Division-level chemical staffs bring chemical detection, decontamination, smoke generation, and other capabilities to the fight. In particular, our experience during recent BCTP Warfighter exercises indicates that staffs must do more to integrate the use of smoke in plans and orders.

In light of the maneuver-support concept (which includes military police, who are not discussed here), and the fact that we are large consumers of smoke during river-crossing and breaching operations, engineers must take the lead in integrating our Chemical Corps brethren's smoke-employment expertise. If your first reaction is to dismiss this notion, perhaps you are not aware of the role that obscurants have played throughout the history of warfare and the great effects they can provide toward achieving success.

Pick a conflict, and you'll probably find that effective use of obscurants made a difference. As early as 2000 B.C., soldiers burned damp straw to smoke enemy positions. At Legnica, Poland, in 1241 A.D., the Mongols used smoke to separate foot soldiers and horsemen. Combatants in the 20th century have used smoke during every major conflict as well. The recently fielded M56 wheeled Smoke Generator System (SGS) and tracked M58 SGS have modernized our inventory of smoke-generating equipment.

Despite historic examples that showcase the effectiveness of smoke and recent improvements in equipment, our experience during BCTP Warfighter exercises shows that chemical staffs often are not integrated in the division fight. Where it was once engineers who fought for a seat at the table, now it's the chemical officers who fight for a seat. It is time that engineers facilitate the integration of chemical staffs, particularly for planning smoke operations on the battlefield. The importance of planning and executing smoke is clearly stated in FM 90-13, *River-Crossing Operations*, and FM 90-13-1, *Combined-Arms Breaching Operations*.

Chemical Corps doctrine (FM 3-50, *Smoke Operations*, and FM 3-101-1, *Smoke Squad/Platoon Operations*) provides the tactics, techniques and procedures units use to employ smoke at operational and tactical levels of war. Smoke has four battlefield applications:

- **Obscure.** Smoke is delivered directly on or immediately in front of enemy positions.
- **Screen.** Smoke is delivered on friendly forces or between friendly and enemy positions.
- **Protect.** Smoke is employed to defeat enemy guidance systems.
- **Mark.** Smoke is used to mark targets and identify friendly positions and prearranged communications.

Combat training centers provide the venue to plan and execute these smoke operations. Whether it is mechanically generated or emplaced by a soldier with a smoke pot, smoke is an effective combat multiplier. During BCTP Warfighter exercises, units that integrate chemical staffs and smoke operations on the battlefield generally are more successful than those that do not. Without early integration of the chemical staff's plans, smoke operations often are an afterthought, if they occur at all, and rarely are synchronized or effective. Planning for smoke should be accomplished at the division level. All too often, smoke assets are task organized to a brigade, where they are further task organized into smoke squads that are incapable of producing large areas of smoke. As one chemical officer noted, when that happens, smoke tends to be a beacon rather than an obscurant.

Figure 1 depicts a brigade-level river-crossing operation. While screening smoke was planned at brigade level, there was no division-wide smoke plan. The brigade generated smoke at a site along a major river, which the enemy observed and correctly surmised to be a river-crossing site. Note that little smoke was used elsewhere in the division zone; there was no plan to do so in support of the brigade river crossing.

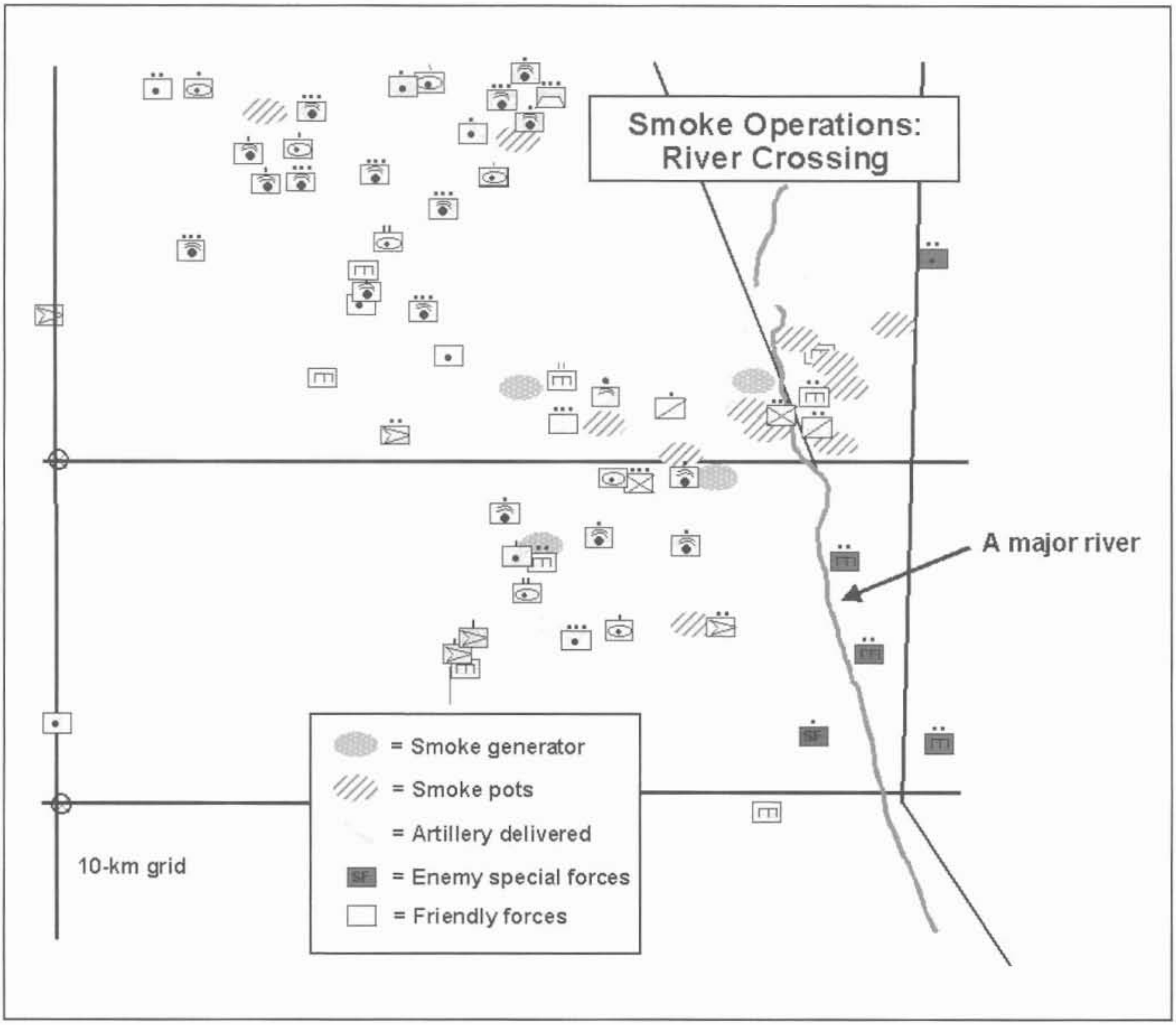


Figure 1

The use of smoke at only one place on the river made it easy for the enemy to detect and interdict the brigade's river-crossing operation.

Compare Figure 1 with Figure 2. In Figure 2, the chemical staff officer created an integrated, synchronized *division-wide* smoke plan that supported two brigade-level river crossings. Instead of using smoke at only a few places on the battlefield, the enemy was faced with many smoke events. The division executed screening and obscuring smoke across the depth of its zone. Accordingly, the enemy faced a dilemma with respect to potential river-crossing sites: *With limited assets, where should I send reconnaissance forces to look first? What do I target?* The enemy required additional time to identify the locations of river-crossing sites, and friendly forces conducted two successful crossings during that time. This is a classic example of "getting inside the enemy's decision cycle," and effective smoke integration made it happen.

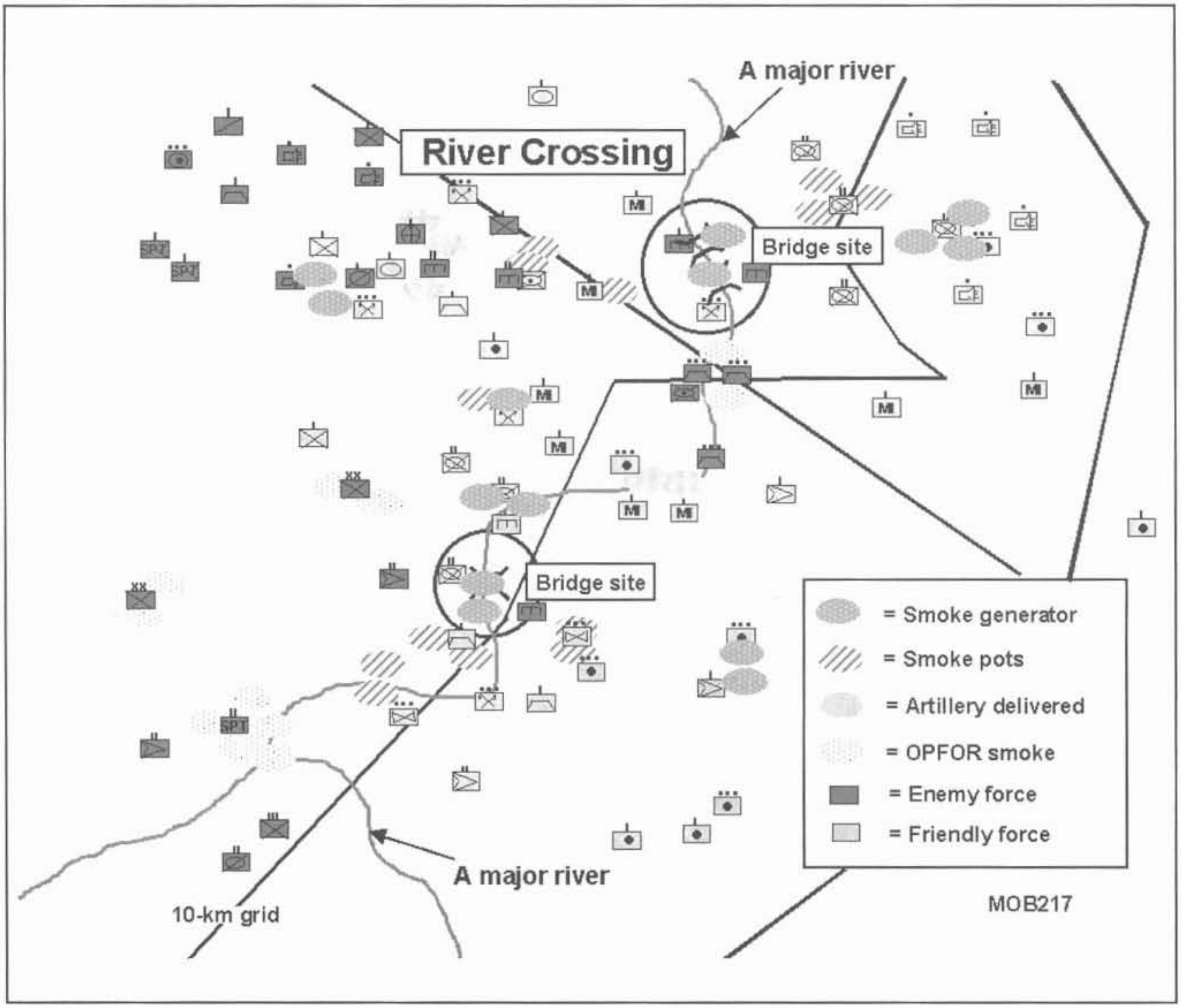


Figure 2

In most theaters of operation, we can expect large numbers of enemy reconnaissance forces. An effective smoke plan can help protect the force. Figure 3 shows a convoy of assault float bridge companies travelling to a river-crossing site. The enemy often includes engineers on his high-payoff target list, and in this case bridging assets were a priority target. Because these bridging units received no force protection from smoke operations, enemy forward observers (in this case special-purpose force [SPF] teams), brought effective fires on the convoy and partially destroyed it before the convoy could reach the river.

Figure 4, page 30, depicts effective smoke operations that enhanced force protection, again during multiple brigade-level river crossings. Note the location of enemy SPF teams, which are located along templated river-crossing sites. In this Warfighter exercise, friendly smoke was used effectively to blind the enemy's reconnaissance effort. Both river crossings were executed successfully.

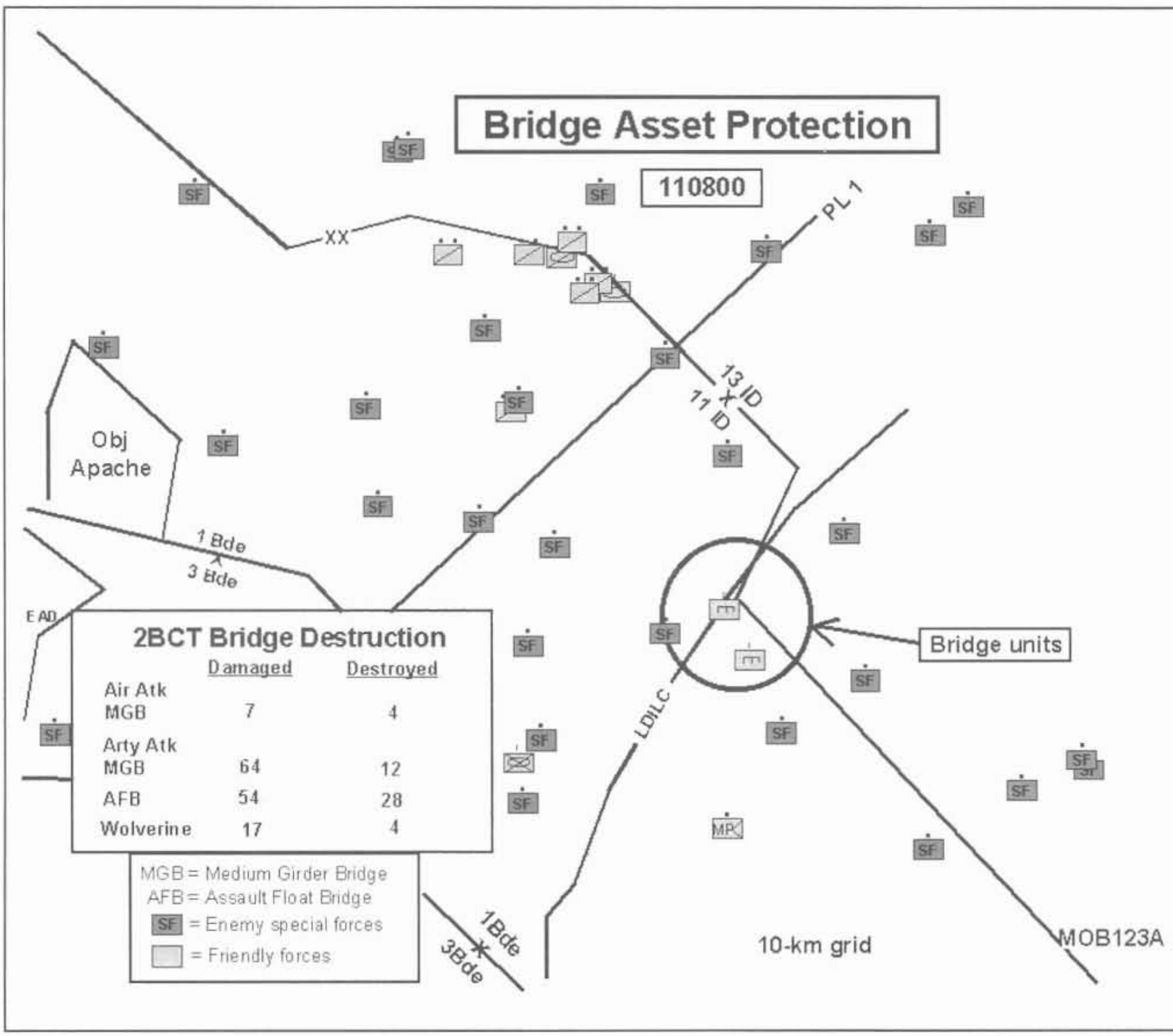


Figure 3

River-crossing and force-protection operations are just two examples where effective smoke support can make a difference. Successful obstacle breaching also relies heavily on effective smoke support. A less used role for obscurants may occur when the defense is developed. There probably are other missions where smoke can be applied with positive effect. However, if the chemical staff is not integrated early in the planning process, this resource will be under- or unutilized.

The fire-support community often states, "No idle guns!" Similarly, engineers exclaim, "No idle blades!" As we transition to the maneuver support concept, let's not miss an opportunity to integrate the chemical staff's expertise in what we do to support the combined-arms team. Engineers are in the right place and this is the right time to secure a seat at the table for chemical staffs. Since smoke support makes us effective, we should lead the way in declaring, "No idle generators!"

Lieutenant Colonel Light is the senior engineer observer/controller for the Battle Command Training Program at Fort Leavenworth, Kansas. He previously served as the S3 and XO of the 168th Engineer Battalion, 3rd Brigade, 2nd Infantry Division, Fort Lewis, Washington.

Major Kulifay is the Battalion XO of the 23rd Chemical Battalion, Camp Carroll, Korea. Previous assignments include senior nuclear, biological, and chemical and smoke observer/controller for the Battle Command Training Program at Fort Leavenworth, Kansas, and chemical staff officer at corps, division, and brigade levels.

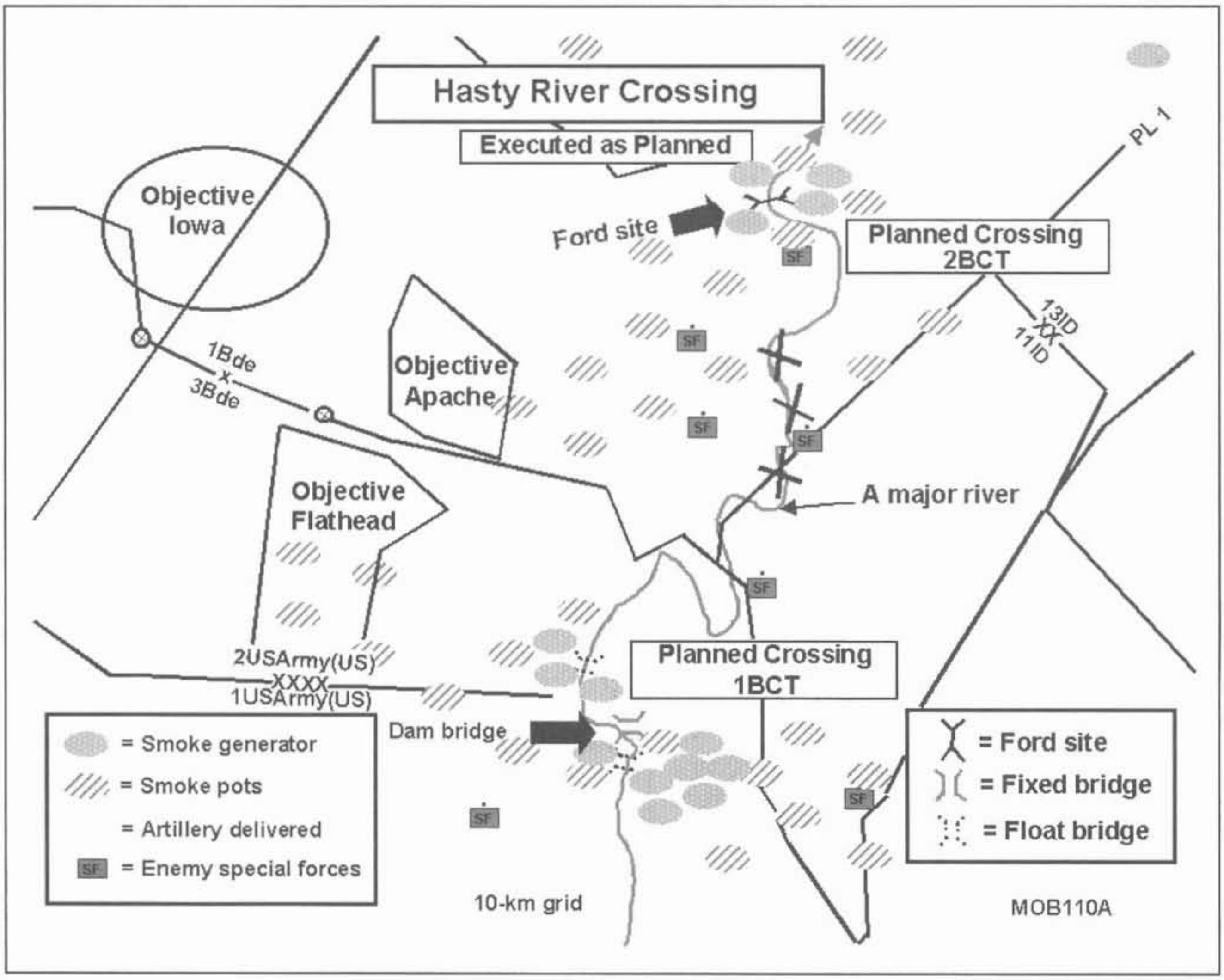


Figure 4

Joint Readiness Training Center (JRTC)

The Engineer Battlefield Assessment and Mission Analysis

By Major Jeff Baker

We are observing a trend at the Joint Readiness Training Center (JRTC) concerning the engineer battlefield assessment (EBA) and how it impacts engineers' ability to be viable members of the combined arms team. That trend is our observed inability to understand the purpose and end state of the EBA process. As a result, engineers rarely provide the maneuver commander with information during a mission analysis briefing (or targeting meeting) that is of any true value to his decision process. Engineer planners experience these difficulties because they do not understand the purpose of the EBA or tie it to the engineer estimate, which ultimately supports the military decision-making process (MDMP); nor do they understand the difference between "state" and "status." Many engineer planners believe the EBA is an engineer-specific document that is of little use for anyone other than engineers. Therefore, many units don't even produce a written EBA.

This article briefly describes the purpose and importance of conducting a thorough EBA as part of mission analysis. It is the first in a series of articles to be published in *Engineer* to discuss details of the EBA and mission analysis.

The "Substandard" Engineer Mission Analysis Worksheet

The following is an example of what we routinely observe as an EBA product.

Assets Available:

- Two light sapper platoons
- One mechanized engineer platoon
- Five dozers
- Eight small emplacement excavators (SEEs)

Specified Tasks:

1. Emplace obstacles in Obstacle Zone A.
2. Provide survivability support to the brigade task force.
3. Emplace a division-directed obstacle at WQ12345678.
4. Plan one scatterable minefield.
5. Submit obstacle plans to division NLT 231800Z FEB 99.

Implied Task: Be prepared to clear Route Falcon in support of the division counterattack.

Constraint: Division NLT defend time is 251800Z FEB 99.

Limitations:

- Authority to destroy bridges is reserved by the joint task force commander.
- No obstacles within 50 meters of Main Supply Route Raven.

If we ever see an EBA, this one is as good as it gets. What's wrong with this worksheet? All the planner did was pull elements from a higher order—no analysis was applied to the information. A properly prepared worksheet should give the supported commander details concerning the exact capabilities of engineer forces. It should list capabilities in terms such as number of breach lanes possible, number of protective positions engineers can construct in a given time period, linear meters of minefield engineers can emplace, minimum time required to clear/repair a flight landing strip given the type of soil and anticipated obstacles or damage, etc. Bottom line—we must *focus* our effort! Additionally, the above worksheet does not help the commander understand the mobility/survivability tasks required or the current state of the mobility/survivability operating system.

Purpose of the EBA

Simply put, the EBA is a mission-analysis tool that provides a structured way of conducting a detailed staff estimate. By following its format, the planner obtains a clear understanding of enemy engineer capabilities (which may produce additional implied tasks) and assists the task force S2 in preparing the intelligence preparation of the battlefield. The EBA also leads the planner to a detailed list of specified and implied tasks and a solid estimate of what the mobility/survivability operating system can provide to the task force. The planner should articulate this information in exact capabilities based on the task force's current state. The EBA must address engineer assets as well as the mobility/survivability operating system as a whole, although we rarely observe this critical aspect being conducted. The EBA must be conducted early in the MDMP, be updated continuously, and be in sufficient detail to provide the commander with a clear understanding of the *state* of mobility/survivability systems—not their *status*.

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MILITARY LOAD CLASSIFICATION TABLE

By Captain Patrick Rowe

The Engineer School web site contains a new feature for soldiers who are unsure of their vehicle's military load classification (MLC). The school has developed a table that pairs the most common vehicles in the Army's inventory with their MLC. Look up the table under *http://www.wood.army.mil/CELL/index.htm*. This web site belongs to the Doctrine Development Division's Center for Engineer Lessons Learned.

Earlier this year, *PS Magazine* informed the Engineer School that soldiers in the field may not have military load classifications readily available for their vehicles. This problem is the result of several factors. First, not all vehicle technical manuals contain the respective vehicle's MLC in the General Information section. Second, not all of the dash data plates attached to vehicles include that vehicle's MLC. Third, the new FM 5-170, *Engineer Reconnaissance,* lacks the MLC table included in the old FM 5-36, *Route Reconnaissance and Classification*. Fourth, Appendix F in FM 5-170 contains formulas for calculating field expedient classifications for vehicles. However, this requires soldiers to measure air pressure in tires and measure the total area of the vehicle's tires or tracks in contact with the ground.

Soldiers in the field must be able to quickly obtain vehicle MLCs without having to perform time-consuming measurements and calculations. With assistance from the Tank-Automotive and Armaments Command, the Engineer School developed the following table listing the MLCs of most vehicles in the Army's inventory. Line item numbers (LINs) and LIN index numbers have been provided to accurately identify the vehicles. The Engineer School will make this table available as a graphic training aid (GTA) and include it in the revised version of FM 5-103, *Survivability* (2nd quarter, FY00), and Change 2, FM 5-170 (4th quarter, FY99).

Table Header Definitions

Model: This field relates to the model description for a national stock number (NSN). Vehicles listed in the table are sorted alphabetically and numerically by their model number.

Item Description: This field relates to the generic nomenclature assigned to a LIN.

LIN: A six-character alphanumeric identification is assigned to generic nomenclature. It describes collectively all NSN items that possess the functional capability expressed by the LIN description. When multiple LINs are listed, the MLC of the heaviest vehicle is given in the MLC column.

LIN Index: This column provides the two-digit index number applied to each LIN data entry record to identify the NSN and shipping configuration. When multiple index numbers are listed, the MLC of the heaviest vehicle is given in the MLC column.

MLC E/L: This column provides the military load classification of the vehicle when empty/loaded. A dash (-) indicates that the MLC of the vehicle is less than three (3). A plus (+) indicates that the MLC of the loaded vehicle depends on the cargo.

Military Load Classification

Model	Item Description	LIN	LIN Index	MLC E/L
AVLB	Armored Vehicle-Launched Bridge, M48-based			46/66
AVLB	Armored Vehicle-Launched Bridge, M60-based			40/57
C7	Loader, Scoop 2.5 cubic yards (cy), w/o roll cage			20
D7	Dozer, w/ blade, w/o winch	W76816		23
D7	Dozer, w/ blade, w/winch			28
FLU-419	Small Emplacement Excavator (SEE) Tractor	T34437	03	9
JD-410	Tractor, Backhoe/Loader	W91074	01	9/10
M1000	Heavy Equipment Transport (HET) Trailer	S70859	01	21/-
M1037	Truck, Utility: S250 Shelter Carrier 4X4 w/equipment (HMMWV)	T07543	01	-/4
M1038	Truck, Utility: Cargo/Troop Carrier, 1.25 T 4X4 (HMMWV) w/equipment, w/winch	T61562	01	-/4
M1059	Carrier, Smoke Generator	C12815	01	10/12
M1068	Carrier, Armored, Command	C11158	01	13
M1070	HET	T59048	01	18/+
M1074	Palletized Load System (PLS) w/crane	T41067	01	24/45
M1075	PLS w/o crane	T40999	01	22/41
M1076	PLS-Trailer	T93761	01	7/26
M1078	Truck, Cargo: 4X4 light military tactical vehicle (LMTV) w/equipment, w/ or w/o winch	T60081	01	9/11
M1083	Truck, Cargo: MTV w/equipment, w/ or w/o winch	T61908	01	11/15
M1089	Truck, Wrecker: MTV w/equipment, w/winch	T94709	01	14/22
M109 A4/A5	Howitzer, 155 mm, self-propelled (SP)	K57667		28
M1090/ M1094	Truck, Dump, w/winch, MTV T65526 = w/o winch; T65594 = w/winch	T64911/ T65594/ T65526	01	12/17
M1097	Truck, Utility: Heavy Variant, HMMWV, 4X4, 1K gross vehicle weight (GVW), w/equipment	R93035/ T07679	36/10	-/4

Model	Item Description	LIN	LIN Index	MLC E/L
M110A2	Howitzer, Heavy, SP, 8-inch	K56981	07	26/29
M113A2/A3; M58	Carrier, Personnel; Wolf (M113-based)	D12087/ C18284/ G87229	17/01	13
M172, M172A1	Trailer, Low-Bed, 25-ton	S70517	01	7/29, 6/36
M198	Howitzer, Lightweight, Towed, 115 mm	K57821	01	9
M1A1	Tank, Combat, 120 mm, w/o Heavy Armor Kit	T13168	01	70
M1A2	Tank, Combat, 120 mm, w/o Heavy Armor Kit	T13305	01	70
M2A1	Infantry/Tube-Launched, Optically Tracked, Wire-Guided (TOW) Missile/ Cavalry Fighting Vehicle	F40307	01	22/28
M270/A1	Multiple-Launch Rocket System (MLRS)	Z57250	01	20/26
M270/A1	Trailer, Low-Bed , 12-ton	S70243	01/03	7/17
M2A2	Infantry/TOW/ Cavalry Fighting Vehicle	F40375	01	31
M2	Cavalry Fighting Vehicle	J81750	01	20/24
M3	Cavalry Fighting Vehicle	C76335	01	24
M35A2	Truck, Cargo: 2.5-ton, 6X6, w/equipment	X40009	01	6/11
M48A5	Tank, Combat, 105 mm	V13101	05	54
M520	Truck, Cargo, 8-ton			10/16
M54 series	Truck, Cargo: 5-ton, 6X6 long wheel base (LWB) w/equipment/ Truck, Cargo: 5-ton 6X6, w/winch, w/equipment	X40831/ X40968	07	9/17
M548	Carrier, Cargo, 6-ton	D11049	01	7/13
M54A1C/A2C	Truck, Cargo, D/S, 5-ton, 6X6	X40931	01/03	9/17
M551/M551A1	Armored Reconnaissance ABN Vehicle	A93125	01	14/16
M553	Truck, Wrecker, 10-ton, 4X4	X63436	01	15/20
M559	Truck, Fuel (2,500-gallon)			10/19
M56	Generator, Smoke, Mechanized (Coyote)	G58151	01	6
M577A1	Carrier, Command Post	D11538	01	10/12
M578	Vehicle, (Light) Recovery	R50544		27
M6	Carrier F/TRAC Bradley (Linebacker)	Z20340		33
M60A2	Tank, Combat, 152 mm	V13270	01	57

Model	Item Description	LIN	LIN Index	MLC E/L
M60A1/A3	Tank, Combat, 105 mm	V13101	03/11	57
M728	Combat Engineer Vehicle	E56578	01	59
M747	C-HET Trailer (also M1000)	S70661	01	11/79
M813A1	Truck, Cargo: Dropside, 5-ton, 6X6, w/equipment	X40794	01	9/15
M814 series	Truck, Cargo: 5T, extra-long wheel base (XLWB)	A26874	11	10/21
M816	Truck, Wrecker, 5-ton, 6X6	X63299	07	18/32
M870	Trailer (pulled by M916)	S70594	01	6/74
M871	Trailer (pulled by M931)	S70027	01	7/52
M872	Trailer, Flatbed, 34-ton (M915 Tractor)	S70159	01,04,03	8/44
M88A1	Vehicle, (Medium) Recovery	ME1377	01	55/70
M997	Truck, Ambulance Litter, 4X4	T38844	01	-/4
M9 ACE	Armored Combat Earthmover	MB0589	01	17/30
M901	Combat Vehicle, Improved, TOW	E56896	01	12
M911	Truck, Tractor, 5-ton (C-HET)	T61035	01	16
M915A1/A2	Truck, Tractor, 6X4	T61103	03/14	8/-
M916	Truck, Tractor, 6X6	T91656	01	12
M920	Truck, Tractor, 8X6	T61171	01	14
M925A1/A2	Truck, Cargo, 5-ton	X40931	28	10/16
M929A2	Truck, Dump, 5-ton	X43708	42	10/17
M930A2	Truck, Dump, 5-ton, 6X6	X43845	35	11/17
M931	Truck, Tractor, 5-ton	X59326/ E01933	10	9/17
M93A1	Recon System NBC (FOX)	R41282	01	19
M966	Truck, Utility, 1.25-ton	T05096	01	3/4
M967, M970 (M900 series)	Trailer, Tank, Fuel, 5,000-gallon	S10059	01	6/21
M977	Truck, Cargo (HEMTT)	T39518	01	18/28
M978	Truck, Tanker (HEMTT)	T58161	01	17/25
M981	Fire Support Vehicle	C12155	01	14
M992	Carrier, Tracked , Field Artillery Ammunition Support Vehicle (FAASV)	C10908	01	22/29
M998 Series	Truck, Utility, Cargo, Transport Carrier, 1.25-ton, (HMMWV)	T61494	01	-/4

Model	Item Description	LIN	LIN Index	MLC E/L
MT-250	Crane, Truck Mounted, Hydraulic, 25-ton	F43429	01	31
RTCC	Crane, Wheel Mounted, (20-ton)	C39398	01	85/ +
(No Number)	Q37 Radar System	A41666	06	13
AN/TPQ-36V7	Q36 Radar System	R14216	05	-/4
M1083 w/winch	Truck, Cargo: MTV, w/equipment	T41135	01	11/16
M105A2	Trailer, Cargo: 1.5-ton 2-wheel, w/equipment	W95811	01	2/4
M35A2C	Truck, Cargo: Dropside, 2.5-ton 6X6 w/equipment	X40077	01	6/11
LMTV	Trailer, Cargo, 2.5-ton	Z36068	01	1/4
XM1113	Truck Utility: Expanded Capacity, 4X4 w/equipment, HMMWV XM1113	Z62562	01	-/6
(No Number)	Trailer, Cargo: MTV w/ dropsides	Z90712	01	3/9
Petroleum, Oil, and Lubricants (POL) MTV	Truck, Tank: POL MTV	Z94047	01	13
M1078 w/winch, w/o winch	Truck, Cargo: LMTV w/equipment (5K-pound Cargo)	T60149/ T60081	01	10/12
M1081	Truck, Cargo: LMTV w/equipment (5K pound Cargo)	T42063	01	10/13
M1093 w/winch, w/o winch	Truck, Cargo, MTV w/equipment (10K pound Cargo)	T41036/ T41104	01	12/16
Grizzly	Grizzly: Combat Engineer Vehicle, Full-Tracked (FTRAC)	Z23978/ Z23910	01	70
MLC 70	Launcher, M1 Tank Chassis (Wolverine)	Z37727	01	70

The Engineer School encourages feedback from users of these vehicles concerning information that is incorrect, omitted, or no longer necessary. Use the following e-mail or mailing address or telephone number to provide comments or suggestions to update and improve this table.

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Book Review

Gulf War, The Complete History, by Thomas Houlahan, Schrenker Military Publishing, New London, New Hampshire, 1999, 471 pages, list $21.00 (paperback). The book is available online from Amazon.com.

In this unusual book, the author has produced a comprehensive combined-arms account that includes the significant but largely unknown contributions of our British, French and Arab allies. The focus of the narrative is on the battalion and brigade levels, where real-time synchronization of combat power actually occurs. The book presents significantly more information than has been available on the Iraqis, including a good order of battle and their actions during the war. Many diagrams and maps help clarify the text. The thoroughness of the author's research has produced a balance that many military history accounts lack. In the process, the author has created a cogent analysis of why the coalition succeeded and the Iraqis did not.

The extent of the coalition's operational victory over the Iraqi Army in the Gulf War has created a myth that has obscured many of the tactical challenges that coalition soldiers had to overcome to achieve success. By interviewing many of the key participants in Operation Desert Storm (the list is more than eight pages long), the author was able to strip away much of the myth that has grown up around the Gulf War. For example, air power knocked out only about 600 Iraqi armored vehicles, not the 2,600 claimed by coalition air forces. Two of the three heavy divisions in the Republican Guard were destroyed (the other withdrew from the theatre of operations to avoid the ground war), and an additional three motorized divisions and one "commando" division were destroyed. Media hype aside, the Republican Guard still has not recovered from the severe mauling inflicted by American and British units during the ground war.

The contributions of combat engineers often are forgotten in military histories. Accounts by general officers paint with broad brushstrokes, while first-person accounts by individuals on the ground lack a tactical perspective and omit the less glamorous work of the sappers. Refreshingly, combat-engineer issues are well represented in this narrative, as shown by the following examples:

- Detailed accounts of major breaching operations conducted by the Marines, VII Corps, and the Arabs of the coalition, including many detailed sketches and photos.
- Information about the remarkable effectiveness of Iraqi field fortifications and decoys against the coalition air forces' sensors and munitions.
- Information on the first use of scatterable mines (primarily GATOR) by the United States since the Vietnam War.
- The casualties and delays caused by our (U.S.) unexploded submunitions that littered the battlefield. The Army has not yet adequately addressed this problem.
- A detailed analysis of all known fratricide incidents, including two that involved combat engineers.
- A description of what is probably the CEV's last close combat action at Al Bussayyah, where 20 rounds fired from its demo gun destroyed 19 heavily fortified buildings.

The author also provides a remarkably detailed accounting of casualties on both sides as well as their causes, allowing readers to assess the relative effectiveness of various weapons.

Combat engineers should find this book to be fascinating reading. It is recommended to all combat arms leaders.

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PRECOMBAT CHECKS AND INSPECTIONS

By Sergeant First Class Robert W. Casteel

The following checklists have been developed for general and Volcano-specific precombat checks (PCCs) and precombat inspections (PCIs). They are based on firsthand experience in units and from observing leaders at the company level and below who struggle to conduct effective PCCs/PCIs at the Joint Readiness Training Center (JRTC). This is by no means a 100 percent solution for correcting difficulties in conducting PCCs/PCIs or emplacing minefields with the Volcano system, but they may help your unit during the critical preparation phase. They have been forwarded to the Engineer School's Doctrine Development Division for inclusion in the next revision of FM 5-10, *Combat Engineer Platoon*.

Sergeant First Class Casteel is a writer/analyst in the Warfighter Engineer Division, Directorate of Training Development. Previous assignments include platoon and squad observer/controller at JRTC and platoon sergeant in A Company, 82nd Engineer Battalion, 1st Infantry Division, Bamberg, Germany.

PCCs/PCIs Checklist

This general checklist serves as a reminder of questions for leaders to ask:

Bolt cutters

- ❒ How many are on hand?
- ❒ How many are required?
- ❒ Do maneuver platoons have any?

Pioneer tools

- ❒ Are the kits complete?
- ❒ Are they serviceable?

Demolitions bags

- ❒ Have they been inventoried? Ensure they are complete, to include tape.
- ❒ Are they serviceable?
- ❒ How many are on hand per squad?
- ❒ Do maneuver platoons have demolitions bags?

Mine detectors

- ❒ How many are on hand per squad?
- ❒ How many are required per squad?
- ❒ How many D cell batteries are on hand?
- ❒ Where is a resupply of batteries available?
- ❒ How many probes are on hand?
- ❒ Do the maneuver companies have any?
- ❒ Have preventive maintenance checks and services (PMCS) been performed?

Load plan

- ❒ Are the vehicles loaded?
- ❒ Are the ruck sacks loaded?
- ❒ Are the soldiers' loads (load-bearing equipment, uniform, and A-bag) consistent with the SOP?
- ❒ Who is carrying the TOE equipment, and where is it located?

Obstacle lane-marking system

- ❒ Are enough marking materials on hand to mark eight lanes per squad?
- ❒ Who is carrying the immediate resupply?
- ❒ Are any other units carrying marking materials?
- ❒ Where can we get more materials (heavy/light)?
- ❒ How many picket pounders are on hand?
- ❒ What is the obstacle-marking SOP for the brigade/division?

Demolitions

- ❒ What is the demolitions count by type?
- ❒ Are the charges prepared according to the mission?
- ❒ Who is resupplying engineers with demolitions—the engineer company/battalion or the maneuver task force?
- ❒ Where is the supply point?
- ❒ What is the transportation plan? Are the modernized demolitions initiators (MDI) and demolitions being transported together or separately?

- ❒ Do maneuver platoons have any demolitions available?
- ❒ What is the cross-load plan?

Volcano

- ❒ Have PMCS been performed according to TM 9-1095-208-23&P, *Unit and Direct Support Maintenance Manual for Dispenser, Mine, M139*?
- ❒ Have function checks been performed?
- ❒ Where are the mine canisters located?
- ❒ Where are the reload mine canisters located?
- ❒ What is the survivability plan?
- ❒ What is the control substitution plan if more than one Volcano is deadlined?
- ❒ How many operators are available?
- ❒ What is the protection plan for movement?
- ❒ Is a copy of the obstacle overlay available?
- ❒ What are the triggers for installation?
- ❒ What is the communications plan?

MICLIC

- ❒ Have PMCS been performed according to TM 9-1375-215-14&P, *Operator's, Unit, Direct Support and General Support Maintenance Manual for Demolition Kit, Mine-Clearing Line Charge (MICLIC)*?
- ❒ Have function checks been performed?
- ❒ Have circuit tests been performed?
- ❒ Where are the MICLIC tubs and rockets located?
- ❒ Where are the tie-down straps for the rocket located?
- ❒ Where are the reload tubs and rockets located?
- ❒ What is the survivability plan?
- ❒ Has a misfire kit been prepared?
- ❒ What is the control substitution plan if more than one MICLIC is deadlined?
- ❒ What is the communications plan?

Modular Pack Mine System (MOPMS) and Remote-Control Unit (RCU)

- ❒ Have PMCS been performed according to TM 9-1345-209-10, *Operator's Manual for Modular Pack Mine System (MOPMS)*?
- ❒ Have function checks been performed?
- ❒ Where are the MOPMS boxes located?
- ❒ How many BA 5598/Us are required?
- ❒ How many BA 5598/Us are on hand?
- ❒ Where can more BA 5598/Us be obtained?
- ❒ How many MOPMS boxes do the maneuver companies and the battalion have?
- ❒ How many RCUs do the maneuver companies and the battalion have?
- ❒ How many operators are in the infantry?
- ❒ Is a copy of the obstacle overlay on hand?
- ❒ What are the triggers for installation?
- ❒ What is the communications plan?
- ❒ Which is the overwatching unit?

Weapons zero

- ❒ Have individual weapons been zeroed?
- ❒ Have crew-served weapons been zeroed?
- ❒ Are tripods on hand?
- ❒ Are traverse and elevation (T & E) mechanisms on hand?
- ❒ Are spare barrels on hand?
- ❒ Are range cards on hand?

Rehearsals for offense/defense

- ❒ Are materials and personnel on hand to construct a rehearsal site?
- ❒ Have squad battle drills (engineer and infantry) been rehearsed?
- ❒ Have platoon battle drills (engineer and infantry) been rehearsed?
- ❒ Have maneuver battle drills been rehearsed?
- ❒ Have the actions on contact (seven forms) been rehearsed?
  - Visual contact
  - Physical contact (direct fire) with an enemy force
  - Indirect fire
  - Contact with enemy obstacles or those of unknown origin
  - Contact with enemy or unknown aircraft
  - Situations involving nuclear, biological, and chemical (NBC) conditions
  - Situations involving electronic warfare tactics
- ❒ Have actions at halts been rehearsed?
- ❒ Have actions on the objective been rehearsed?
- ❒ Have actions in the assembly area been rehearsed?
- ❒ Have actions at base camps been rehearsed?
- ❒ Have reconsolidation and reorganization been rehearsed?
- ❒ Have actions on contact while deploying the Volcano been rehearsed?

- ❒ Have rollover drills with vehicles been rehearsed?
- ❒ Have fire drills with vehicles been rehearsed?

Vehicles

- ❒ Have PMCS been performed according to the appropriate TM?
- ❒ Are Class III basic loads on hand?
- ❒ What is the Class III resupply plan?
- ❒ Are spare parts on hand for vehicles and special equipment (if applicable)?
- ❒ Are unit identification markings on the vehicles?
- ❒ What is the casualty marking plan?
- ❒ Does each vehicle have a map and graphics?
- ❒ Have communications checks (short- and long-range) been performed?

Communications

- ❒ Are the AN/CYZ-10s loaded?
- ❒ Has communications security (COMSEC) been loaded?
- ❒ Are radio transmitters (RTs) loaded and the time set?
- ❒ Is there a 3-day supply of MANPACK batteries on hand?
- ❒ Are there spare HUB batteries on hand?
- ❒ Are there spare AN/CYZ-10 batteries on hand?
- ❒ Have communications checks (long- and short-range) been performed?
- ❒ Are the OE-254 antennas on hand and serviceable?

Night vision goggles

- ❒ Is there one pair on hand for each driver, track commander, and squad leader?
- ❒ Are AN/PVS-4s on hand for all M203 and M249 weapons?
- ❒ Are AN/TVS-5s on hand for all M2 machine guns and MK 19 weapons?
- ❒ Are there spare batteries on hand?
- ❒ Are there spare AA batteries on hand?
- ❒ Have PMCS been performed?

AN/PSN-11

- ❒ Has COMSEC been loaded?
- ❒ Is the AN/PSN-11 set up and initialized for the geographicial location?
- ❒ Are spare memory batteries on hand?
- ❒ Is there a 4-day supply of BA 5800s on hand?
- ❒ Are all authorized accessories on hand?
- ❒ Are the vehicle power and external antennas operational?

Class IV/V supplies

- ❒ What supplies are on hand?
- ❒ What supplies are on the battlefield?
- ❒ Are there enough in both places?
- ❒ Are more available?
- ❒ Who is in charge of them during offensive and defensive operations?
- ❒ What hauling assets are available?
- ❒ Where are Class IV/V supply points located?
- ❒ What is the unit SOP for setting up Class IV/V supply points?
- ❒ What equipment is on site?
- ❒ Are extra gloves on site for laborers?
- ❒ What is the accountability plan?
- ❒ Does the supply point have communications?
- ❒ Does the supply point have a copy of the obstacle plan or a breakdown of materials?

Traffic control point (TCP) materials

- ❒ Are wire and pickets on hand?
- ❒ Are mines on hand?
- ❒ Are sandbags on hand?
- ❒ Have guard shacks been constructed?
- ❒ What survivability materials are on hand?
- ❒ What is the United Nations TCP design?
- ❒ Where is the quick reaction force (QRF) located and what is its response time?

Mine-clearing blade (MCB)

- ❒ How many are serviceable and where are they located?
- ❒ Have PMCS been performed according to TM 9-2590-509-10, *Operator's Manual for Mine-Clearing Blade for M1, 1PM1, M1A1, or M1A2 Abrams Tank*?
- ❒ Are replacements and repair parts available?

Mine-clearing roller (MCR)

- ❒ How many are serviceable and where are they located?
- ❒ Have PMCS been performed according to TM 5-2590-214 *Operator's Manual for Roller Kit, Mine, and Mounting Kit, Mine-Clearing Roller?*
- ❒ Are replacements and repair parts available at the maintenance area?

M9 ACE

- ❐ Have PMCS been performed according to TM 5-2350-262-10?
- ❐ How many steel road wheels are on hand in the platoon?
- ❐ How many steel road wheels are in the battalion's prescribed load listing (PLL)?
- ❐ How many aluminum road wheels are on hand in the platoon?
- ❐ How many aluminum road wheels are on hand at the battalion PLL?
- ❐ What is the availability of petroleum, oil, and lubricants (POL) (15-40W, 10W, 90W)?
- ❐ Is the basic POL load located with the platoon sergeant or with the platoon leader?

Miscellaneous

- ❐ What support can we get from the maneuver company?
- ❐ What are the time lines of major meetings?
- ❐ What are the report times and formats?
- ❐ When are the critical face-to-face meetings with engineer command post (CP) personnel and the commander?
- ❐ When are the conference calls with the engineer commander via FM radio?
- ❐ When are the conference calls with the maneuver commander via FM radio?
- ❐ How often does the engineer CP want situation reports (SITREPs) from platoons?
- ❐ What is the time line for obstacle-marking-system upgrades?
- ❐ What is the maneuver time line for major events and meetings?
- ❐ What is the mission preparation time line?
- ❐ When is the intelligence update?
- ❐ Is a copy of the unit SOP available?
- ❐ Is a copy of the operations order (OPORD) and graphics available?

Volcano Checklist

PCCs/PCIs before deployment. Ensure that the following are on hand:

- ❐ All parts of the Volcano system
- ❐ Vehicle-mounted AN/PSN-11s (pluggers)
- ❐ A full load of M89 training canisters
- ❐ Electrical contact cleaner spray
- ❐ Canvas and bows
- ❐ TM 9-1095-208-10-1, *Operator's Manual for Dispenser, Mine, M139 w/Mounting Kits*
- ❐ TM 9-1095-208-23-2&P and parts manual
- ❐ FM 20-32, *Mine/Countermine Operations*
- ❐ FM 90-7, *Combined-Arms Obstacle Integration*

Planning considerations for deployment

- ❐ Ensure that for each 2-vehicle Volcano team, the following are on hand:
  - 2 Volcano system vehicles
  - 4 Volcano operators
  - 1 NCOIC
- ❐ Rehearse reload battle drill.
- ❐ Ensure that the following spare parts are on hand:
  - 1 Hand control unit (HCU) *
  - 1 Dispenser control unit (DCU) *
  - 2 Launcher rack cables
  - 1 Power cable
  - 2 Launcher racks *
  - 4 ID Connector shunt plugs (one for color/shape)

* *Indicates control substituted parts from another nonmission-capable system.*

Miscellaneous planning considerations

- ❐ Determine how many Volcano systems are on hand.
- ❐ Determine how many canisters are on hand.
- ❐ Determine if ground or air Volcanos are being used.
- ❐ Identify the effect of the Volcano minefield (disrupt, fix, turn, block).
- ❐ Use air Volcanos forward of the forward edge of the battle area (FEBA).

- ❒ Use Volcanos to develop the engagement area (EA).
- ❒ Determine the location of Volcanos on the ground.
- ❒ Identify the hide position locations.
- ❒ Identify the route to the minefield.
- ❒ Know when rehearsals are planned (day and night).
- ❒ Identify the decision points for situational and reserve obstacles.
- ❒ Identify the named areas of interest (NAIs).
- ❒ Identify the triggers and alternate triggers.
- ❒ Know the deception plan.
- ❒ Know which vehicle will be used for rehearsals.
- ❒ Plan for a backup vehicle, in case the primary vehicle breaks down.
- ❒ Prepare a reload plan, if needed (the suggested manpower is 12 personnel—eight on the ground and four on the truck).
- ❒ Know the survivability plan.
- ❒ Know the security along the route.
- ❒ Know the observer plan.
- ❒ Site the EA with the overwatching unit.

Survivability

- ❒ Dig survivability positions for each Volcano system.
- ❒ Park the air Volcanos with the attack helicopters.
- ❒ Move the Volcanos to new hide positions after each contact.
- ❒ Camouflage Volcanos in hide positions.
- ❒ Move the Volcanos at night (whenever possible).
- ❒ Have escort vehicles and dismounts in the front and rear.
- ❒ Clear, proof, and confirm route before moving the Volcanos.

PCCs/PCIs

- ❒ Establish communications with the platoon and company.
- ❒ Ensure that the AN/PSN-11s operate properly and have crypto.
- ❒ Run the built-in test before loading the canisters.
- ❒ Run the built-in test after loading the canisters.
- ❒ Ensure that operator vehicle maintenance (OVM) and basic issue items (BII) are on hand for the Volcano and carrier.
- ❒ Ensure that the obstacle plan is on hand.
- ❒ Ensure that the OPORD brief is on hand.

Rehearsals

- ❒ Perform day and night rehearsals.
- ❒ Use a HMMWV or a vehicle of equal size.
- ❒ Mark the centerline for day and night execution (at a minimum, the start and end points may need intermediate markers).
- ❒ Mark the evacuation routes for day and night.
- ❒ Perform rehearsals with the primary and backup operators.
- ❒ Rehearse a malfunction plan.
- ❒ Check the scatterable mine warning (SCATMINWARN) and report the communications net.

Maintenance

- ❒ Ensure that dirt and moisture are kept out of the racks.
- ❒ Check the operation of the Volcano system daily.
- ❒ Use TM 9-1095-208-10-1 for operator-level maintenance.
- ❒ Protect all cables from being stepped on.
- ❒ Keep a stock of cables in PLL.
- ❒ Perform a function test on the HCU and DCU.
- ❒ Check and clean the rack mounting ball detent pins daily. (Keep spares on the vehicle.)

Driver's Training: An In-House Solution

By First Lieutenant David P. Burris and Sergeant Lovetta M. Ritchie

When soldiers are injured or killed in an accident, it is sometimes because they lack the training to safely drive the vehicles they are required to operate and maintain. Well-trained drivers can handle emergency situations caused by track loss or a lack of steering response or braking power without panic, whereas untrained operators typically have accidents in these same situations. Drivers should not operate vehicles for even short distances without the correct training and licensing.

Personnel at the 5th Engineer Battalion at Fort Leonard Wood identified driver's training as a weakness across the battalion. To correct this deficiency, they developed a battalion-level program to train new drivers and re-educate current drivers. In addition to considering the requirements specific to Fort Leonard Wood, they evaluated the way driver's training had been conducted in other units to which they had been assigned. They also reviewed the following pertinent regulations:

- AR 600-55, *The Army Driver and Operator Standardization Program*
- AR 385-55, *Prevention of Motor Vehicle Accidents*
- FM 21-306, *Manual for the Track Combat Vehicle Driver*
- FM 21-17, *Driver Selection, Training, and Supervision: Track Combat Vehicles*

When developing the program, battalion personnel ensured that all facets of training were covered. They included driver maintenance responsibilities, driving in all types of weather and over all types of terrain, and emergency procedures peculiar to each type of vehicle. With the battalion's wide range of vehicle types (everything from M113A3s to HMMWVs to M916s to AVLBs), this was one of the most challenging blocks of instruction to develop.

Battalion personnel developed a 40-hour program that covered all aspects of vehicle operations, including mandatory accident avoidance training and a block of instruction covering night driving and the use of night vision devices. Instructors include the battalion's motor sergeant, maintenance technician, and Master Drivers. The schedule for the week-long class is shown in the figure. At the conclusion of the training, students are familiar with the HMMWV and are prepared to begin driver's training on larger and more complex pieces of equipment. Final licensing remains the responsibilty of Master Drivers within each company.

Many of the training aids used in the class were available through the installation's Training Support Center. These included videos on preventing driving while intoxicated; using seatbelts; and operating vehicles such as the HMMWV, 2.5-ton truck, and HEMMT. The lessons were compiled into a driver's training booklet that has space for students to take notes.

Since implementing the program in October 1998, the battalion has trained more than 50 new drivers. Feedback from the course has been very positive, and after each class an after-action review is performed to futher refine the training. The class is scheduled each quarter, and the schedule is published as part of the battalion's quarterly training guidance. This gives units time to plan and ensure that soldiers who need driver's training can attend the course.

Driver's Training Schedule

Day 1	
0800-0830	Course Introduction
0830-0930	TMs, LOs, Using DA Form 5988-E/2404, Equipment Inspection Maintenance Worksheet
0930-1030	Practical Exercise: Dispatch Procedures (DA Form 5988-E)
1030-1130	Safety Rules and Procedures
1130-1300	Lunch
1300-1400	Effects of Physical Laws/Loading Trucks
1400-1430	Accident Prevention
1430-1500	Accident Report Procedures (DD Form 518, SF 91)
1500-1600	Practical Exercise: Report an Accident
1600-1630	View Video TF (VT) 20-6374 "Consequences"
DAY 2	
0830-0930	Driving Under Adverse Road Conditions
0930-1030	View Video on Winter Driving Tactics
1030-1130	Practical Exercise
1130-1300	Lunch
1300-1400	Night Vision Goggle Introduction
1400-1500	Night Vision Driving
1500-1600	View Video "Night Vision Goggles"
1600-1630	Review
DAY 3	
0830-0930	View Video "Introduction to HMMWV Operations"
0930-1130	HMMWV Familiarization
1130-1300	Lunch
1300-1630	PMCS Instruction
DAY 4	
0830-0930	Review HMMWV Familiarization
0930-1130	Practical Exercise
1130-1300	Lunch
1300-1630	Review Practical Exercise
DAY 5	
0830-1130	Hands-On Test
1130-1300	Lunch
1300-1400	Comprehensive Test
1400-1430	Test Review and Course Critique
1430-1600	DA Form 348 Issues

For more information, call the battalion maintenance officer at (573) 596-0141 or DSN 581-0141.

First Lieutenant Burris is the 5th Engineer Battalion maintenance officer.

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Sustaining Readiness—From the Bottom Up

By Colonel Joseph Schroedel

Company commanders often claim that they cannot manage their own training—that their schedules are driven from the top. Their chief concern is insufficient time to train individuals, squads, and platoons, which are the foundation of the combined-arms team.

More than ever, today's operational and training environment tests the time-management abilities of first-line commanders. Doing more with less is not feasible. Having more time is one solution, and an often-overlooked way to gain time is to make more effective use of our capabilities, especially our quality soldiers, leaders, and training doctrine. The key is to adopt training strategies that motivate individuals and small units to take responsibility for their own training, just as they would in combat.

Composition and Timing of Squad Stakes

Phase I: Leader Certification and Individual Task Evaluation. Begin this phase 90 days before Phase II.

- Leader Certification Exercise (before any evaluation).
- Common training tasks (CTTs).
- Army Physical Fitness Test (APFT) (conducted by the battalion within one week of beginning Phase II).
- Weapons qualification.

Phase II: Collective Task Evaluation. This four-day field training exercise (FTX) is conducted under battlefield conditions.

- *Prepare-for-combat lane:* Conduct precombat inspections (PCIs), rollover, and fire drills and acclimate to environment.
- *Attack lane:* Rehearse breaching, using the MICLIC, hand-emplaced mines, bangalores, and lane-marking equipment.
- *Defend lane:* Emplace row minefields, triple-standard concertina, Modular Pack Mine System (MOPMS), hasty road craters, and 11-row wire obstacles.
- *Maintain lane:* Conduct preventive maintenance checks and services (PMCS) and PCI verification.
- *Patrolling lane:* Navigate dismounted, react to direct and indirect fire, call for fire, and evacuate casualties.
- *Sustain lane:* Employ an M8 alarm; react to nuclear, biological, and chemical (NBC) attack; apply M9 paper; and execute mission-oriented protective posture (MOPP) exchange and personal decontamination.
- *Reconnaissance lane:* Conduct route and obstacle reconnaissance and sweep and clear the route.

Phase III: 12-Mile Ruck March. Perform immediately after Phase II.

- Maintain squad integrity through the entire march.
- This is a "test of will" – squads are exhausted after Phase II.

Figure 1

In combat, frontline soldiers own the motivation and responsibility to fight—and they will assume that responsibility. General Richard Cavazos captured it best when he said, "Show frontline troops an advantage, or there will be no battle." He was not only referring to soldiers' confidence in tactical plans but also to their confidence in themselves and their willingness to fight. Ultimately, our training programs must focus on this bottom-up motivation—to fight and to train to fight. It is the hallmark of the American way of war.

The decisive actions of individual American soldiers and small units are well known. General Wesley K. Clark, Supreme Allied Command, Europe, recently cited the motivation of nations that are seeking NATO membership: "It's not America's leading-edge technology that interests them. It's the discipline of our training; the commitment of our soldiers to each other; the cohesion, trust, and respect within our units; and the competence of our leaders and the trust exhibited by their subordinates."

That reputation was built on the quality of our soldiers, the competence of our leaders, and the effectiveness of our training doctrine. This article describes one method of stimulating bottom-up responsibility for training squads that are worthy of the American Army's reputation.

Squad Stakes

The 1st Infantry Division Engineer Brigade Squad Stakes is a three-phase training and evaluation program. It is a competition against tough standards, but unlike competition for Expert Infantryman Badges or Expert Field Medical Badges, squads are evaluated *as a squad* on both individual and collective tasks. Squad Stakes is also more than just an external evaluation. It is a comprehensive readiness program that integrates soldier, leader, and unit development; personnel, training, and resource management; and motivation. The bottom line is that Squad Stakes is designed to motivate training from the bottom to ensure that we are ready for any mission, anytime, anywhere.

Squad Stakes is a brigade-planned and battalion-executed program that integrates the engineer qualification tables (EQTs), mission-essential task list (METL)-related tasks, and individual combat skills into a single, comprehensive, scenario-based evaluation. EQT tables I through IV are included in Phase I, and tables V through VIII are included in Phase II. The METL crosswalk is used to ensure that all perishable individual skills and battle tasks are included. Figure 1 shows the composition and timing of each phase of Squad Stakes.

Semiannual Squad Stakes Scheduling

January	February	March	April	May	June
Leader Certification Phase I - - - - - - - - -	- - - - - - - - - CTT Weapons	- - - - - - - - - APFT	Phases II and III	Company STX (engineer platoon exercise evaluation)	CMTC

Figure 2

Squad Stakes reinforces the effectiveness of the Army's widely recognized training doctrine by focusing on the results of the training. The measure of effectiveness is not the outcome of the program; it is the performance of squads during combined arms training exercises such as those at the Combat Maneuver Training Center (CMTC). By scheduling the Stakes so they support sequential and progressive training plans of the supported maneuver brigades, engineer battalions make better use of available combined arms training opportunities. For example, if Squad Stakes is scheduled before company-level combined arms simulation training exercises (STX), quality engineer platoon exercise evaluations can be conducted during the company STX. A typical semiannual scheduling of Squad Stakes is shown in Figure 2.

Bragging Rights

Squad Stakes training is based on the fundamental assumption that soldiers will strive for excellence and maintain a high level of combat readiness if they—

- Can trust their leaders to be committed to maintaining squad integrity.
- Are held accountable to their squad for achieving and maintaining high performance standards.
- Can win recognition ("rights").

The objective of Squad Stakes is to stimulate bottom-up motivation to train by combining the effects of squad integrity, accountability, and recognition. These three principles work together to create a training environment that makes our training doctrine work as it was designed to work—from the bottom up.

Integrity

Squad integrity demands that leaders be committed to prudent personnel management practices. S.L.A. Marshall concluded in *Men Against Fire* that soldiers in combat fight for each other. The same must be true in peace. Our training programs, and not just those at our combat training centers, must place every soldier in the situation Marshall described. A squad's cohesion and confidence cannot be tested the first time against a live enemy. Soldiers must be able to work together, and Squad Stakes measures their commitment to each other.

Maintaining squad integrity is essential to building the cohesion and confidence necessary to succeed in combat. Our personnel management practices play a significant role in achieving commitment among soldiers. Whether assigning new personnel, task organizing for a mission, or managing personal development, our actions tell soldiers whether their team is as important to us as it is to them.

Some practices that contribute to squad integrity are—

- Manning squads at a level that permits some soldiers to be absent (for school, leave, etc) and still have adequate squad strength to conduct viable training.
- Minimizing personnel turbulence by reassigning soldiers for developmental reasons only, such as reassignment as a team or squad leader upon promotion.
- Attaching squads to platoons in another battalion when task organizing, which demonstrates the combat power effect of unit cohesion.

These and other practices establish the foundation for maintaining combat-ready squads. Once this basis for cohesion has been established, the squad can legitimately be held accountable for its training.

Accountability

Accountability of individuals to the team is vital to developing cohesion. Squad Stakes fosters individual accountability by integrating the evaluation of individual and collective tasks. The overall squad evaluation is a two-tiered process. First, all tasks are evaluated against Army standards. Then the results are combined to determine an overall squad evaluation. The important point is the integration of individual and collective evaluations.

The following example describes the effect of this integration: A squad failed to achieve Distinguished Squad status because one soldier failed the APFT by one sit-up. The individual wasn't blamed for the squad's failure. Instead, the squad realized that had they stayed together and pushed each other during the APFT, they all would have done better. They also discovered that Distinguished Squads had more vigorous physical training programs. They took these lessons to heart and achieved Distinguished Squad status on subsequent Stakes.

Squads are scored as a squad on every phase. While scoring is essential to setting high standards, Stakes is a training event. Failure to achieve minimum standards requires immediate retraining and re-evaluation. The scoring mirrors tank and infantry tables to reinforce a common combined arms language; a score of 900 is distinguished and 700 is qualified. Figure 3, page 46, shows the scoring for each phase.

The scoring system reinforces integration of individual and collective tasks by establishing high standards for each task as

Squad Stakes Scoring

Phase I: Individual Skills (300 Points)

- CTT: The squad is tested as a squad.

  100 points for all first-time GO.

- APFT: All members must pass the test.

If APFT score is:	Squad average score is:
290-300	100 points
270-289	90 points
250-269	80 points
240-249	70 points

- Weapons: Individuals are awarded points:

  Expert: 100 points

  Sharpshooter: 90 points

  Marksman: 80 points

  The squad score is the average of individual scores.

Phase II: Squad Drills (600 Points)

- Consists of six lanes of 100 points each, with four to six drills per lane.

  Score on each lane: Percent of subtasks correctly accomplished x 100.

  Failure of one critical subtask = failure of task.

Phase III: 12-Mile Ruck March (100 Points)

- Start, execute, and finish as a squad.

Score:		
3 hours or less	=	100 points
3-4 hours	=	90 points
4-5 hours	=	80 points

Figure 3

well as for the overall event. The ultimate objective of every squad is to achieve recognition for its continuous training efforts. It is impossible to achieve distinguished status without continuous training.

Outstanding performance is recognized by a Distinguished Squad Badge—a distinctive bronze badge attached to a leather tab and worn suspended from the inner button of the right upper BDU pocket. To earn this badge, a squad must achieve a first time GO on every task and achieve an average score of 90 percent or more for all phases combined. To date, the success rate is 20 percent.

Visible recognition is important to soldiers. In addition to the badge, the distinguished squad symbol is stenciled on squad vehicles.

Recognition

Recognition is fundamental to motivation. Soldiers and leaders must want to train every day. Given the proper motivation, they will find ways to control the impact of limited resources, "hey you" missions, and other distractions that are often cited as reasons why training cannot be conducted. Clearly, it takes more than just a badge to stimulate motivation. Squad Stakes stimulates motivation for rigorous and continuous training by making recognition meaningful through the following:

- High but achievable standards.
- Squad leader responsibility for achieving results.
- Integration of the full range of individual and collective tasks.
- Competition against standards rather than the performance of other units. The best unqualified unit is still unqualified.
- Visible recognition of performance (bragging rights).
- Reinforcement of the chain of command.

We have all known or been members of teams that exceeded the wildest expectations of the collection of average individuals brought together by fate. We have experienced the power of teamwork when it raises the level of every individual beyond their best performances. We have experienced the bonds of shared hardships and the resulting commitment to the team over any individual. Squad Stakes capitalizes on the power of those human experiences.

We have also experienced the human desire to advertise our association with a winning team. Pride is born of success against tough odds. Bragging rights belong to the team whose long-term commitment to hard work lifts them to the highest standards of team and individual performance.

Squad Stakes bragging rights include:

- Award of the Distinguished Squad Badge by the division commander. (The CG pins a badge on each recipient.)
- Award of a division commander coin.
- Award of an Army Achievement Medal to each squad member.
- Award of a serial-numbered engineer brigade coin and a coin certificate.
- Squad entry into the Engineer Brigade Hall of Honor.
- Selection for special training missions.

Special Missions

Squad Stakes does not end at the finish line of the ruck march. Distinguished squads are immediately given priority for special training missions, such as—

- Bern, Switzerland, 50-kilometer ruck march (squad members earn Swiss commendation medals).
- Nijmegen 100-mile ruck march (squad members earn medals).
- Elbe Stoehr best-ranger competition, an international infantry competition (teams may win trophies).

Special missions help sustain the motivation to maintain a high level of readiness. They give squads tougher challenges to prove their true worth and afford further opportunities for recognition. Special missions also demonstrate the commitment of the chain of command to achieving and maintaining high standards. Squad Stakes reinforce the chain of command in other ways too.

Reinforcing the Chain of Command

Leaders are responsible for setting and enforcing standards. One critical element of the Squad Stakes is the role of leaders. All leaders are employed in a manner that reinforces the chain of command, takes greater advantage of the experience and responsibilities of senior noncommissioned officers, and provides opportunities for leader development. Some leaders' roles are listed below:

- Brigade commander: Establish and enforce standards.
- Brigade command sergeant major: Conduct Brigade Leader Certification Exercise.
- Battalion commander: Plan and execute Squad Stakes.
- Battalion command sergeant major: Train and evaluate platoon sergeants.
- Company commander: Train platoon leaders and operate company command post.
- Company first sergeant: Train platoon sergeants and monitor lane standards.
- Platoon leaders: Serve as lane officer in charge and evaluate troop-leading procedures (follow the squad in its own track while negotiating each lane).
- Platoon sergeant: Serve as lane NCO in charge and evaluate all tasks (ride with the squad).
- Squad leader: Lead the squad to achieve standards.

Leader Certification Exercise

Before every Squad Stakes, a Brigade Leader Certification Exercise is conducted to ensure that all leaders understand the standards and how to evaluate individuals and units against the standards. Using Army standards for all tasks, the brigade command sergeant major organizes and runs the exercise with the assistance of the battalion command sergeants major. Company first sergeants serve as trainers for the exercise. The primary training audience is platoon sergeants since they are the chief evaluators during the Squad Stakes. The exercise consists of the following steps:

- Each platoon sergeant is issued a copy of the evaluation standards.
- All platoon sergeants simultaneously observe the execution of each task by an individual or squad (videotape is an option).
- All platoon sergeants independently grade the task.

After each task is evaluated, the command sergeants major discuss whether each subtask should have been evaluated as GO or NO GO. Discussion continues until all platoon sergeants clearly understand how the task should be performed.

Squad Stakes places senior NCOs in teaching and mentoring roles. Too often first sergeants and platoon sergeants become focused on administrative and logistic functions at the expense of their tactical expertise. Not only is their experience irreplaceable, their example is critical to the development of junior NCOs and officers.

Leader Development

Squad Stakes offers several opportunities for developing leaders. For platoon leaders, participation in the Leader Certification Exercise and the Stakes is one of their most significant developmental experiences. During the certification, they gain an appreciation for the professionalism, knowledge, and experience of their platoon sergeants by observing the execution of each task and the subsequent discussions among senior noncommissioned officers.

During the Stakes, platoon leaders serve as platoon leaders on a lane. They are responsible for issuing the order to squad leaders, accepting reports (according to the tactical SOP) during the conduct of the lane, and evaluating troop-leading procedures at the conclusion of the lane (by conducting an after-action review with squad and team leaders). Since troop-leading procedures are not scored as part of the evaluation, new platoon leaders are routinely tasked to head lanes (with their own platoon sergeant) to give them the experience of leading squads. This provides platoon sergeants with an ideal opportunity to establish a closer relationship with their platoon leaders and begin the training process of our Army's newest leaders.

The brigade derives much from this exercise: increased cooperation between battalions, greater standardization of unit performance, increased professional development of leaders, and more. The ultimate benefit is the ease with which task organizations are built because of the clear understanding of standards between units. Maneuver units confidently expect, and receive, the same standards of performance from any unit in the brigade.

Summary

Squad Stakes is a comprehensive readiness program that combines the effects of commitment to squad integrity, the dynamics of squad members holding each other accountable for maintaining high levels of readiness, and worthwhile recognition for outstanding performance. Whether squads achieve distinguished squad status or not, they are motivated from within to take responsibility for their training. They strive to achieve and maintain a level of combat readiness that instills a strong sense of confidence in their ability to fight any enemy, win, and survive to fight again.

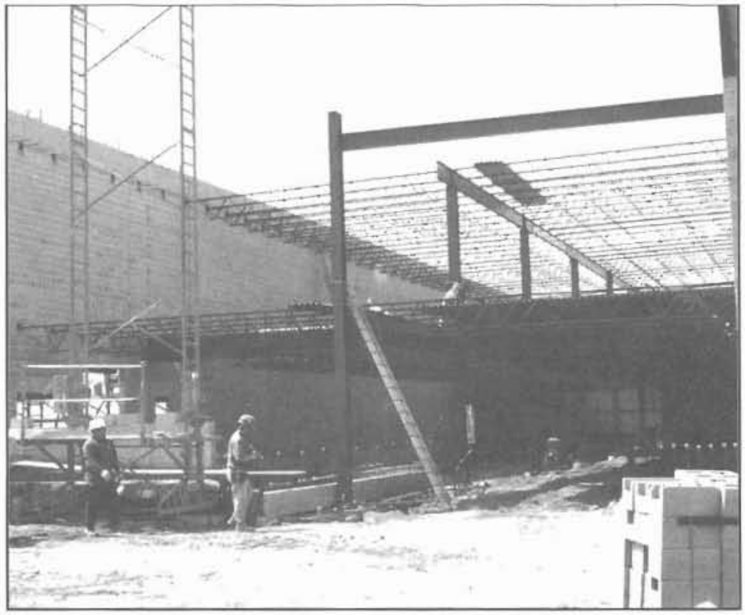
Colonel Schroedel is executive officer for the Secretary of the Army. He previously commanded the 1st Infantry Division Engineer Briagde and the 1st Engineer Battalion. COL Schrodel has served in tactical units throughout most of his Army service.

Delivering High-Quality Products With the CPM

By Captain Ivan P. Beckman

The goal of the U.S. Army Corps of Engineers is to deliver high-quality projects to its customers—on time and at cost. The Critical Path Method (CPM) of construction management is one technique used to achieve this goal. The CPM is a graphic tool for coordinating five aspects of construction—time, people, materials, equipment, and money.

While every construction contract would benefit from using the CPM, it is often neglected by both the government and the contractor and used only to process pay applications. However, the CPM is essential to fighting unnecessary time delays and cost overruns. As effort is put toward the critical path, certain elements may no longer remain critical and other key tasks may become critical. The CPM is essential in identifying the migration of critical elements. This article describes how everyone involved in a construction project benefits from using the CPM and gives examples of how it can be applied in the field.



Using the CPM helps keep construction projects, such as this maintenance facility at Tinker Air Force Base, Oklahoma, on schedule.

Valuable Tool

The Critical Path Method is a valuable tool for the government, the customer, and the contractor. By using this graphic management tool, it becomes obvious when unexpected events affect a project and require coordination.

Government

The government's representative must challenge every proposed change against the CPM and force the contractor to use his schedule. The CPM is a tool to supervise and manage construction and to prevent unnecessary delays in critical path activities. For example, the customer may request a minor change in an activity that will impact a critical activity. The government should use the CPM to show the customer how the change will delay the contract completion date and increase overhead costs. This information, which the customer may have overlooked, will help with decision making at all levels. The government should use the CPM as a negotiating tool by challenging time extensions for modifications and allowing them only if the contractor proves an impact on the critical path.

Customers

Customers should use the CPM as a requirements and date planning tool. By following the CPM, they will gain a greater understanding of a project's completion, which may be before or after the original estimate, and they will know when to move tenant units into and out of facilities. Customers can use the CPM to develop their own movement time line. They will also know when to provide equipment to the contractor that is government-provided/contractor-installed, based on the contractor's schedule.

Contractor

By correctly applying the CPM technique, contractors can greatly improve their job performance through resource leveling. Prime contractors can cross-level and focus their labor force and equipment on activities that have critical path importance. Subcontractors can see how their work fits into the project and can improve scheduling, planning, and ordering. Construction superintendents and project managers must be the primary keepers of the CPM.

Applying the CPM

Use of the CPM in field units saves time and money. It allows contractors as well as the government and customers to realize the relative importance of every construction activity based on the float time available and network logic. An activity that is delayed more than the allowable float time delays the entire construction project by the same amount of time. Delays that affect the critical path of a project are costly to contractors and the government. If a project is delayed, the contractor pays his extended overhead

How the Critical Path Method Works

The following examples show how the CPM can be used:

Project One

A contract modification was required to change the size of a chiller and provide additional cooling capacity in a new facility. The chiller had not yet been ordered. The contractor claimed an additional 28 days of delay for which he was due a time extension and extended overhead in the amount of $56,000. The potential time extension would cause the user-need-by date to be missed by a month. The new facility's user had invested considerable time and planning in an anticipated turnover date and would experience planning difficulties and added cost to extend a lease and delay the movement. During negotiations, the government required the contractor to use the CPM to explain his time extension request. The contractor identified one key activity in the CPM—"Install Chiller"—that the change affected and which caused all other delays. A study of the CPM showed that "Install Chiller" had 43 days of float time. The activity's early-start date was more than 12 weeks away, while the contractor's proposal cited a 12-week period to order and receive the chiller. The government representative suggested that through the logic of the contractor's CPM, he was not due additional time for the modification. The contractor, not able to argue against his own logic, conceded that the additional time extension was not required and dropped the requested time delay from the proposal. This saved the government considerable money and time.

Project Two

The project superintendent and quality control manager conducted construction planning on the project CPM, which was posted in the office trailer. The contractor updated activities with actual start and finish dates and color-coded activities to indicate completion status. The superintendent used the CPM to notify subcontractors of upcoming work requirements. Subcontractors used the CPM to schedule their work based on the completion of the preceding construction activities. The contractor used the CPM to closely watch critical path activities, which received priority effort. The contractor effectively cross-leveled resources (workers and equipment) for the benefit of the project. On this project, the contractor could boast that he was still on the original schedule despite 27 days of weather delay. This was mainly due to the contractor's understanding and application of the CPM technique on the job. It is important that project superintendents master their project schedules and the CPM technique early in the life of their projects.

along with liquidated damages. However, if a contractor is granted additional time as part of a modification, the government pays the price with money and time. The government must challenge each time extension against the CPM to determine if it is legitimate and then appropriately compensate the contractor.

Using the CPM also improves construction quality. Contractors can schedule construction activities during the best conditions within float-time windows. For example, it is not necessary to rush a concrete project during the winter if there is adequate float time for the activity to be done in the spring. Depending on preceding and subsequent activities, it may be possible to pour floor slabs after a weather-tight facility is built to control concrete curing conditions. Float time and network logic can and should be used to schedule activities under the best possible conditions.

The following suggestions may help project engineers apply the CPM in the field:

- **Scrutinize the preliminary CPM.** Contractors are required to provide the government with a preliminary CPM within 30 days after a notice to proceed, which covers the first 60 days of work. During that 60 days, contractors must produce a detailed initial CPM that covers the entire contract.
- **Scrutinize the initial CPM.** Ensure that construction superintendents and project managers explain their initial CPM in detail. Some contractors hire a subcontractor to write the CPM, and the subcontractor may turn it in for approval without the construction superintendent seeing it. Carefully review a contractor's submittal, and if the schedule doesn't seem logical, require a resubmission.
- **Emphasize construction superintendents' ownership of CPMs.** Superintendents must understand the logic of their CPMs and the importance of critical path activities. They must know which activities have float time and how much time is available per activity. Ensure that superintendents post their CPM in their construction trailer and keep it updated. Using the superintendents' CPM as a guide, frequently discuss the construction status with superintendents and project managers.
- **Scrutinize contractors' CPM updates.** Contractors are required to submit an updated CPM with every pay application along with a short narrative describing changes in the network since the last pay application. Reject the pay application if an update is not included. Ensure that contractors follow their own schedules.
- **Use the CPM in negotiations.** Contractors must use the CPM to justify all requests for time extensions due to weather delays and construction modifications. Contract time extensions should be granted only if critical path activities are delayed.

Key to Success

The Critical Path Method is the construction management tool of choice for project engineers in the field. When it is applied correctly, the government protects itself from excessive time delays and cost increases; contractors provide higher-quality projects on time and at cost; and customers gain a greater understanding of projects and increase their ability to plan. A mutual understanding of projects through the CPM provides the government, contractors, and customers the key to construction success.

Captain Beckman is a project engineer in the Tulsa District, U.S. Army Corps of Engineers, Southwest Division.

PALLETIZED LOAD SYSTEM:
STREAMLINED ACQUISITION SUPPORTS ENGINEERS

By Peter Motzenbecker and Gregory C. Edgin

An article in the April 1995 issue of *Engineer*, "Applying PLS Technology to the Engineer Fleet," detailed the benefits of load-handling system technology to engineers. The article illustrated some proposed equipment changes that resulted from inserting the Palletized Load System (PLS) as a prime mover in engineer combat heavy battalions. Since then the PLS project manager has worked with personnel from the U.S. Army Engineer School to refine engineer user concepts and economically produce PLS-compatible hardware for soldiers in record time. By employing streamlined acquisition initiatives and the integrated team approach, they have made it possible to field the first engineer-specific mission modules 31 months after initiating the acquisition process (see figure). This represents a significant decrease in the normal product acquisition time of 48-60 months and allows the integrated process team (IPT) to get badly needed, modernized equipment into the hands of soldiers.

PLS Engineer Mission Module Time Line	
Start acquisition process	February 1997
Award contract	September 1997
Deliver hardware	March 1998
Complete OT/DT	December 1998
Begin fielding	September 1999

Analyzing the Need

Engineer School personnel and the PLS project manager commissioned a detailed analysis of engineer units and missions to determine the best way to exploit the mobility and interchangeable payload/module capability of the PLS truck. Analysis showed that significant savings could be achieved using the PLS rather than currently fielded equipment, particularly for horizontal construction tasks. For example, in the 40-mile "Road Damage Repair" task, PLS trucks and trailers outfitted with a PLS dump module reduced project completion time by 68 percent. Using the PLS truck and trailer to complete the "Ammunition Storage Construction" task resulted in a 53 percent reduction in project completion time.

The PLS and engineer communities decided to pursue procurement of the PLS flatrack-based engineer mission modules (EMMs) to replace the individual, single-purpose systems acquired in the past. For example, the M918 bituminous distributor and the M919 concrete mobile mixer were fielded in the 1970s and had less-than-favorable operational readiness histories. Both systems were mounted on dedicated chassis and, by the nature of their missions, were used infrequently. To complete the modular concept, another system—a dump truck—was needed to supplement the bituminous distributor and concrete mobile mixer.

An EMM integrated process team was formed in February 1997 to review the available information. The team visited a field unit that had M917, M918, and M919 trucks; viewed the equipment in its operational environment; and interviewed soldiers. The team evaluated individual features of the equipment for incorporation of commercially available improvements. The goal was to reduce acquisition and support costs while increasing performance.

An example of needed improvements was the concrete mobile mixer's auger bearings. They had to be greased before every use but still some failed when the mixer operated in a harsh alkaline environment. The IPT identified a need for sealed, lube-for-life bearings.

As with other types of sustainment engineering equipment, the EMMs would be nondevelopmental items. Therefore, emphasis was placed on standard commercial equipment and features. The intent was to mount the standard commercial body on a standard PLS-compatible M1077 flatrack. The only nonstandard features would be those needed to integrate the body onto the flatrack.

Engineer Mission Modules

The evaluation process resulted in a low-rate-initial-production contract for the following EMMs:

Bituminous Distributor

This 2,800-gallon unit has computer-controlled spray rates that adjust to changes in vehicle speed, which is sensed by a radar unit that does not require ground contact. Two diesel-fired burners heat the bitumen. A folding spray bar is a unique feature required to integrate the unit on the PLS flatrack. A universal power interface kit (UPIK) mounted on the PLS truck provides hydraulic, electric, and pneumatic power connections through the use of quick-disconnect fittings.

Concrete Mobile Mixer

The mixer can be used on the PLS truck or trailer or as a ground-mounted, stand-alone unit. In the transport mode, the capacity is five cubic yards, and in the stand-alone mode, the capacity is eight cubic yards. To accommodate stand-alone operation, an on-board diesel power supply provides all hydraulic, electric, and pneumatic power. Stand-alone operation is accommodated by four hydraulic legs that lift the flatrack off the ground and provide the clearance required to operate the mixer continuously. Two tanks with a total capacity of 460 gallons provide water for concrete production and cleanup. The water tanks can be loaded either conventionally or from a pond or stream with the on-board pump. Three extension chutes allow the concrete to be emplaced up to 12 feet away.

Dump Body

This equipment has a capacity of 12 cubic yards without sideboards and 14 cubic yards with sideboards. It can be operated from both the PLS truck and trailer. The body and tailgate are controlled from the cab. The PLS truck-mounted

The versatility of the PLS system with EMMs is depicted in this photo of the EMM concrete mobile mixer with PLS dump body. Upon arrival at the work site, the PLS truck can off-load the concrete EMM for stationary operation, then load the dump body from the trailer to perform dump operations.

The EMM water-distributor module is intermodal transportable and is powered by its own diesel engine. It has a 3,000-gallon, stainless-steel tank and is equipped with a self-loading, 600-gallons-per-minute pump unit. The water cannon's 175-foot spray range complements the 50-foot hose and nozzle.

UPIK provides power for the body. The bed is constructed of 0.250-inch-thick high-hard steel, and the headsheet and sides are of 7-gage steel. The tailgate is a combination of 7- and 10-gage steel.

Testing

After first-production unit hardware is delivered, developmental testing (DT) usually is completed before operational testing (OT) with soldiers in mission scenarios begins. Because the PLS chassis had already been fully tested and released, much of the normal automotive developmental testing was unnecessary. Developmental testing personnel saved both time and money by collecting their data during the operational testing phase.

Fielding of engineer mission modules is scheduled to begin in September 1999. Bituminous distributors will replace M918s one for one in construction support companies, combat heavy companies, and at the Engineer School. Concrete mobile mixers will replace M919s one for one in combat heavy companies, utility teams, port opening companies, and at the Engineer School. While not intended to replace a particular dump truck, dump bodies will displace two dump trucks in each utility team, six from each port opening company, and two from each construction support company.

The Future

What does the future hold for engineer mission modules? A water-distributor prototype unit has been produced and is currently being evaluated by soldiers. This unit has a 3,000-gallon capacity and would replace the M920 tractor and 6,000-gallon semitrailer-mounted unit. A water-distributor module on the PLS truck and one on the trailer would provide 6,000 gallons of nonpotable water in a highly mobile package. The water-distributor module could be configured for use in an auxiliary fire-fighting mission. Additional modules under consideration include a well-drilling rig, a mobile shop, a rock crusher, a mobile crane, and a water-purification module.

The EMM integrated process team is showing the engineer community what they can expect in the future by aggressively pursuing new and innovative contracting opportunities. We have taken that first critical step by streamlining the processes required to get the best equipment to soldiers in record time. Future efforts will focus on expanding on these successes to increase our visibility and utilization within the engineer community.

Mr. Motzenbecker serves as project leader on engineer mission modules and is the systems engineer on the PLS. He is Level III Acquisition Certified in Systems Planning, Research, Development and Engineering. Mr. Motzenbecker holds a bachelor's degree in mechanical engineering from Michigan Technological University.

Mr. Edgin is a project manager and technical lead for Science Applications International Corporation in support of the project manager for heavy tactical vehicles. He holds a master's degree in management from Walsh College of Business and Accountancy.

PERSCOM Notes

By Sergeant Major Teressa Fillmore

Due to recent changes in the Engineer Branch, there are several changes in the personnel who serve you. I will take this opportunity to introduce new members of the Engineer Branch at the Personnel Command (PERSCOM).

- Sergeant Major Theressa J. Fillmore, military occupational specialty (MOS) 75H, Branch Sergeant Major.
- Master Sergeant Harry Pomeroy, MOS 12Z, Professional Development Noncommissioned Officer (PDNCO), career management field (CMF) 12.
- Sergeant First Class Susan L. Fortune, MOS 81T, PDNCO and Assignment Manager, CMF 81.
- Sergeant First Class Andre Williamson, MOS 62N, PDNCO, CMF 51.

SGM Fillmore has an extensive 24-year background in personnel. She has served at company, battalion, brigade, corps, echelons above corps, and post levels, in both tables of distribution and allowances (TDA) and modified tables of organization and equipment (MTOE) units. She has held assignments with the Aviation, Signal, Military Intelligence, Engineer, and Air Defense Artillery Branches and the Recruiting Command. At the company, battalion, and brigade levels, she has served as the company clerk, Personnel Services (PS) NCO, and the Personnel Administrative Center (PAC) NCO in various locations. Her experience with engineers includes PSNCO and PAC supervisor for three years in a One-Station Unit Training battalion at Fort Leonard Wood. At the corps level, SGM Fillmore was the G1 sergeant major for V Corps Headquarters in Heidelberg, Germany, and deployed with Operation Joint Endeavor as the DCSOPS (FWD) sergeant major. At echelon above corps, she served on the U.S. Army Europe's DCSPER staff as a force structure NCO. At the post level, she was most recently the Adjutant General sergeant major at Fort Bliss, Texas. SGM Fillmore has attended all requisite leadership schools. She arrived at PERSCOM in May 1999 and expects to serve two or three years with the Engineer Regiment.

A Vietnam veteran of the First Cavalry Division, MSG Pomeroy re-entered the Army in 1982, serving in the 19th Engineer Battalion, Fort Knox, Kentucky. After completing an assignment with the 547th Engineer Battalion in Germany, he served with the 5th Engineer Battalion at Fort Leonard Wood, Missouri. He then returned to Germany and the 54th Engineer Battalion. Next he completed a tour as observer/controller at the National Training Center, Fort Irwin, California. He recently served as first sergeant, 588th Engineer Battalion, Fort Hood, Texas. MSG Pomeroy has served in Operation Desert Storm and has held numerous leadership positions as squad leader, platoon sergeant, engineer platoon trainer, and first sergeant. MSG Pomeroy arrived at PERSCOM in May 1999, ready to serve the Engineer Regiment.

SFC Fortune joined the Army in January 1983. After completing initial entry training at Fort Dix, New Jersey, and Fort Belvoir, Virginia, she was stationed at Fort Hood, Texas, as a cartographer. Later she transferred to the 29th Engineer Battalion, Fort Shafter, Hawaii. During this time she reclassified to terrain analysis and served for two years as a terrain analyst for the 25th Infantry Division (Light), G2 Terrain Team. She then returned to Fort Belvoir for four years as an instructor for the basic and advanced terrain analysis courses at the Defense Mapping School (DMS). During her last year at DMS, she also served as an air assault instructor. She attended Drill Sergeant School and successfully completed a two-year tour at an Advanced Individual Training company at Fort Belvoir. Her next assignment was in Hawaii for three years. During this time she served as platoon sergeant for the terrain platoon of the 70th Engineer Company, 29th Engineer Battalion. She spent two years as NCOIC of the 25th Infantry Division (Light) Terrain Team. SFC Fortune arrived at PERSCOM in January 1999 and plans to move on as a first sergeant after completing her tour.

SFC Williamson joined the Army in October 1979 as a cannon crewman. After a two-year tour at Fort Hood, he spent 27 months in Germany. Later he reclassified to a 62J general construction equipment operator at Fort Hood. He transferred to the 503rd Engineer Company in Germany for 26 months and then spent six years at Fort Benning, Georgia, with the 43rd Engineer Battalion (Heavy), serving as a section sergeant. During that tour he supported Operations Desert Shield and Desert Storm, Operations Restore Hope and Continued Hope in Somalia, hurricane relief missions in South Carolina and Florida, and a nation-building project in Costa Rica. SFC Williamson returned to Germany for four years with the 94th Engineer Battalion (Heavy), where he served as a platoon sergeant and battalion horizontal construction inspector. During this tour he spent 16 months deployed in support of Operations Joint Endeavor, Joint Forge, and Able Sentry. After completing a tour at PERSCOM, he hopes to be assigned as a first sergeant in a combat heavy battalion.

The staff at PERSCOM remains committed to providing excellent, professional service to the field. We are part of the engineer team and will work to make the Engineer Regiment more effective by placing the right people in the right places at the right time.

Sets, Kits, and Outfits: An Update

By Alan Schlie

This is the first of four articles on sets, kits, and outfits. This article focuses on tools for the construction trades; the second will concentrate on pioneer, mining, and demolition tools; the third on bridging, diving, lighting, and fire-fighting tools; and the fourth article will feature tools for technical specialties.

The successful accomplishment of every mission is linked to one or more sets, kits, or outfits (SKOs) that contain the soldiers' tools of the trade. While the principal "tool" for every soldier is a weapon—rifle, pistol, howitzer, tank—numerous SKOs allow soldiers to perform individual tasks such as assembly, operation, maintenance, repair, packing, or lighting activities. Each weapon has a cleaning "kit," and if it is not used properly, the weapon doesn't function for very long.

Definitions

How do sets, kits, and outfits differ? A *kit* is a collection of tools or components in a small bag or pouch, designed for use and carried by an individual or a crew. For example, weapons have cleaning kits, and a mechanic's toolbox is a kit. A *set* is a collection of tools used by a group of soldiers (a squad, section, or platoon) to perform an organizational mission. A set may include tool kits but not other principal items of equipment that are assigned a line item number (LIN). The squad carpenter's set includes a file kit and a chisel kit. An *outfit* is an assemblage of tools or equipment that may include separately type-classified items as a component. A pneumatic tool outfit contains an air compressor and a trailer (separate major items) and numerous pneumatic hand tools, some of which have individual LIN identification.

The Engineer School is the proponent for 123 SKOs that include tools for topographic support systems, lighting, fixed and float bridging, general and topographic surveying, fire fighting, diving, railway construction and repair, electric power generation and distribution, demolition, mine laying and marking, pipeline construction, drafting, and materials testing. Other SKOs include hydraulic and electric construction tools; carpentry, masonry, electrical, and plumbing tools; and pioneer tools. The school works closely with various agencies in the Army Materiel Command to develop, document, and field SKOs. Rock Island Arsenal is currently fielding the hydraulic electric tool outfit. Tank-Automotive and Armaments Command at Warren, Michigan, is beginning a comprehensive review of all bridge sets. Communications-Electronics Command at Fort Monmouth, New Jersey, is the compiler for light sets and other sets containing electronic components. General Services Administration in Kansas City assembles all SKOs containing construction-related hand tools.

The Organization Branch of the Engineer Directorate of Combat Developments, which is responsible for developing and reviewing SKOs, began a five-year cyclic plan in 1998 to upgrade every SKO. Partnering with a commercial tool supplier has allowed the Engineer School to make several SKOs available for purchase at a time when the pace of unit deployments accelerates and the utilization of state-of-the-art tools speeds mission accomplishment. Field involvement and user testing in this developmental process ensures that tools meet soldiers' needs. In addition, regulatory guidance is being updated to include both generic and specific authorizations. This is necessary to add SKOs that were not included in the regulations and that units were hesitant to request. Regulatory guidance describes the SKOs, lists items needed to support them or that they support, and includes shipping characteristics.

Carpenter's Sets

As a result of the recent review of carpenter's sets, components were realigned, creating a stand-alone squad box of hand tools that is supported by increasingly versatile platoon boxes. The platoon boxes previously included seldom-used tools and extra handles or tools for special applications. Because of the review, some hard-to-maintain tools were replaced by tools that are more commonly used by the construction industry today.

The **Squad Carpenter's Set** still contains nonpowered hand tools. New items include speed squares; heavy-duty tool belts; heavier, waffle-faced framing hammers; shingling hammers; taping knives; and a nut driver kit. The set weighs 120 pounds and is packed in a 9-cubic-foot transport case.

The **Platoon Carpenter's Set** has saws and drills powered by 18-volt batteries. The set is completely reconfigured with 5 3/8-inch trimcut saws;1/2-inch variable speed, reversing drill/driver/hammers; a reciprocating saw; a jig saw; and numerous drill bits and saw blades. The set weighs 130 pounds and is packed in a 12-cubic-foot transport case.

The **Trailer-Mounted, Woodworking, Base Maintenance Shop Equipment Set** contains electric saws and drills and pneumatic nailers. The set consists of three subkits, each in its own transport and storage box and designed to fit on the trailer with the 10-kilowatt generator.

The *Table Saw and Router Kit* consists of a 10-inch portable table saw and stand; a plunge router; a jig saw; and blades, bits, and extension cords. This kit weighs 300 pounds and is packed in a 20-cubic-foot transport case.

The *Multisaw and Drill Kit* contains a 12-inch miter/compound saw; a 14-inch circular chop saw; a 10 1/4-inch circular saw; a 7 1/2-inch circular saw; a reciprocating saw; 1/2-inch drive variable speed drills; an electric shear/nibbler; and various clamps, blades, bits, countersinks, and circle cutters. This kit weighs 335 pounds and is packed in a 20-cubic-foot transport case.

The *Pneumatic Nailer and Compressor Kit* consists of an electric, 2-horsepower air compressor; two pneumatic framing hammers; nail pullers; 150 feet of air hose; a moisture separator; couplers; and extension cords and nails. This kit weighs 315 pounds and is packed in a 13-cubic-foot transport case.

Platoon Carpenter's Set

Table Saw and Router Kit

The **Mason's and Concrete Finisher's Tool Set** has been reconfigured to support a platoon, with enough individual tools for six soldiers to lay block or brick. Twenty-four feet of interchangeable, sectionalized handles fit the brooms, screeds, and floats, enabling the components to fit into the transport case. The set includes mortar pans, boards, and stands; various floats, edgers, and trowels; knee boards; buckets; a rebar cutter/bender; a side wheel grinder; mason's shovels and hoes; hand pump sprayers; a laser level; and buckets, nozzles, and garden hoses. New additions are a 3-cubic-foot-capacity, gasoline-powered mortar-mixing machine; 16-foot ladders; 12-foot collapsible ladders; 3-foot-high portable stands; and four sections of 5-foot-high by 8-foot-long scaffolding, with walk boards and casters.

The **Electrician's #1 Tool Set** will continue to support squad-level electricians with the latest in protected hand tools. Included in the upgraded set are an 18-volt cordless saw, a drill/driver/hammer, a reciprocating saw, a snake light, a right-angle drill, a tool set with various circuit-testing devices, lockouts and padlocks, work belts, a laser level, fish tape, a bounce light, flood lights, extension cords, and a site box. The normal assortment of saws, chisels, hammers, benders, blades, strippers, sockets, hex keys, and wrenches have been retained in upgraded motif.

Mason's and Concrete Finisher's Tool Set

The **Pipefitter's 1/8-Inch- to 2-Inch-Diameter Pipe Tool Kit and Pipefitter's 2-1/2-Inch- to 4-Inch-Diameter Pipe Tool Kit** have been combined into a single set that is allocated to the platoon. There's an assortment of pipe wrenches, cutters, and reamers; a hand-driven and electric die head-threading machine; a tristand chain vise; powered drain cleaners; recycling oiler; heat gun; propane torch kits; a bounce light; and flood lights. The normal complement of pliers, screwdrivers, pry bars, chisels, levels, work belts, flux, solder, PVC fixative, Teflon tape, extension cords, and job site box are provided. This set is in its final stages of development.

Safety equipment provided in each box includes ultraviolet eye protection, antifog goggles; ground fault circuit interrupter surge protectors; dust masks; and rubber hand guards on chisels. Carpenter hammers and hatchets have steel handles, and handles on other hammers have a black plastic covering over a fiberglass core. This is a recently patented process by NUPLA Corporation that increases comfort and reduces stress to users' arms.

New transport and storage cases represent the latest in manufacturing. The cases are rotationally molded of high-quality polyethylene resins to military specifications. They are resistant to solvents and acids. The color is molded in, so they never need painting. The edges are rounded to reduce the risk of injury. They are stackable and can be loaded or moved by forklift. They are airtight to keep out dirt and moisture, can be decontaminated, and are recyclable. The handles are high-strength, high-density polyethylene that is unaffected by common fuels or solvents. They are recessed and spring loaded to stay out of the way. And they offer a grip that's comfortable and big enough to easily accommodate a gloved hand. Noncorrosive, nonreflective metal catches, hinges, and strikes are placed in recesses to prevent being sheared off during rough handling. Stainless steel inserts are molded in to give catches, hinges and strikes added strength.

The tool sets developed so far have been used successfully during deployments to Mongolia, Bangladesh, Thailand, and Honduras by combat heavy units from Hawaii, Fort Lewis, and Fort Polk. Eventually, the sets will be issued to all units, but for now they must be purchased with operational funds.

The good news is the warranty on the tools. Any tool that becomes inoperable or presents a safety hazard through "fair wear and tear" will be replaced at no charge. GSA and the tool supplier have created 1-800- telephone numbers to facilitate the exchange. The bad news is in fielding the sets. Current regulatory guidance requires units to purchase upgrades to SKOs with their operational funds. The Engineer School has chosen to make the SKOs available for units to purchase until fielding plans and alternate funding programs are developed. National stock numbers (NSN) for the new tool sets will be rolled under the SKO's LIN, because it is the LIN that is authorized in the modified table of organization and equipment, not the NSN. This would eliminate the requirement for units to maintain both boxes.

Summary

A future article will discuss the Pioneer Tool Sets currently being reviewed, and we expect that there will be substantial changes. Input from users is strongly encouraged. Get involved, and make your tool sets work for you.

Send your ideas and comments to the Director of Combat Developments, Engineer Division, Organization Branch (Tom Knotts or Alan Schlie), 320 Engineer Loop, Suite 141, Fort Leonard Wood, Missouri 65473. Telephone numbers are commercial (573) 563-6191, DSN 676-6191, and fax (573) 563-4089/5056. The e-mail address is schliea@wood.army.mil.

Mr. Schlie is a force development analyst with the Directorate of Combat Developments, U.S. Army Engineer School. A retired command sergeant major, he has served in various capacities in Europe, Korea, and CONUS throughout his career.

OBSTACLE COORDINATION POINTS

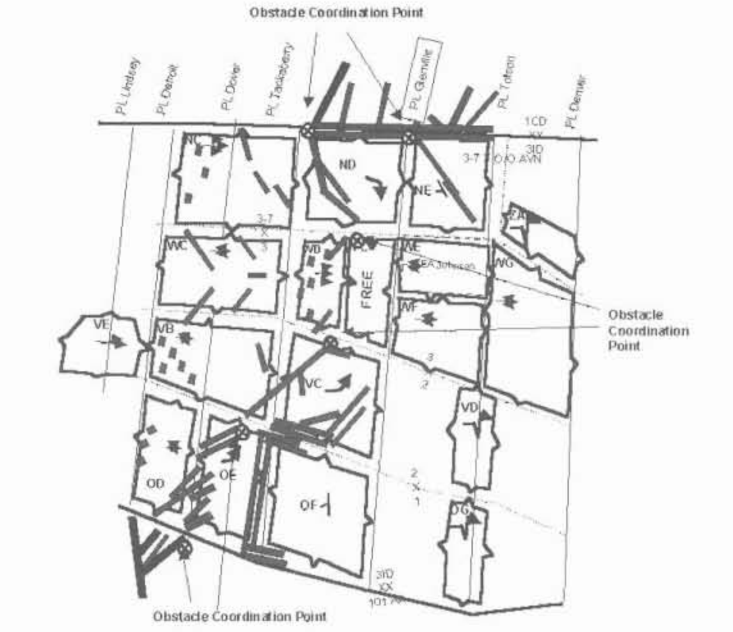
By Colonel David W. Washechek, Lieutenant Colonel James A. Price and Captain Kevin Pettet

Although obstacle coordination points are not current doctrine, this article describes a tactic, technique, and procedure that engineers in the XVIII Airborne Corps found useful during the 3rd Infantry Division Warfighter Exercise at Fort Stewart, Georgia, on 7-12 February 1999.

The XVIII Airborne Corps developed a Corps-level obstacle plan with designated *obstacle coordination points* in support of the Corps maneuver plan. By doing so, XVIII Airborne Corps engineers ensured coordinated obstacle effort throughout the Corps sector, which enabled the Corps to shape the battlefield and fight one fight with massed combat power. In doing so, XVIII Airborne Corps forced the World Class opposing forces into Corps- and division-level engagement areas where they were easily destroyed.

The doctrinal foundation for an obstacle coordination point is found in the definition of a *coordinating point* in FM 101-5-1, *Operational Terms and Graphics*: a control measure that indicates a specific location for the coordination of fires and maneuver between adjacent units. The engineer interpretation of a coordinating point is a place where leaders coordinate their obstacle effort across division and Corps boundaries in support of the maneuver plan.

An obstacle coordination point is not a point on the ground that dictates exactly where obstacles are tied in, but rather a graphic-control measure. These points can be established at Corps, division, brigade combat team, or task force levels. At the Corps level, obstacle coordination points are established along boundaries (flanks) between divisions. At the division level, they are established along boundaries (flanks) between maneuver brigades.



The Corps established two obstacle coordination points on 3rd Infantry Division's northern flank and one on its southern flank, with the intent to turn the enemy into 3rd Infantry Division's sector. In turn, the 3rd Infantry Division established three obstacle coordination points within its sector with the intent to turn the enemy from the flanks into the center sector. These points helped leaders ensure that all obstacles along division flanks were coordinated and emplaced so no gaps existed in the plan. The obstacle coordination points reinforced the commander's intent and synchronized the obstacle effort across the entire sector.

The XVIII Airborne Corps used obstacle coordination points to help the commander communicate his intent during defensive operations. They supported the commander's description of how he wanted to shape the defensive battlefield space, ensured synchronicity of obstacle effort and covering fires, and accelerated leader involvement.

Established obstacle coordination points prevented seams in the obstacle plan (between sectors/boundaries) and eliminated the need to "redesign" portions of the obstacle effort. This saved the Corps, division, and brigades time, manpower, and material resources.

Colonel Washechek commands the 3d Infantry Division's Engineer Brigade. A graduate of the United States Military Academy, he holds a master's degree in civil engineering from Brigham Young and is a registered professional engineer in Virginia.

Lieutenant Colonel Price is the Assistant Corps Engineer, XVIIII Airborne Corps. He is currently deployed to the EUCOM AOR and is serving as the Branch Chief, J3 JOPES Support Element.

Captain Pettet is the XVIII Airborne Corps Engineer Plans Officer. He is a graduate of the U.S. Military Academy, the Air Assault and Airborne Schools, the Engineer Officer Advanced Course, and CAS3 and holds a master's degree from the University of Missouri-Rolla.

INSTRUCTING AT THE U.S. MILITARY ACADEMY... MORE THAN JUST TEACHING CADETS

By Major R. Mark Toy

You have just completed company command and have spent your entire Army career "with troops." One option for your next assignment is advanced civil schooling with a follow-on assignment to the United States Military Academy. If you choose this option, consider the Department of Geography and Environmental Engineering (D/GEnE), which provides numerous opportunities to further develop engineer officers. Although your primary task will be instructing, the benefits of an assignment in the D/GEnE extend far beyond teaching.

Applying for a Position

The department head and program directors review the files of all applicants for instructor positions. Those selected attend a fully funded graduate school for two years of concentrated study in an environmental engineering; mapping, charting, and geodesy (MC&G); or geography program. Although applicants may voice a desire as to the school they attend, the department head and appropriate program director make the decision. After graduation, applicants report to West Point in the summer and prepare to teach during the fall semester.

Programs

Engineer officers in the D/GEnE at West Point instruct in one of the following programs:

- **Environmental Engineering** instructors teach either core courses or electives. Core courses are *Introduction to Environmental Engineering, Environmental Systems Analysis,* and *Environmental Systems Design*. Elective courses include *Hydrogeology, Water Resources Planning and Design, Solid and Hazardous Waste Management,* and *Meteorology and Air Pollution.*
- **Mapping, Charting, and Geodesy** is becoming the most popular course of study in the D/GEnE. Courses include *Remote Sensing, Cartography, Photogrammetry, Surveying, Geographic Information Systems,* and *Descriptive Astronomy.*
- **Geography** offers such challenging courses as *Cultural and Political Geography; Foundations in Geography; Military Geography;* and *Geography of Russia, Asia, Latin America, Middle East and Africa, North America, and Europe.*

First-year instructors in the D/GEnE teach the department's core course, *Terrain Analysis*, during their first semester. Required for all sophomores, the course provides basic knowledge of the earth and environmental sciences. Students also learn to conduct comprehensive terrain analyses at area or local levels using atlases, maps, remotely sensed imagery, and geographic information systems. Teaching *Terrain Analysis* provides excellent opportunities to interact with young cadets who will soon select an academic major. Instructors can demonstrate to them the value of a degree in the geographic or environmental sciences.

Concurrently, or by the second semester, instructors begin teaching courses in any of the three D/GEnE programs. By the end of the second and into the third year, instructors become the director of one or more courses. The director updates course content, mentors junior faculty, and handles administrative duties. In the final year of their assignment, instructors become assistant professors of their respective discipline.

Being an instructor in the D/GEnE involves much more than teaching, and these "other-than-teaching" opportunities set an assignment here apart from other Army nontroop assignments. Nonteaching duties not only offer an opportunity to participate in cadet development but also help with officer development. Where else can an engineer officer acquire a professional engineering (PE) license, teach military science and land navigation, and help influence top-notch lieutenants to join the Corps of Engineers?

West Point cadets learning proper land navigation techniques.

Acquiring a PE License

West Point instructors from the Engineer Branch are well on the way to getting a PE license. All states require some engineering experience as a prerequisite for obtaining a PE license. By virtue of their branch and number of years served in the Army, D/GEnE instructors already have most of the necessary years of experience required in many states. One year in graduate school and teaching time at USMA also count as engineering experience. License applicants must state all their experience, and a good place to start is with the job description of their officer evaluation reports.

In preparing for the PE examination, particularly for the examination in environmental engineering, the D/GEnE is a good place to be. Both the department head and the environmental engineering program director hold doctorate degrees in environmental engineering and are registered professional engineers. Moreover, the department head has a Diplomate in Environmental Engineering certificate. His duties include serving as vice chairman of the Environmental Engineering Exam Committee for the National Council of Examiners for Engineering and Surveying. About three-fourths of the West Point environmental engineering rotating faculty are licensed professional engineers. The rest are engineers-in-training, or are preparing to take the exam within the next year. *Note: To take the PE examination, applicants must have already passed the Fundamentals of Engineering Exam and have been designated an engineer-in-training.* Instructors at West Point are surrounded by capable engineer officers who are more than willing to answer questions and help them prepare for the PE examination. By the end of a three-year assignment, engineer officers can depart from West Point with a professional engineer license.

Teaching Military Science

The United States Military Academy follows a two-semester academic year. Between the first and second semesters is a two-week period in January called *military intercession*, when cadets receive military science instruction. Freshmen receive instruction in map reading and troop-leading procedures. Sophomores and juniors study *Combined Arms Operations 1* and *2*, respectively. Seniors, who will soon be commissioned second lieutenants, take a class called *Tools of the Trade and the Leader's Legal Role* to prepare for the challenges they will face as platoon leaders.

Most of the officers at West Point are assigned to the dean's office and provide instruction for military intercession. In the D/GEnE, officers teaching military science classes have an outstanding opportunity to share their experiences as an engineer company commander, platoon leader, and staff officer to young lieutenants-in-training. It is also an opportunity to stay connected to the Engineer Branch. Many cadets will soon choose a branch, and military science instructors can introduce them to the Corps of Engineers.

Teaching Land Navigation

Unique to the D/GEnE is the annual summer task of instructing the sophomore class in the art of land navigation. This training period is an excellent opportunity for officers to return to their Army roots and "get back with troops." With the assistance of soldiers and noncommissioned officers from the active Army (typically the 10th Mountain Division), the department provides training for approximately 1,000 cadets over a three-week period. The D/GEnE teaches basic and advanced land navigation skills under day and night conditions. As an officer-in-charge of one of three land navigation sites, instructors completely control the set-up and execution of land navigation training. Their instruction is most important to these junior leaders, who must be proficient in this critical Army task as platoon leaders.

Selecting a Branch and Post

One of the most rewarding experiences for an instructor at the USMA is participating in the cadet branch and post selection process. An Engineer Branch representative (a major or lieutenant colonel) is assigned to the academy in the Department of Military Instruction. This engineer officer coordinates the branch and post selection process for all seniors who select the Corps of Engineers as their branch. The Engineer Branch representative typically solicits assistance from all engineer officers at West Point. As representatives of the Corps of Engineers, USMA engineer instructors provide valuable information to the Army's future engineer lieutenants. Branch selection is one of the most important decisions that cadets will make in their military careers, and most of them are eager to learn about officers' experiences in engineer units. After cadets select the Engineer Branch, they choose the location of their first three-year assignment. Once again, the experiences of an engineer officer will be valuable to the cadets as they select a post. The bottom line is that as engineer officers, we have a vested interest in finding the very best second lieutenants to join our ranks. As part of the D/GEnE, engineer officers have a direct impact on future engineer platoon leaders who may someday serve in their battalion.

The Right Choice for You!

An assignment in the D/GEnE at West Point will be one of the most challenging and rewarding experiences of your Army career. As a member of the faculty, your responsibilities and opportunities to excel go far beyond teaching cadets. Not only will you become a better officer intellectually, you will continue to hone your military skills. Most importantly, you will help shape the lives of the young men and women who join the Corps of Engineers and lead our Army into the 21st century.

For more information about joining the faculty in the D/GEnE at West Point, call the personnel officer at commercial (914) 938-3321 or DSN 688-3321.

Major Toy, an Assistant Professor of Environmental Engineering in the D/GEnE, will attend Command and General Staff College this summer. Previous assignments include company commander and assistant S3, 864th Engineer Battalion, Fort Lewis, Washington. MAJ Toy is a graduate of the U.S. Military Academy and holds master's degrees in environmental engineering from UCLA and business administration from Boston University. He is a registered professional engineer in Virginia.

(Continued from page 31)

State vs. Status

The term "state" refers to the *capability* of mobility/survivability assets in terms of what we can provide to support the task force's mission. Instead of simply regurgitating the assets available, the planner should brief the commander on precise engineer capabilities. For example, state the number of breach lanes, number of protective positions, linear meters of obstacle effort, etc., that engineers can provide and as required estimates of what the task force as a whole could provide if necessary. *Status* is simply how many widgets we have. The maneuver commander does not care how many widgets we have; he wants to know if engineers can support the mission and, if not, what additional tasks must be completed or what additional assets must be acquired. Ask yourself "Why am I telling the commander this?" The engineer planner must ask himself "So what? What does my analysis, this processed information that I am about to share with my commander or fellow members of his staff, mean to the task force as a whole?" He must provide that information in terms that are useful to the commander. Don't say "Sir, I have four of six dozers operational. I will be followed by the Air Defense Officer." Instead, say "Sir, I have four of six dozers operational, and with those assets I cannot achieve your required level of survivability for the task force by the No Later Than Defend Time. My recommendation to overcome this shortcoming is to…"

Conclusion

The EBA is the foundation of all engineer planning and the basis of engineer integration in the combined-arms team. However, engineer planners routinely exclude the preparation of an EBA when they conduct a mission analysis. A detailed EBA must be prepared to provide the information required for units to be successful during mission analysis and subsequent planning activities for the task force.

Future articles by the JRTC observer/controller team will address specific tactics, techniques, and procedures for the EBA and planning tools we have seen units use successfully at the training center.

Major Baker served as the Senior Engineer Company Observer/Controller at the Joint Readiness Training Center, Fort Polk, Louisiana, when this article was written. He currently is the CTC Branch Chief, Center for Army Lessons Learned, at Fort Leavenworth, Kansas. Previous assignments include brigade engineer, assistant battalion S3, and commander, B Company, 326th Engineer Battalion, 101st Airborne Division (AASLT); assistant brigade S3, 2nd Infantry Division, Camp Howze, Korea; and platoon leader and company executive officer, 37th Engineer Battalion, (CBT)(ABN), Fort Bragg, North Carolina.

Engineers in the Philippines a Century Ago

By James W. Dunn

When the United States declared war on Spain on 25 April 1898, the cry was "On to Cuba," and the War Department immediately began assembling Army units in Florida in anticipation of a land campaign that ultimately would include Puerto Rico as well as Cuba. While Companies C and E, Battalion of Engineers, headed for Tampa, a naval battle halfway around the world resulted in other engineer units deploying to California for another land campaign—this one in the Philippine Islands. Thus, the Spanish-American War, initially seen as a crusade to free the Cuban people from harsh Spanish rule, became a two-ocean war, which would eventually involve the Americans in operations against newly liberated Filipinos.

On 1 May, Commodore George Dewey's U.S. Navy Asiatic Squadron defeated a Spanish flotilla in Manila Harbor, but he knew that ground forces would be needed to take the city of Manila. Emilio Aquinaldo, leader of the Republic of the Philippines, had 12,000 Filipino irregulars besieging the city, but he could not hope to successfully attack the 13,000 Spanish regulars defending it. An American Army force was needed for such an attack.

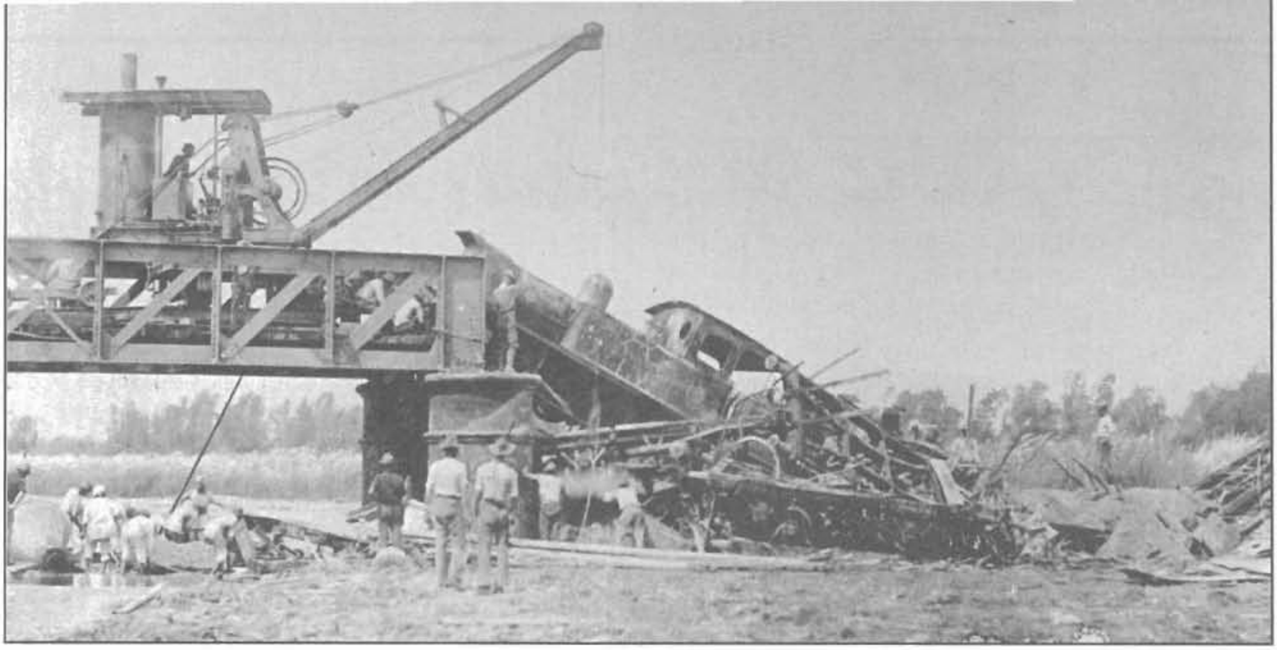
As Major General Wesley Merritt organized the U.S. Army's VIII Corps in the San Francisco area in preparation for movement to the Philippines, Company A, Battalion of Engineers, commanded by Additional 2d Lieutenant William D. Connor, left New York City by railroad for San Francisco to join the VIII Corps. General Merritt sent his force to the Philippines in three expeditions. The first left without engineers on 25 May, but Lieutenant Connor and a detachment of 20 enlisted engineer soldiers accompanied the second expedition when it left on 15 June. The third expedition left on 27 June with the rest of Company A and arrived at Cavite, in Manila Harbor, on 1 August.

By that time, Connor's detachment had moved forward from Cavite to Camp Dewey, just three miles south of Manila. Lieutenant Connor conducted a reconnaissance of the Spanish lines and made a rough topographic map. He then put his engineers to work building portable trestle bridges to cross San Antonio Creek in front of the Spanish lines. By the time the rest of Company A arrived at Camp Dewey on 7 August, the plan of attack and the engineers' role in it were in place.

General Merritt organized his attack force into a division commanded by Brigadier General Thomas M. Anderson, with two infantry brigades under Brigadier Generals Francis V. Greene and Arthur MacArthur. Merritt planned to advance the two brigades north astride the road from Camp Dewey to Manila with newly promoted Rear Admiral Dewey's squadron providing cannon and machine-gun fire against the Spanish defenses. Greene's force, with Connor's platoon in support, would have its left flank on Manila Bay, while MacArthur, with 1st Sergeant James Reardon's platoon supporting, was to move forward on the right of the road. The Spanish, realizing their difficult position, had agreed to surrender after a show of force, but the Americans were uncertain about how much of a show of force they could expect.

The two brigades attacked at 0930 on 13 August through gaps the engineers had cut in defensive wire under cover of darkness. Engineers accompanied the first troops into Manila, repairing bridges and destroying field fortifications along the route of advance. It was all over by 1130.

A U.S. Army engineer ferry in the Philippines, in 1899.



U.S. Army engineers retrieve an engine that insurgents had run off a washed-out railroad bridge near Angeles, Philippines, in 1899.

The Spanish troops were defeated, but a threat from another source hovered over Manila as the engineers got busy cleaning up a city surrounded by Filipino irregulars eager to reap the rewards of the Spanish defeat. But the Filipinos gradually realized they had traded Spanish rule for American rule. As the Americans took over, General Merritt put Lieutenant Connor in charge of the city's water-supply system, while Sergeant Thomas F. Kennedy led a detachment of 20 enlisted men to clear the Pasig River for navigation. Engineers also reconnoitered and surveyed the city and immediate surrounding areas, including positions occupied by Aguinaldo's Filipinos. On 29 January 1899, Aguinaldo arrested Sergeant Henry L. Fisher and his four-man engineer detachment when their reconnaissance took them into the Filipino lines. They were released unharmed on 3 February, but the next day a battle erupted between the American and Filipino forces. The Philippine Insurrection had begun.

On 28 March, the Americans, knowing they were not strong enough to defeat Aguinaldo, began a drive north along the railroad to San Fernando to gain time and operating room and to await reenforcements. Engineer 2d Lieutenant William P. Wooten and a 25-man detachment from Company A supported the drive, repairing the railroad and building bridges and rope ferries over rivers. MacArthur arrived in San Fernando on 5 May and ordered operations to stop for the duration of the rainy season. When Captain William L. Sibert's Company B, Battalion of Engineers, arrived in Manila on 10 August, the Philippine Command formed the engineers into a provisional battalion of two companies. Meanwhile, the Americans built up ground troops in preparation for an offensive.

In the fall, near the end of the rainy season, the Americans began a three-pronged drive north toward Lingayen Gulf. MacArthur attacked along the railroad toward Dagupan, while Brigadier General Henry W. Lawton's cavalry heavy force protected the right flank with a drive through San Jose toward San Fabian, and Brigadier General Lloyd Wheaton conducted an amphibious assault at San Fabian. On 5 November, engineer Lieutenants Sherwood Cheney and Horton Stickle, with a detachment of 20 enlisted men from Company A, departed Manila aboard the troop ship *Aztec* as part of an amphibious assault force. While some of those engineers unloaded men, supplies, horses, and mules from transport ships anchored a mile offshore in Lingayen Gulf, others cleared the beach of obstacles, opened access roads, and repaired bridges along the route of advance inland. Meanwhile, Lieutenant John C. Oakes, with a 40-man detachment from Company B, supported the cavalry drive by repairing roads and bridges, and Captain Sibert led the rest of Company B in supporting MacArthur by putting the railroad into operation as part of the line of communication.

By mid-December, Aguinaldo's Filipinos were defeated as a conventional force, and the Americans thought the war was over. But they soon realized that, while the conventional war was over, a different type of war had begun. The Filipinos simply melted into the hills to conduct guerrilla operations against the Americans for several years into the new century. Finally subdued in the years before World War I, the Filipinos became staunch American allies in World War II. In that war, two more amphibious operations took place in Lingayen Gulf: one when the Japanese attacked the Philippines in December 1941, and another when General Douglas MacArthur's American troops returned in January 1945. The Philippines gained independence from the United States in 1946, and today the two nations have mutual interests in the western Pacific.

Additional Reading

Andrew J. Birtle, *U.S. Army Counterinsurgency and Contingency Operations Doctrine, 1860-1941*; U.S. Army Center of Military History, 1998, 319 pages.

Graham A. Cosmas, *An Army for Empire;* White Mane Publishing Company, 1994, 349 pages.

Dr. James W. Dunn is a historian in the Office of History, U.S. Army Corps of Engineers, Alexandria, Virginia.

ENGINEER UPDATE

Commercial numbers are (573) 563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Maneuver Support Center (MANSCEN)

Fort Leonard Wood Reunion. The Ozarks-based Army post is having a reunion, and everyone who has ever trained or served here is invited back for a visit.

Fort Leonard Wood officially becomes the Maneuver Support Center (MANSCEN) on 1 October 1999 and will assume responsibility for training military police and chemical defense specialists as well as continue the mission of training engineers and basic training soldiers. More than $220 million has been spent on improvements to the post, which received the additional training missions after Fort McClellan, Alabama, was ordered to close in 1995.

Activities will be held throughout the week of 26 September through 1 October and will culminate in an activation ceremony and open house on Friday. More information will be published as the event draws near.

POCs are MAJ Mark Rodwell and CPT Mark Cheadle, -6150.

Directorate of Training Development (DOTD)

Field Manual Update. The following field manuals (FMs) are scheduled for publication:

- FM 5-34, *Engineer Field Data*, and FM 20-3, *Camouflage, Concealment, and Decoys*, are at the Army Training Support Center (ATSC) awaiting printing. Both manuals are posted to the Engineer School's Publications Page: http://www.wood.army.mil/PUBS/newpubs.htm).
- Change 1 to FM 20-32, *Mine/Countermine Operations*, and Change 1 to FM 5-250, *Explosives and Demolitions*, also are at ATSC awaiting printing. These changes bring Army doctrine in compliance with the United Nations Convention of Certain Conventional Weapons (CCW) mandate that all fragment munitions produce fragments that are visible by X-ray (such as metal or rock). These changes are posted to the Engineer School's Publications Page at the above web address. Printed copies will be dated 30 June 1999.
- FM 20-11, *Military Diving*, dated 20 January 1999, has been distributed to field units. It is available on the Army Doctrinal Training Digital Library at *http://155.217.58.58/atdls.htm*.

The following manuals are scheduled for publication and release to the field within the next 180 days:

- FM 5-436, *Paving and Surfacing Operations*
- FM 5-434, *Earthmoving Operations*
- FM 5-472, *Materials Testing*

POC is Sandra Gibson, -4100.

Total Army School System (TASS) Battalion Schools. The Engineer School recently completed three distance-learning CD-ROMs for the 51B10 (Carpentry and Masonry Specialists)

Reclassification Course. These CD-ROMs will be Phase I of the new Total Army Training System (TATS) Course. Soldiers must complete the CD-ROM portion of the course prior to completing the Inactive Duty Training (IDT) (Phase 2) and Active Duty Training (ADT) (Phase 3) portions of the course. Topics covered include base mathematics, measuring devices, construction drawings, carpentry tools, and masonry tools. The CDs will replace about three days of resident instruction. The planned date of implementation to TASS battalions is 1st quarter, FY01. The Engineer School's Multimedia Division currently is working on the distance learning portion of the 63E10 Reclassification Course.

POC is Terry Tapp, -4116

Directorate of Combat Developments (DCD)

New Tool Kit for Maintenance Personnel. The Tool Kit, Crimping, will be added to Hydraulic Systems Test and Repair Units (HSTRU). The lightweight tool is hand-operated and requires no power source. Because it allows hydraulic hose to be repaired on the spot rather than replaced, the kit saves down time and trips to the motor pool. The kit includes a 4-inch caliper; a hose-end holder; and a durable, compact carrying case. Units may purchase the Tool Kit, Crimping, using NSN 5180-01-458-6737; the cost is $306.52.

POC is SSG Joseph Malong, -7236.

Tool Kit, Crimping

Mobile Field Lavatory System. Field sanitation is a concern for every commander. Units should check out the Mobile Field Lavatory System's web site at *http://www.briefrelief.com* for items that will allow soldiers' needs to be met in the field and during deployments. The site lists several NSNs for products that meet federal and state requirements and have been tested and approved by all military branches.

POC is Alan Schlie, -6191.

News and Notes

Engineer Officer Candidate School (OCS) Reunion. All officer candidate classes, World War II through the present, are invited to Engineer OCS Reunion 99. It will be held at Fort Leonard Wood and Lake of the Ozarks, Missouri, 27-31 October 1999. The reunion is for former OCS candidates; staff and faculty of the Engineer Officer Candidate School, U.S. Army, Fort Belvoir, Virginia; and alumni of branch and branch immaterial officer candidate schools who later commissioned engineer. The reunion is an activity of the forming OCS Association, which is collecting and preserving OCS historical material and recording lessons learned.

POC is Thorpe Mealing, (404) 231-3402.

Lead the Way

By Command Sergeant Major Robert M. Dils
U.S. Army Engineer School

Safety

As professional officers, noncommissioned officers, and soldiers, we learn from the first day of Army training to make safety and good safety practices part of everything that we do. We are taught that nothing is more important than safety. The key to working safely is good risk assessment and risk management. The Maneuver Support Center's Safety Office, at Fort Leonard Wood, has prepared a superb tool to assist with your units' risk assessment and risk management program—the *MANSCEN Risk Management Toolbox* CD-ROM. A partial list of items included on the CD-ROM follows:

Booklets

- Commanders and Staff Risk Management Booklet
- Small Unit Risk Management Booklet

Cards

- Copy Ready Leaders Card
- Copy Ready Program Card
- Example Leaders Card
- Example Program Card
- MANSCEN Heat Index Card
- MANSCEN Wind Chill Card

Example Briefing Materials

- Course Of Action Briefing
- Example Battle Update Briefing
- Example Risk Management Program Briefing
- MANSCEN Motor Vehicle Risk Briefing
- Operational Versus Accidental Risk Briefing
- Risk Management Briefing, Formats No. 1 Through No. 3
- Senior-Level Officer Professional Development Briefing

Example Policy Memorandum

- Example Policy Letter

Example Regulation

- Fort Leonard Wood Regulation 385-5
- Example Safety Annex

Example Work Sheet

- Deliberate Risk Assessment Work Sheet

Copies of the CD-ROM are available upon request. In addition, the MANSCEN Safety Office has a useful family safety training package for use with the Family Support Group Safety Training Program. The package contains a Powerpoint slide briefing that addresses summer and fire safety. The briefing includes view graphs, notes, and a script. There is also a 3 1/2-inch computer disk that contains all the materials. This is a world-class safety tool for families.

These safety tools are available from the Maneuver Support Center Safety Office. Call Mr. Fred Fanning at (573) 596-0116 or DSN 581-1275. His e-mail address is fanningf@wood.army.mil. The Safety Office's fax number is (573) 596-0017. These products are also available at the MANSCEN safety web page. The address is *http://www.wood.army.mil/safety.*

Engineer Command Sergeants Major Training Conference

Final plans are underway for this year's fall Engineer Command Sergeants Major Training Conference. It will be held in the Washington, D.C., area during the period 25-29 October 1999. This informative conference will focus on new engineer doctrine, training, equipment, force structure, and the Noncommissioned Officer Education System (NCOES). Many special presentations will be conducted, in addition to a staff ride at the Antietam Battlefield. The conference is open to all engineer command sergeants major from all components. The Engineer School's Engineer Personnel Proponency Office is responsible for planning and conducting this conference. To provide conference information, a special web site will be established on the Fort Leonard Wood Home Page at *http://www.wood.army.mil* . Check it out.

New Engineer School Command Sergeant Major

CSM Arthur D. Laughlin, 130th Engineer Brigade, Hanau, Germany, has been selected as the Engineer School's new command sergeant major. CSM Laughlin has more than 28 years of service and has served at every level of NCO leadership, from squad leader to brigade command sergeant major. CSM Laughlin's extensive experience will be a tremendous asset to the Engineer School and the Engineer Regiment. He will report to Fort Leonard Wood by the end of August.

Command Sergeant Major, 3rd Infantry Division

CSM George Ruo, an engineer command sergeant major, recently was selected to be the Command Sergeant Major, 3rd Infantry Division, Fort Stewart, Georgia. CSM Ruo joins CSM Harold Montgomery, 1st Infantry Division, as an engineer serving as a division-level command sergeant major.

Congratulations to these two great engineer senior leaders!

Integrity

"A man of character in peace is a man of courage in war."
Lord Moran, "Anatomy of Courage" - 1945

Brigadier General William Ludlow

Brigadier General Ludlow was a distinquished engineer, explorer, and soldier. He received three commendations for bravery in the Civil War. Later in his career, while on leave of absence from the U.S. Corps of Engineers, he was Chief Engineer in the Water Department of Philadelphia. One day a factory owner, used to getting more than his share of water for his factory, walked into Ludlow's office. The visitor handed Ludlow a $50 bill so that he could "buy cigars for his boys." To show his contempt, Ludlow took out one of his own cigars and offered his visitor another. He then folded the $50 bill, lit it with a match, and used it to light his own cigar and that of his visitor. When the bill had been reduced to ash, Ludlow asked his visitor how he liked the cigar.

History Office, U.S. Army Engineer School

PIN: 077382-000