Engineer

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Panther II

Improving Engineer Mobility

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CLEAR THE WAY

By Major General Clair F. Gill
Commandant, U.S. Army Engineer School

One Corps, One Regiment, One Fight

What an exciting time to be a soldier and an engineer! It has been an honor and a great privilege to have served as *your* commandant for the past two years. I titled this, my final note to you, with a thought that has had special meaning for me throughout my 30 plus years in uniform. *One Corps, One Regiment, One Fight* is a unifying theme which acknowledges that we are all part of the same team—whether military, civilian, or contractor; or TO&E/TDA Army, U.S. Army Corps of Engineers, or Department of Public Works. Ours is a noble profession based on the physical and technical realities of nature. It provides service and support to the Army, its combat maneuver elements, and the soldiers and civilians of this great nation.

I built on the term "relevancy" in two of my State of the Branch speeches during annual ENFORCE conferences here at Fort Leonard Wood. My intent was to awaken the broad engineer community to our *raison d'etre* and to warn that we will be diminished by infighting or an unwillingness to change and adapt to a rapidly evolving world. We live in an environment that is largely governed by immutable laws of economics and physics (gravity, force, weather, etc.), but we can gain efficiencies through better use of the tools of science and technology, improved systems and automation, and improved business practices. We will never fall to irrelevance because of the critical nature of what we do: Engineers provide life support; mobility, countermobility, survivability, and topographic support; protect the environment; and construct structures and facilities. However, if we fail to react to our customers' needs, do not demonstrate our ability to help others get their jobs done, or point the finger of blame at others, we will continue to suffer at the resource troughs. Counter to the basic principles of humility, we must extol the virtues of our soldiers and workforce and champion the great work that they do. We must remain agile and flexible—and ready to do the dirty work.

Our hallowed Engineer School is evolving to meet the needs of the 21st century. On the 7th of June we broke ground for the construction of more than $200 million worth of new educational and training facilities. We accomplished this with the assistance of the Kansas City District of the Corps of Engineers, a great civilian contractor, and much support from TRADOC and the Department of the Army. Now we are embarked on an exciting venture with our brethren from the Military Police and Chemical Corps branches to create a new schoolhouse concept we call the Maneuver Support Center or MANSCEN.

The top-quality facilities we will construct are just the visible part of this venture. Far more important is the spirit of cooperation we are engendering with our fellow leaders from Fort McClellan. Together we will consolidate and integrate what is possible, common, and makes sense, while protecting our branch identities. I can report that we will save the Army a *lot* of dollars and people. With your help we will make this venture work really well.

I've left some work in progress. For example, we are fighting to save the principles embodied in our ERI organizations, creating joint doctrine (which is moving quite well), and developing the Grizzly, Wolverine, and a family of mine-detection systems. A never-ending battle is the need to garner crucial resources needed to teach and train future generations of leaders and soldiers. We are beginning to think of ourselves as "masters of terrain," but much remains to be done to make this reality. My replacement, MG Bob Flowers, will have his hands full as soon as he takes the reins at the end of July, but I know he has a competent staff to support him. I will tell General Flowers that he can count on the help and support of our great Engineer Regiment. Essayons and farewell.

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COMMANDER/COMMANDANT
Major General Clair F. Gill

MANAGING EDITOR
Catherine Eubanks

FEATURES EDITOR
Shirley Bridges

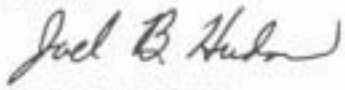
GRAPHIC DESIGNER
Jennifer Morgan

By Order of the Secretary of the Army:

DENNIS J. REIMER

General, United States Army
Chief of Staff

Official:



JOEL B. HUDSON
Administrative Assistant to the Secretary of the Army
03759

Front Cover: *The teleoperated robotic Panther II, with its M1 chassis, is the Army and Marine Corps' first functional prototype mine roller with vehicle-width rollers. It is equipped with a navigation system that allows an operator to preprogam a route or mission. Photo by Jim Ray, Fort Leonard Wood TSC.*

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The Multirole Engineer Battalion

By Lieutenant Colonel James R. Rowan

As U.S. forces prepared to move into Bosnia in late 1995, crossing the Sava River loomed as a major obstacle. In addition to the challenges of the river's width, depth, and bank conditions, and the unknown enemy and mine-threat situation, there was the overarching challenge of command and control of the crossing area. The 1st Armored Division needed general support engineers to emplace a float bridge and execute the engineer tasks required to conduct a deliberate river crossing of the division and a large portion of V Corps assets. This mission was assigned to the 16th Engineer Battalion (Corps)(Mechanized) and Task Force Volturno, named for the Volturno river crossing conducted by the 1st Armored Division and the 16th Engineer Battalion in Italy during World War II. This article describes the formation of Task Force Volturno, the missions executed during Operation Joint Endeavor, and the benefits of a multirole engineer battalion for future operations.

Task Force Volturno

When initially formed, Task Force Volturno included the 16th Engineer Battalion, the 502d Engineer Company (Assault Float Bridge), the 586th Engineer Company (Assault Float Bridge), the 38th Engineer Company (Medium Girder Bridge [MGB]), and the 535th Engineer Company (Combat Support Equipment [CSE]). With this organization, the task force had mechanized combat engineers capable of conducting any combat engineer mission. In addition, there were fixed and float bridge companies to cross the Sava River and the CSE company to build and upgrade roads, access routes, approaches, and ramps into the river.

The task organization of separate companies under a corps mechanized engineer battalion follows current Army doctrine. FM 5-100, *Engineer Operations*, states that one of the capabilities of such a battalion is to provide command and control for assigned and attached units. Task Force Volturno deployed out of Germany ahead of the 1st Armored Division's organic engineer assets and arrived in Croatia and Bosnia before the direct support engineer units aligned with the division's two brigade combat teams. Based on a habitual training relationship developed in Germany, two companies of the 16th Engineer Battalion were prepared to provide engineer support to the 1-1 and 3-5 Cavalry Squadrons and the 4-12 Infantry Battalion. Using corps engineer assets allowed these key maneuver units to have dedicated engineer support as they moved into Bosnia ahead of the other 1st Armored Division maneuver and engineer elements. Meanwhile, the Task Force Volturno headquarters, one line company, and the separate companies completed the missions associated with crossing the Sava River.



A bulldozer from the 535th CSE prepares ramps at the Sava River to support the division's redeployment to Germany.

Missions

The 1st Armored Division Engineer Brigade commander realized the advantages the multirole engineer battalion provided to division operations and elected to keep Task Force Volturno intact throughout Operation Joint Endeavor. Early in 1996, the float bridge companies returned to their home stations, and the 55th Engineer Company (MGB) joined the task force. With its mix of combat engineer companies, bridge companies, and a construction company, Task Force Volturno could execute almost any engineer mission required in the 1st Armored Division sector. As U.S. forces moved farther south into Bosnia, elements of Task Force Volturno continued to move ahead. They cleared and proofed routes, upgraded main supply routes, conducted hundreds of kilometers of route reconnaissance, reconned and classified more than 100 bridges, emplaced armored vehicle-launched bridges (AVLBs) to upgrade key routes, built MGBs, and hauled in gravel to construct much-needed parking and maintenance areas.

Force Structure. Throughout the first 11 months of Operation Joint Endeavor, four battalion-sized U.S. engineer units operated in the Task Force Eagle sector under the 1st Armored Division Engineer Brigade commander. Two divisional engineer battalions (the 23rd and the 40th) were in direct support of the two brigade combat teams. The 16th Engineer Battalion (Corps)(Mechanized) and the 94th Engineer Battalion (Combat)(Heavy) operated in general support of the division. Several smaller engineer units operating in the U.S. sector came from multinational brigades—Russian, Danish, Finnish, Swedish, Turkish, Hungarian, and Romanian.

Task Organization. Within this robust engineer force structure, Task Force Volturno brought several unique capabilities to the fight, the most important being the ability to internally task organize for any mission. The combat engineer battalion provided a mechanized force capable of conducting clearing or proofing missions. Organic .50-caliber machine guns mounted on armored vehicles provided security. Bridging was possible using either AVLBs or the MGB company. Several MGBs were emplaced and later replaced with Bailey bridges. Since the bridge companies were attached to Task Force Volturno, the security and countermine capability typically required for bridging in Bosnia were provided without additional units. Task Force Volturno also ran a theater bridge park with up to seven sets of Bailey bridges on hand. Horizontal construction and a tremendous haul capability also were available within the task force.

Since it had such diverse capabilities, Task Force Volturno was located at Camp Bedrock in the center of the Task Force Eagle sector. The 1,200-man base camp was the only base camp in Bosnia where an engineer commander served as the senior tactical commander. The central location allowed task force units to operate anywhere within the U.S. sector. The mix of wheeled and tracked vehicles allowed soldiers to operate throughout the division's vast geographic area.

Task Force Volturno units augmented the 23rd and 40th Engineer Battalions, which supported the 1st and 2d Brigades of the 1st Armored Division. Typical support included minefield clearing; bunker destruction; and hardstand, combat trail, and ammunition holding area construction. Task force companies also provided engineer support to units in the division that lacked a task force engineer battalion in direct support of their base camps and operations. These units

included the corps support group, the divisional aviation brigade, the artillery brigade, the division main, the division rear, and several remote signal sites within Tuzla Valley.

Force Protection. For Task Force Volturno units, the primary engineer mission was assisting with force protection at base camps. The task force constructed several hundred bunkers and fighting positions throughout Bosnia. They also provided technical expertise and supervised the sandbagging of these structures. The task force emplaced more than 100 kilometers of triple-standard concertina wire and built numerous checkpoints and guard points. The division used concertainers (cloth-lined, wire mesh bastions filled with rocks, sand, shale, and earth) to provide protection against direct-fire weapons. Because of the high cost of delivering vast amounts of fill to base camps, task force units began a shale quarry. They hauled more than 50,000 cubic meters of fill for protective structures. This was critical because divisional battalions do not have dump trucks. By combining the assets of corps mechanized companies, the bridge companies, and the CSE company, Task Force Volturno had the equivalent of more than 100 5-ton dump trucks to conduct their enormous haul mission.

General Support. The general support role of Task Force Volturno allowed the division engineer some latitude in directing engineer efforts. Maneuver brigade commanders kept their direct support engineers fully employed. The general support engineers gave the division a capability to shape the future battlefield. They worked on redeployment routes, bridge and raft ramps, bridge anchor systems, and redeployment base camps while direct support engineers concentrated on such zone-of-separation missions as clearing minefields and destroying bunkers and trench lines.

Each of the multinational brigades brought an engineer capability, but they sometimes lacked enough engineer forces to complete missions within their sector. The multinational engineers were attached to their country's maneuver forces and did not receive orders through U.S. engineer channels. General support engineers allowed the division engineer to influence engineer efforts in the multinational brigade sectors without having to change the division's task organization or become overly directive with another nation's forces.

Countermine. As the only corps mechanized engineer battalion in Europe, the 16th Engineer Battalion was charged with becoming the countermine proponent. Long before deployment, battalion officers and senior NCOs and engineers from other units in Europe trained at Fort Leonard Wood to develop a countermine assessment and a training plan for units deploying to Bosnia. The 16th Engineer Battalion conducted mine-orientation training for the division units deploying first. When the battalion received orders to deploy, training was moved to the Combat Maneuver Training Center (CMTC) in Germany. The CMTC adopted the battalion's program of instruction as the standard for all U.S. soldiers and support personnel deploying into theater.

Benefits

The 16th Engineer Battalion was able to successfully organize and accomplish a wide range of missions. Some benefits of a multirole engineer battalion include:

- As general support engineers, they were not as constrained by habitual relationships as the direct support engineers. The unit could internally task organize and mass efforts as needed. The direct support engineers of a division typically are allocated an engineer company in support of a maneuver task force, and it can cause great concern within the brigade if one task force loses its normal share of engineer battalion assets.
- The corps mechanized modified table of organization and equipment (MTOE) supports a large, diverse organization better than the divisional MTOE.
- Corps mechanized units have a slightly greater command and control capability because they are authorized a communications officer, an intelligence officer, and a maintenance officer. These positions are not supported under the divisional MTOE.
- More maintenance personnel are allocated to a corps mechanized unit than to a divisional engineer unit. This extra maintenance capability allows units to operate over greater distances and to be less reliant on a maneuver task force for maintenance and recovery support.

Task Force Volturno also provided several less obvious benefits:

Command and Control. A key advantage was the task force's ability to provide command and control to the separate engineer companies. Doctrinally, the engineer brigade headquarters performs this mission. However, the austere headquarters of a division engineer brigade supporting 15 brigade-equivalent units could not provide the same degree of support to companies as Task Force Volturno.

Flexible Structure. The capabilities within the multirole engineer battalion provided the engineer brigade and the division commander with a flexible engineer structure. While engineer units were never kept in reserve, the multirole battalion was able to reallocate forces and respond quickly to several emergencies within U.S. and multinational brigade sectors.

Professional Development. There were many developmental opportunities for officers assigned to the task

force. Officers from attached companies typically worked in their specialized area and seldom interacted with other companies or a battalion staff as task force officers did during Operation Joint Endeavor. In turn, the attachment of up to four additional companies with very different equipment and personnel provided a tremendous opportunity for battalion staff officers to manage a wide spectrum of requirements. FM 5-100 states that an engineer battalion can provide command and control for up to five companies. Task Force Volturno's ability to continuously command and control six to eight units was due to the mission, enemy, terrain, troops, and time available (METT-T) in Bosnia. Once the Task Force Eagle sector was established, the headquarters was relatively stationary and secure and could devote additional staff effort to the companies. Also, the deliberate pace of this operation allowed a greater span of control than the typical fast-paced, high-intensity operation allows. All task force members benefited by working together on the wide variety of missions—mine clearing and proofing, bridge and route reconnaissance, force protection, road construction and repair, airfield construction, bridge construction, overhead anchorage system design and construction, security, and base-camp construction and decommissioning.

Limitations

Task Force Volturno overcame several limitations, most of which could have been avoided with proper planning.

Funding. Funds were suspended or diverted from many corps units to pay for the 1st Armored Division's mission in Bosnia. The 16th Engineer Battalion's deployment preparations were halted or delayed several times due to insufficient funds. Eventually, the 1st Armored Division Engineer Brigade provided funds for critical deployment supplies.

Reports and SOPs. Even though most Task Force Volturno units were from the 130th Engineer Brigade and were assigned to the same corps as the 1st Armored Division, they used different reports and tactical standing operating procedures (SOPs). The problems resulting from these differences decreased as Bosnia-specific SOPs were developed and implemented.

Equipment. The fielding of new equipment, specifically the single-channel, ground-to-air radio system (SINCGARS), had not been completed for all corps units when the deployment order was received. New radios were installed, but this placed great logistics and training burdens on units that were already busy with countermine operations and deployment preparations. The 55th Engineer Company from Fort Riley, Kansas, never received the SINCGARS and had to rely on older, less capable, and not fully compatible 12-series radio systems.

Logistics Support. Once in sector, continual changes in the maintenance and supply units providing support was a major challenge. The 16th Engineer Battalion was supported by six different maintenance units during its deployment. With each change, the logistics trail became longer. During one period, repair parts were unavailable while the supply system tried to catch up with the tactical situation.

Personnel. As the deployment continued, personnel shortages increased. Early in the operation, Task Force Volturno units were resourced at 100 percent of their authorized personnel strength. Throughout the year-long deployment, losses exceeded gains, and by the end of the year units were down to about 80 percent of their authorized personnel. Divisional engineer unit strengths declined at a lesser rate. Although Task Force Volturno units were attached to the 1st Armored Division, personnel managers in the division could not affect personnel strengths in attached corps units since they would eventually redeploy to their home stations.

The Future

The multirole engineer battalion works—it was validated in the Balkan theater of operations. While this operation had a specific mission with a unique set of METT-T, it is possible to extrapolate and visualize that the concept has great potential for any operation where corps engineers will be called into a division sector. The multirole capability currently is being fielded for bridge units. Now is the time to establish the corps mechanized engineer battalions as multirole task forces. The minor problems encountered in Bosnia could have been resolved in a training environment, making the task force more effective and quicker to establish when needed. The force structure is in place. This proposal does not require additional forces or funds. Let's task organize now and get the most out of the engineer resources we have available.



Lieutenant Colonel Rowan commands the 54th Engineer Battalion in Bamberg, Germany, and commanded the 16th Engineer Battalion and Task Force Volturno in Bosnia-Herzegovina. He previously served with the 7th, the 82d, and the 299th Engineer Battalions; the 4th and the 5th Infantry Divisions; and was an assistant professor of mathematics at West Point. LTC Rowan is a graduate of the U.S. Military Academy and holds a master's degree in Operations Research from Georgia Tech and a master's of Military Arts and Science from the Command and General Staff College.

Multinational Mine-Strike Recovery Operation

By Brigadier General Stanley F. Cherrie



During my 32-year (plus) military career, I have had the great fortune to garner a significant amount of service in multinational assignments. It began in 1979 with assignment to the British Army Staff College. In 1992, I became deputy chief of staff, G2/G3, of the Ace Rapid Reaction Corps (ARRC), where we planned and were ready for deployment to Bosnia in support of a NATO peace-enforcement mission. In 1994, I moved to the 1st Armored Division as the assistant division commander-maneuver. Little did I know that I soon would be thrust in the middle of NATO's Operation Joint Endeavor peace-enforcement mission and be part of the largest multinational peacekeeping operation in history. During the fourth month of this American-led, Multinational Division North operation, I assumed control of the mine-strike recovery operation described in this article.

Diary commentaries are presented to demonstrate the complex nature of multinational operations and the advantages provided by the breadth of engineering skills available in multinational units. The commentary shows how difficult it is to operate in a heavily mined area.

The Mine Strike

17 April 1996. A multinational patrol from the Nordic/Polish (NORDPOL) Brigade became disoriented while patrolling the zone of separation. The group, consisting of two Danes and nine Lithuanians, entered a minefield and struck an antitank mine with their lead vehicle, a Mercedes GD240, which is a small, jeep-type vehicle. The driver, a Danish private, was thrown from the vehicle and sustained fatal injuries. The commander, a Lithuanian lieutenant, was trapped under the overturned vehicle and subsequently died. Two back-seat passengers were critically injured and thrown free of the vehicle. Patrol members in the other two vehicles (another GD240 and an ambulance) were not injured. U.S. medical evacuation (MEDEVAC) helicopters carrying Norwegian Medical Company personnel were flown to the scene and lifted the survivors to safety (see diagram, page 7).

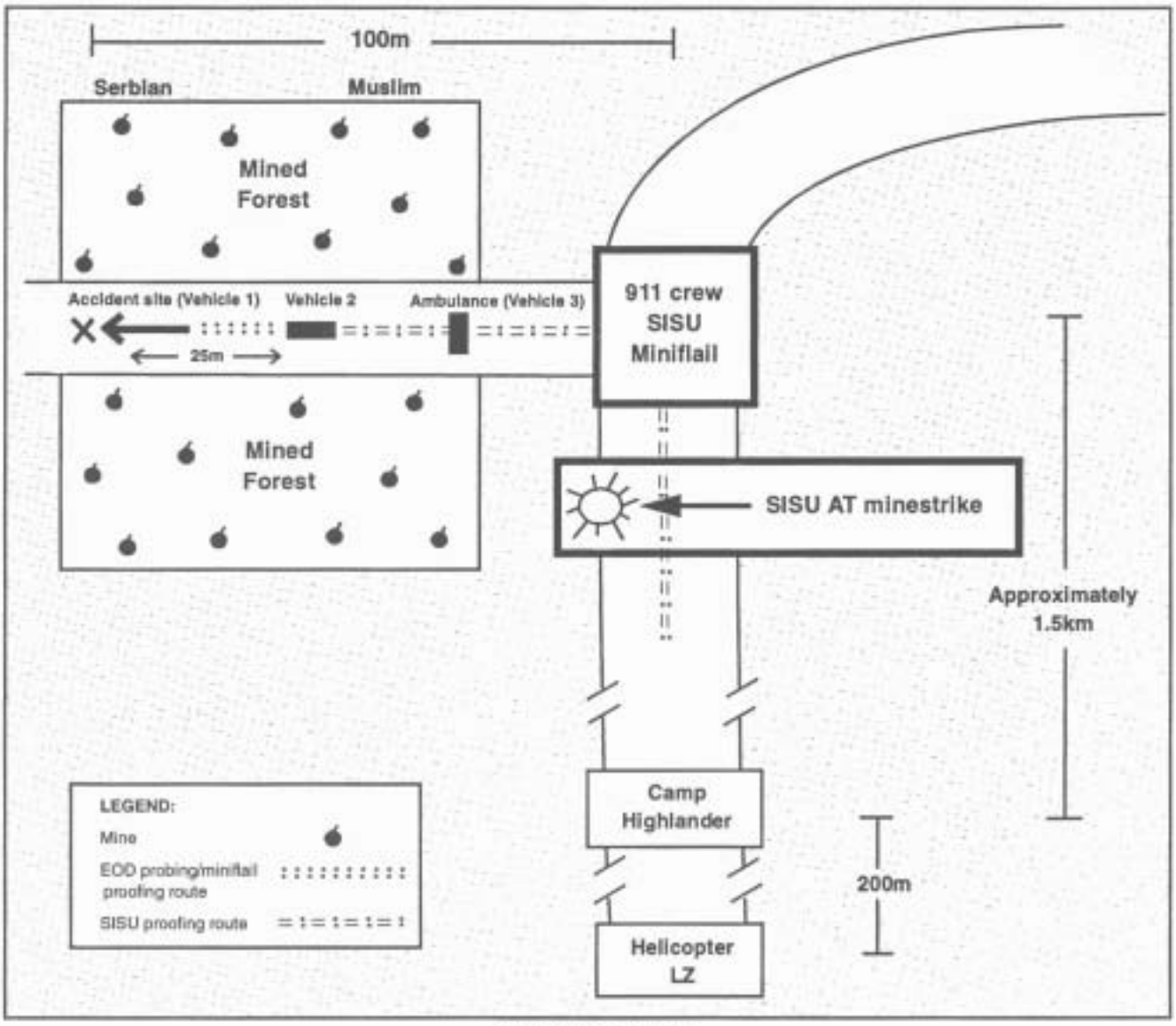


Diagram of Events

The Recovery

18 April. The Danish Battalion (DANBN) set up a camp about 1.5 kilometers from the accident site and assembled recovery personnel, equipment, and a command and control element. The camp was called Camp Highlander because it was atop a lofty saddle in the northwest (NORDPOL) sector of Task Force Eagle (see diagram). The DANBN conducted a photo reconnaissance of the mine-strike area, and their photographic data proved to be invaluable in the recovery effort.

The recovery team discovered that the road to the accident site and the associated wood line, although not a designated or marked minefield, were heavily mined. Initial clearing and proofing operations to approach the accident site detonated several antitank and antipersonnel mines, making progress very slow and deliberate. Near the end of the first day, the body of the Danish soldier was recovered. At the end of the day, the Lithuanian soldier's body and three vehicles remained in the minefield.

19 April. The operation started late because the Finnish SISU mine flail, a large, 6-wheeled, armored vehicle, slid off the narrow mountain approach trail, blocking the entrance to the command-and-control site. Then, when it was recovered and began flailing, it hit a large antitank mine and was disabled (see diagram).

An assessment of the events that had taken place thus far produced the following significant facts and deductions:

- This was a NORDPOL mission with Task Force Eagle in support.
- Political decisions regarding the local memorial ceremonies and subsequent national funeral arrangements made time an extremely important factor.
- The major approach route and the area around the vehicles were heavily mined. Examinations of mine-sheet data from both NORDPOL and the U.S. indicated mixed (Serbian/Muslim) minefields, which made the extrication mission even more hazardous.



Photo by 55th Sig. Co. (Combat Camera)

SPC Orasco, 16th Engineer Battalion, and the U.S. miniflail depart Camp Highlander enroute to the recovery site.

- Task Force Eagle units possessed the requisite equipment and expertise to effect the extrication without further loss of life.

The Task Force Eagle commander directed me to move to the site and assure the NORDPOL command structure that the task force would provide any assistance possible. We conducted a miniature war game of options as to how to best use all of Task Force Eagle's expertise to recover the body as quickly as possible without further injury or loss of life. We determined that equipment such as MEDEVAC helicopters with winches, SISU mine flails, the U.S. robotic miniflail, and a "911" rescue team were needed to accomplish the mission.

20 April. For a host of cogent reasons, the U.S. 16th Engineer Battalion had independently scheduled an aerial reconnaissance in preparation for the extrication. In an operation requiring deliberate action and strict delineation of responsibilities, this type of independent action was a problem that could not be allowed, so I cancelled it. We needed one chain of command or the operation would break into factions working against each other, thus increasing the potential for further tragedy. The energies of the entire task force had to be channeled into one recovery effort.

UH60s flew us to the accident site. Before landing, we made several aerial passes over the site to become oriented and bring the digital images we had studied into perspective. From this overflight, we got a true feeling for the environment in which our forces would operate.

We landed on a narrow gravel mountaintop road (see diagram, page 7) and walked 200 meters to Camp Highlander. The DANBN commander and his operations officer then briefed us around a small-scale model of the area made from baked mud, twigs, string, etc. It was primitive but effective.

We first considered an aerial option wherein we would lower explosive ordnance disposal (EOD) personnel onto the second vehicle, allowing them to use this "safe haven" as a starting point for hand probing a 1-meter x 35- to 40-meter lane to the destroyed vehicle. Once this time-consuming procedure was accomplished, the 911 crew would be lowered to the second jeep, where they would use the cleared lane to the vehicle and free the lieutenant's remains. We discarded this option, however, because of the level of training needed to lower personnel onto a 2-meter-by-2-meter platform surrounded by mines and the inordinate amount of time required to deliberately probe nearly 40 meters.

An alternative ground option was developed using the large Finnish SISU flail to clear a path to the ambulance, remove it, then flail to the second vehicle. We would then use the U.S. miniflail to beat a path from the second vehicle to the accident site. We considered the risk of ruining the miniflail if it hit an antitank mine, but time was critical and the risk was considered acceptable. Our multinational allies had mixed reactions to this plan.

Another alternative involved using the Serbian engineers who had supposedly sited the minefield. They wanted to be



Probed work area shows the left front side of the overturned vehicle.

flown to the other side (the Serbian side) of the minefield and probe back from there. Data from our Task Force Eagle mine center indicated that the area contained mixed Serbian and Muslim mines. Therefore, regardless of the Serbian engineers' courage, this option was considered to be far beyond the prudent risk assessment limits allowed for U.S. forces.

Everyone reluctantly conceded that the ground option was the best all-around plan. However, the DANBN commander informed us that the SISU mine flail, the "backbone" of the ground option, could not be at the site for several hours. This unexpected delay caused us to reevaluate our plans because, in my opinion, we could not "burn" 6 or 7 hours of daylight waiting for the flail to arrive.

After another hurried meeting around the terrain model, we decided to use a combination of the ground and air options. This was possible because a significant capability had just emerged from within the task force. The Russian engineers had offered a team consisting of two engineers and a sniffer dog with a handler. The Russians had used this combination with great success in Afghanistan, and it seemed a great boost to our ability to safely approach the area.

About 1430, the NORDPOL Brigade commander arrived on site to assess progress and was briefed on our plan. We also conducted operational briefings to the MEDEVAC crews and EOD personnel who would do the flying and rappelling. Then they returned to their helicopters for some on-site crew training and rehearsal of winch and harness-lowering techniques. Although the rehearsal process consumed valuable daylight hours, this was a "no shortcuts" operation from start to finish. Rehearsals were a must!

At 1630, both MEDEVAC helicopters flew to the accident site, where the insertion of EOD personnel began. The intent was to conduct both the ground and air operations simultaneously until the flailing and command and control helicopter noise became too distracting to the soldiers doing the deliberate probing.

Shortly after 1800, while the probing operation was still in progress, we gathered again to discuss plans for the next day. Timing, command and control, and equipment positioning were key issues that had to be hammered out.

Meanwhile, with darkness approaching, air removal of the EOD personnel was being executed according to plan. Once that was done, we made a short telephonic situation report to the Task Force Eagle commander. Before retiring for the night, we made sure that everyone had the next day's schedule and their mission order and that the necessary equipment was ready and available.

21 April. Back at Camp Highlander, we gathered around the invaluable hand-made terrain model, where the Danish engineer company commander gave a briefing on the morning's projected activities. The large Finnish flail had cleared its way to the ambulance without incident and was to retrace its route to the base camp to ensure a mine-safe status on the approach road. We had decided to use the larger flail for that task because the miniflail could not withstand an antitank mine strike. We would save the miniflail for the much-needed close-in work. Around 0730, while clearing behind the ambulance, the large flail hit the first of several antipersonnel mines.

The MEDEVAC helicopters arrived on time and inserted the EOD personnel as planned. Shortly thereafter, the combat camera crew arrived and was briefed on the situation. Their mission was to capture the multinational nature of the operation and focus on the equipment and techniques used. Their photographs were important for later evaluation and analysis.

Now that the mission was in progress, it was time to think about what was next. The future challenge was the close-in mine clearance near the vehicle itself. The 911 crew needed



Russian mine-sniffer dog and handler.

space to work safely when removing the victim from under the vehicle. Although the crew was good, their certification training did not include performing in such limited space or under these hazardous conditions.

While gathered around the terrain model, we used aerial photos of the site to formulate a plan that integrated the probing efforts with that of the miniflail. The miniflail operator understood what was required and was qualified, trained, and ready to tackle the task.

The morning quiet was shattered by a thunderous boom when Swedish EOD personnel detonated another mine along the edge of the access road. Shortly thereafter, the Russian sniffer team began to proof the road leading to the accident site.

About 1000, the miniflail operator began the 1 1/2-kilometer walk to the accident site in his leaden shoes and antifragmentation gear. Everything we had planned was in motion, and there seemed to be more than enough daylight to accomplish the task.

Shortly after 1100, problems began to occur. My experiences in the multinational arena had taught me to "expect the unexpected." From this point on in the operation, that axiom held true. For example, the Russian team, whose mission was to clear only to the back of the ambulance, took it upon themselves to go half-way to the second vehicle, picking up antipersonnel mines by hand, disarming them, and throwing them into the woods. This was extremely hazardous and not in the plan. It had to be stopped—which I did as quickly as possible.

Another deviation from the plan soon occurred. Although we had decided to clear a semicircle around the objective vehicle, the probers had begun to clear a full circle. This option was the safest to be sure, but it was not possible due to the time constraints posed by political pressure to remove the body and meet mandated funeral dates. After some discussion with the DANBN commander, he reluctantly stopped the EOD team from pursuing the circle-clearing option.

By 1130, the miniflail operator was in position. He was extremely warm in his protective gear but had the foresight to strap a dozen bottles of water to his machine before leaving base camp. The Danes joked about having to take a break to turn the miniflail operator upside down to drain the water from his suit! Although we were working under extreme pressure, spirits were high among the multinational team.

Around 1300, the EOD personnel completed their mission. In addition to the two probers, we had inserted a third EOD member after giving him a short lesson on how to operate the digital camera and hand-held video camera. We would use his close-up photos in a full dress rehearsal with the 911 personnel. These pictures allowed the 911 crew to determine which equipment from their huge arsenal of tools was needed at the site.

After the EOD team had been removed, the SISU flail began its flailing operations and set off 10 to 12 antipersonnel mines. These explosions confirmed our assessment that the area was thickly infested with mines.

By 1600, conditions were set to begin the extrication phase of the operation. An access route to the second jeep had been demined and the ambulance removed. The miniflail had cleared a lane wider than the probed lane around the second jeep to the accident site. The SISU command vehicle and the 911 crew and their equipment were standing 100 meters to the east of the site along with the SISU flail. A second miniflail with an operator and Swedish EOD personnel were waiting in reserve.

At this point, progress seemed to come to a halt. We still had more than three hours of daylight and could not afford to squander any of it. I discovered that the mission holdup was because several Swedish EOD personnel were painstakingly hand sweeping an area that had been flailed for two hours. Their intent was to gain assurance that the area was cleared of mines. While that was the 100-percent risk-free measure, it would obviously take until dark to complete. Additionally, their activity was not part of the plan and had to be stopped so we could continue the operation. I issued orders to curtail this activity and soon had it under control.

Sequence of Events

17 April

- An 11-man patrol from the NORDPOL Brigade hits an antitank mine, killing two soldiers and seriously injuring two others. One of the dead soldiers is pinned under the disabled vehicle.
- MEDEVAC helicopters rescue the survivors.

18 April

- Camp Highlander is set up to house the team tasked to recover the two bodies.
- Initial mine-clearing operations begin.
- The body of one soldier is recovered.

19 April

- A Finnish SISU mine flail begins to flail toward the accident site.
- SISU flail is totally disabled when it hits a large AT mine.

20 April

- Second SISU flail is ordered to the accident site.
- EOD personnel rappel into the accident area to probe.

21 April

- Flailing operations get to the ambulance and vehicle 2.
- Ambulance is removed.
- Russian mine-sniffer team proofs the road to the disabled vehicle.
- Miniflail operations are conducted to the accident vehicle.
- The body of the trapped soldier is recovered.

The miniflail began to flail the area along the north side of the destroyed vehicle. On its third pass, the miniflail became stuck. After several attempts to extricate it, we opted to leave it there and proceed with the rescue operation.

By 1830, the rescue team began to lift the jeep with hydraulic jacks. We lowered the litter basket to the clearing behind the second vehicle, and at 1835 the body was lifted out. As the command and control element, we presented arms and held our salute until our comrade-in-arms was taken aboard the helicopter and flew out of sight.

Lessons Learned

My 5-year association with multinational forces has given me a solid appreciation for the characteristics of foreign armies, which sometimes are markedly different from those of the U.S. Army. The recovery operation described herein embodies many of these characteristics. Lessons learned from this operation should be applied to training and preparations for future operations—both peacekeeping and war.

- Multinational operations take more time! Differences in language; tactics, techniques, and procedures (TTP); and doctrine cause the pace to be *much* slower than usual. Operations must be planned in detail, discussed thoroughly, and rehearsed more often than in a national unit.
- Other nations sometimes have equipment and capabilities that we do not possess. Multinational commanders must know the *total* capabilities of their forces and optimize the mixture for efficient mission accomplishment. The Swedish EOD capability, the Finnish flail, our miniflail, and the Russian mine-sniffer team are perfect examples of this mixture.
- Operational commanders must issue orders in a tactful and diplomatic manner. The orders process in multinational operations often is more collegial and less structured than the U.S. process. Firm control is still a must. Time in the unit and seasoning are the enablers for the rookie U.S. commander here.
- Multinational operations tend to generate actions that are independent of the basic plan. I believe this is more a function of organizational differences and a lack of understanding than mere impulsiveness by subordinates. Such actions must be recognized and kept in check.

Summary

Experience has shown that soldiers of all nations have a deep core of professionalism that is displayed by all ranks when called upon to tackle tough missions such as this mine-strike recovery operation. Although predominantly a NORDPOL operation, the entire task force's resources were brought to bear in a truly multinational effort to extricate the personnel and equipment involved in this disaster. The EOD probers, the flailers, the dog handler, the miniflail operator, the helicopter winch operator, and the pilots all shared a common bond of professionalism. When their skills were combined, they spelled mission success.

Brigadier General Cherrie is the assistant deputy chief of staff for training, Fort Leavenworth, Kansas. Previous assignments include assistant division commander-maneuver, 1st Armored Division, Baumholder, Germany; and G2/G3, Headquarters, Allied Command Europe Rapid Reaction Corps, Rheindahlen, Germany. BG Cherrie is a graduate of the British Army Staff College and the Army War College. He holds a master's degree in public administration from Shippensburg University, Pennsylvania.

All photographs by the 55th Signal Company (Combat Camera)

More Than Technology

By Major Judson Cook

Much discussion goes on in the profession of arms about whether the technological developments and capabilities available to U.S. armed forces constitute a revolution in military affairs. The ability to dominate information warfare, the use of unmanned aerial vehicles to gather intelligence, and a tactical and strategic internet supported by satellite communications certainly change how we plan to fight wars. However, history has shown that technological developments alone are not adequate to achieve decisive victory.

In very recent history—28 January to 6 February 1997—the U.S. Army simulated a future conflict involving the U.S. military. Personnel in the "Army After Next" program, a research group at Training and Doctrine Command, organized the war game to examine warfighting issues possible within the next 25 years.

In this war game, friendly (Blue) forces were surprised when, at the outset of the battle, the opponents (Red) destroyed their satellites. Blue forces relied on the satellites to provide the intelligence platforms and digital communications links needed to facilitate command and control and track logistics flow. The strikes against satellites confounded the Blue leadership because their war plans were based on an assumption of information dominance. While the attack destroyed most of both the Blue and the Red satellites, Red was willing to sacrifice their satellites because Blue was more dependent upon them and, therefore, had most to lose from their destruction. One observer reported that the strike against satellites took the war back to the 1950s in terms of technology. [1]

Rationale

Nations focus on developing new technologies and improving war machines that increase their ability to directly destroy the opposing force. Superior killing systems are important, but they are not the only basis for winning wars. Regardless of technological advances in warfare, sooner or later combat becomes close-up—a man-against-man struggle for survival. This has been true in warfare from the first conflict through the last and is not likely to change. The following example typifies this maxim by showing how technology cannot replace the human dimension of war.

Pacific Theater, World War II

In the Pacific theater in World War II, the United States understood the importance of technology but recognized that machines were merely a means for achieving a strategic end. In the 1930s, Japan and the United States (in the U.S. "Orange Plan") envisioned similar war plans. The two nations anticipated an initial Japanese conquest of the islands in the western Pacific, a U.S. effort to fight its way across the ocean toward Japan, and that the end of the war would result from a fleet-against-fleet battle.[2] The United States therefore developed machinery and weapons to assist in this great naval battle.

As the war in the Pacific developed, the United States equipped itself with modern aircraft carriers, bombers, submarines, and destroyers to pursue a strategy designed to cut off the Japanese from critical resources, devastate the Japanese economy's ability to produce war machines, and demoralize the Japanese population, thereby causing their government to collapse. In 1941, Japan had more naval power available than the United States—they had 63 submarines and 10 carriers, while the U.S. had 56 submarines and two carriers. By 1942, Japan increased its carrier fleet to 11 (with 550 aircraft)[3], but by 1943 the U.S. increased its naval presence to 600 warships with 1,941 carrier-based aircraft.[4] Although both nations developed technologically advanced fleets, a great naval battle between the opposing fleets did not decide the outcome of the war.

The Japanese used their modern weapons to deliver the first blow. In December 1941, Japanese naval vessels and aircraft struck a surprise attack against the U.S. fleet at Pearl Harbor. Following that attack, the Japanese enjoyed a 6-month winning spree as they expanded their base of operations from Japan into the Pacific Ocean. Because the Pacific is so vast, both countries found it necessary to gain operating and logistical support bases for their great fleets on various islands.

Land warfare in the Pacific was born of the need to maintain these forward operating and logistics bases. From December 1941 to April 1942, the Japanese gained control of Malaya, the Philippines, Singapore, and Bataan. The Japanese influence spread over the Pacific as powerful U.S. military leaders were forced to withdraw. The United States found itself on the losing side of a war for control of the Pacific. Millet and Maslowski offer a great summary of the U.S. perspective on the Pacific. They write:

After the Allied rout in Burma in May 1942, General Joseph W. Stilwell

spoke of the disaster in his theater, but his words applied to the entire American experience in the first six months of World War II:

"I claim we got a hell of a beating...and it is humiliating as hell." [5]

The United States resorted to a ground campaign partly to gain operating and logistics bases and partly to gain respect. Regardless of the reasons for the island-hopping campaigns across the Pacific, the United States committed itself to waging battle against an enemy prepared to fight to the death. Because of the distance of these island outposts from Japan (and later due to successful U.S. submarine attacks against Japan's merchant marine), the Japanese land forces were cut off and lacked resources. With their backs against the wall, the Japanese fought to retain their territory.

U.S. military leaders could not and did not rely solely on technology to achieve their strategic goals against Japan. The battle for Iwo Jima, which lasted for a month in 1945, was typical of the fierce fighting that occurred in the Pacific. The capture of this island, valued as a base for crippled B-29 bombers returning from runs against the Japanese, cost the U.S. forces 26,000 casualties, of which 6,000 were deaths. U.S. Marines fought against an invisible enemy entrenched in caves and bunkers equipped with machine guns. U.S. forces used flame throwers, grenades, and explosives to route them from their hiding places. Thus, the United States employed troops on the ground who were engaged in close, direct combat. Their intent was to gain territory that would enable the United States to pursue its strategic bombing campaign against Japan. U.S. ground forces fought the Japanese to gain safe airfields for the 25,000 air-crewmen (flying 2,400 B-29s) who made emergency landings on Iwo Jima from March to August 1945.[6]

In the 2 1/2-month battle for Okinawa in 1945, the Americans had close air support and more artillery than the Japanese, who again were dug into a system of caves and bunkers. Even with their technological advantages, the Americans had to mount an infantry assault to overcome the Japanese. As at Iwo Jima, the fighting caused heavy casualties (100,000 Japanese soldiers and 40,000 U.S. soldiers killed). [7] The Americans were beginning to learn a lesson we would have to relearn in the Korean Conflict and the Vietnam War:

...you may fly over a land forever; you may bomb it, atomize it, pulverize it, and wipe it clean of life—but if you desire to defend it, protect it, keep it for civilization, you must do this on the ground, the way the Roman legions did, by putting your young men into the mud.[8]

The point is that even as nations develop technology and improve weapons systems, they must understand that war requires the commitment of ground soldiers who are willing to die to defeat their enemy. Advanced weapons systems alone have never won a victory.

Another related point is that a technologically or materially inferior enemy can fight on terms that negate the superior force's advantage. By 1945, when the battles at Iwo Jima and Okinawa were fought, the U.S. submarine campaign against the Japanese merchant fleet and strategic bombings on the Japanese mainland left Japanese ground forces wanting for supplies, materiel, and reinforcements. Yet, to be decisive, the United States resorted to close ground combat—the very form of warfare that the enemy was most capable of waging. The same argument held true for the U.S. action in Vietnam. Similarly, in the futuristic war game described above, the Red force evened the playing field by crippling the Blue force's informational advantage.

"...Even as nations develop technology and improve weapons systems, they must understand that war requires the commitment of ground soldiers who are willing to die to defeat their enemy."

The Lesson

U.S. military forces should continue to develop technology and improve weapons systems. Engineer modernization efforts focus on systems that improve enemy and friendly situational awareness, development of digitized terrain systems, and development of intelligent mine systems. These systems enhance engineer support to the maneuver commander, make engineer contributions to combined arms operations relevant into the 21st century, and increase the lethality of the U.S. Army. But as we develop these systems, we must realize that they are merely a means to an end. We must maintain enough vision to recognize that overdependence on dominating the battlefield via technology has failed in the past. The human dimension in combat must remain paramount.

We should not develop a force based mainly on the assumption that we can achieve perfect intelligence and flawless situation awareness. As we learned in the 1997 Army After Next war game, our assumptions may prove invalid. Our adversaries may mimic our technology, develop a countermeasure that defeats it, or resort to a form of warfare that renders it useless. In the end, battles and wars are won because of the will and determination of young people willing to fight against an equally determined enemy. It would be an error to convince ourselves and our nation otherwise.

(Continued on page 15)

Engineers Working Smarter—Not Harder

By Major Anthony C. Funkhouser and Second Lieutenant Mabry Sumner

Every engineer who has ever driven pickets for hours on end has little affection for the cast iron, 40- to 50-pound driver. During countless repetitions, they pick it up over their head and drop it to drive pickets into ground that is often rocky and dense. The opposing force (OPFOR) engineers at the National Training Center (NTC) drive more than 3,500 pickets per rotation in some of the rockiest terrain at Fort Irwin, California. So the 11th Armored Cavalry Regiment set out to find a better way.

The Regimental Engineer Section's NCOIC contacted a commercial vendor for brochures on pneumatic post drivers of various sizes and capabilities. A local vendor came to the NTC to demonstrate a medium-duty post driver weighing 54.6 pounds and requiring a 42 cubic feet per minute (cfm) compressor set at 90 pounds per square inch (psi). It operated off the 58th Combat Engineer Company's (OPFOR) standard 250 cfm compressor and allowed us to connect two drivers simultaneously.

The demonstration was conducted in some of NTC's rockiest terrain known as the "Iron Triangle." By the end of the day, as a battle drill began to evolve, a squad with one post driver placed 300 meters of triple-standard concertina in 17 minutes.



Soldiers from the 58th Combat Engineer Company operate the two-man post driver.

Advantages

During the March 1997 Advanced Warfighting Experiment at the NTC, the 11th Armored Cavalry Regiment used the new post drivers, or "automatic picket pounders" as we call them, to build a motorized rifle battalion defense. During this defense, 1st Platoon/58th Combat Engineer Company (OPFOR) constructed 14 300-meter minefields with antifratricide fences and 14 300-meter triple-standard concertina fences in 12 hours. During the last 10 defenses before we had the new post driver, our average time for this work was between 16 and 17 hours. The automatic picket pounder operated similar to a pneumatic jackhammer and drove picket after picket.

A crew of four soldiers operated the automatic picket pounder. One soldier drove the 5-ton dump truck pulling the 250 cfm compressor, one carried the automatic picket pounder, one operated the throttle and untangled the hoses from bushes, and the fourth soldier held the pickets. The soldier operating the automatic picket pounder only had to guide the device on the picket. The weight of the device was sufficient to drive the pickets when it was operating. This crew drove pickets for a 300-meter triple-standard fence in less than 20 minutes. Installation time for a 300-meter minefield marking fence aver-

aged between 7 and 8 minutes. It took less than one second to drive a single picket.

The speed of the automatic picket pounder is only one of its benefits. It can also drive pickets in almost any type of terrain. When we had to build obstacles over broken terrain and on hard, compacted tank trails, the automatic picket pounder was extremely helpful. We did not put pickets across tank trails in the past, because we could not drive the pickets to the necessary depth with a manual driver. Even with the automatic picket pounder, soldiers had to increase the time the device operated and pull down on its handles to get the pickets into the ground.

On extremely rocky terrain, we only had to move the pickets around until we could wedge them between the rocks. Now that the picket crew was no longer exhausted from the endless pounding with the manual driver, they placed the pickets in deeper than normal, making it difficult to remove them. With the manual driver, we normally used 6-foot pickets and drove them an average of 6 to 8 inches deep. The average depth for the automatic picket pounder was 12 to 14 inches. The picket pounder ensured that there were no gaps in the obstacles and that the obstacles would not come out easily even in rough terrain.

Disadvantages

On the minus side, the hoses that connect the automatic picket pounder to the compressor seemed to catch on every creosote bush in the desert as we moved across the obstacle frontage. The hose would then pull back on the 55-pound driver that the soldier carried. After constructing obstacles for several kilometers, this became very irritating. To overcome the problem, we constructed a boom to hold the device and route the hose up and over the boom to keep it off the ground.

Another problem with the picket driver was that it drove the pickets too deep! When we policed the battlefield the day after a battle, it was hard to get the pickets out of the ground. We tried pulling them out using straps attached to a 5-ton dump truck, but the straps could not withstand the pressure without breaking. Then we tried using the winches on the 5-ton dump truck and the HMMWV and found that steel cables worked well in removing the pickets. In the future, we will not set the pickets so deep that we cannot remove them.

Conclusion

In light of our experience, we recommend units consider locally procuring picket pounders if auxilary power units are available. We also suggest that the Engineer School include hydraulic picket pounders as SEE attachments.

The automatic picket pounder has allowed us to increase the emplacement speed and effectiveness of obstacles. Its ability to drive pickets in all terrain and to any depth without exhausting the soldiers was a great benefit to the OPFOR. The post driver proved its usefulness during the Advanced Warfighting Experiment and will continue to be an integral part of OPFOR obstacle emplacement.

Major Funkhouser is the Regimental Engineer, 11th Armored Cavalry Regiment, Fort Irwin, California. Previous assignments include observer/controller, Fort Irwin; small group instructor, Fort Leonard Wood, Missouri; Commander, B/D Company, 8th Engineer Battalion, Fort Hood, Texas. He holds a master's degree in engineering management from the University of Missouri-Rolla and is a professional engineer.

Second Lieutenant Sumner is the 1st Platoon leader, 58th Engineer Company, 11th Armored Cavalry Regiment, Fort Irwin, California. He holds a bachelor's degree in mechanical engineering from the University of Tennessee.

(Continued from page 13)

Endnotes

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[4]Allan R. Millet and Peter Maslowski, *For the Common Defense, A Military History of the United States of America*, New York, The Free Press, 1984, page 433.

[5] Ibid, page 401.

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[8] T. R. Fehrenbach, *This Kind of War: A Study in Unpreparedness*, 1994, Fort Leavenworth, Kansas, The U.S. Army Command and General Staff College Press, pages 426-433.

Major Cook, an engineer officer, is a student at the Command and General Staff College. He holds a master's degree from the University of Texas and is a professional engineer in Virginia. He has served in combat engineer assignments with the 1st Infantry and 3rd Infantry Divisions. MAJ Cook is scheduled to serve as S3 of the 14th Engineer Battalion, Fort Lewis, Washington.

ENFORCE Breakout Sessions Tackle Regimental Issues

By Lieutenant Colonel Susan Myers and the ENFORCE Team

Have you ever wondered what really happens at an ENFORCE conference? Breakout sessions held throughout the conference are part of an Engineer Regiment initiative to pull together all of the experience, great ideas, and issues discussed at the conference. The feedback generated from these sessions is then incorporated into the Engineer Regiment's strategic plan. Eight sessions were conducted during ENFORCE 97: Doctrine Development, Trend Reversal and Engineer Qualification Tables, Heavy Division Engineer Redesign, Light Engineer Force Structure, ACE and SEE Readiness, Integrated Concept Team (Combat Heavy), Bridging, and Countermine Concept.

Breakout sessions provide a forum to inform personnel about ongoing schoolhouse initiatives, solicit feedback, and formalize strategic planning efforts for issues critical to the regiment's success. This year participants selected the sessions they wanted to attend from the ENFORCE agenda and most came prepared for the discussions, which resulted in some lively debates. This was the first year that U.S. Army Corps of Engineers (USACE) division and district commanders participated in the sessions, and we intend to include more USACE topics next year. Highlights of the sessions follow.

Doctrine Development

By Captain Shawn Howley

The session concentrated on publications currently under revision. Feedback and insights gained from the discussion will provide a great resource for authors as they develop these warfighting manuals. Three manuals were discussed:

***Joint Publication 3-34,* Joint Doctrine for Engineer Operations.** We discussed Chapter II, "Joint Engineer Fundamentals," which joint force commanders should consider when planning and executing engineer operations that parallel, support, or enhance the strategic goals and campaign plan. Attendees were invited to review Chapters II and III and submit comments by 15 May. These chapters appear on the Engineer School's home page at http://www.wood.army.mil/DDD/JOINT/joint.htm.

***FM 90-13-1,* Combined Arms Breaching Operations.** We discussed the breaching challenges facing commanders, the theory behind breaching operations, and the various types of breaching operations available to commanders. The group provided input on planned changes in breaching fundamentals and organizations that the author is making in the field manual.

***FM 20-32,* Mine/Countermine Operations.** This manual provides U.S. armed forces with technical guidance for conducting mine and countermine operations and emphasizes maneuver and engineer staff planning and coordination. It will be used by all elements of the combined arms team.

Trend Reversal and Engineer Qualification Tables

By Captain Darrell Strother

We began with a demonstration of the "Trend Reversal" compact disc (CD) developed by the Engineer School's Combined Arms Branch. This user-friendly CD will help units reverse problem trends identified at the combat training centers by identifying some tactics, techniques, and procedures to correct them. The CD is scheduled for distribution via Internet by January 1998.

Resource issues dominated the discussion concerning the Engineer Qualification Tables (EQT) (see chart). The major issue was the Engineer School's position to constrain development of the EQT by the resources provided in DA Pam 350-38 (STRAC manual). No consensus was reached by the group, and we will continue to study the issue. Another point of discussion is apparent redundancy in the tables. Active Component units want to eliminate redundant tables. The Reserve Component units represented at the session want to maintain some redundancy to allow for both unit certification and qualification.

Comments gathered during the session will be used to revise the EQT. Draft copies will be fielded to selected units for comments, and the final EQT will be presented to the commandant for approval.

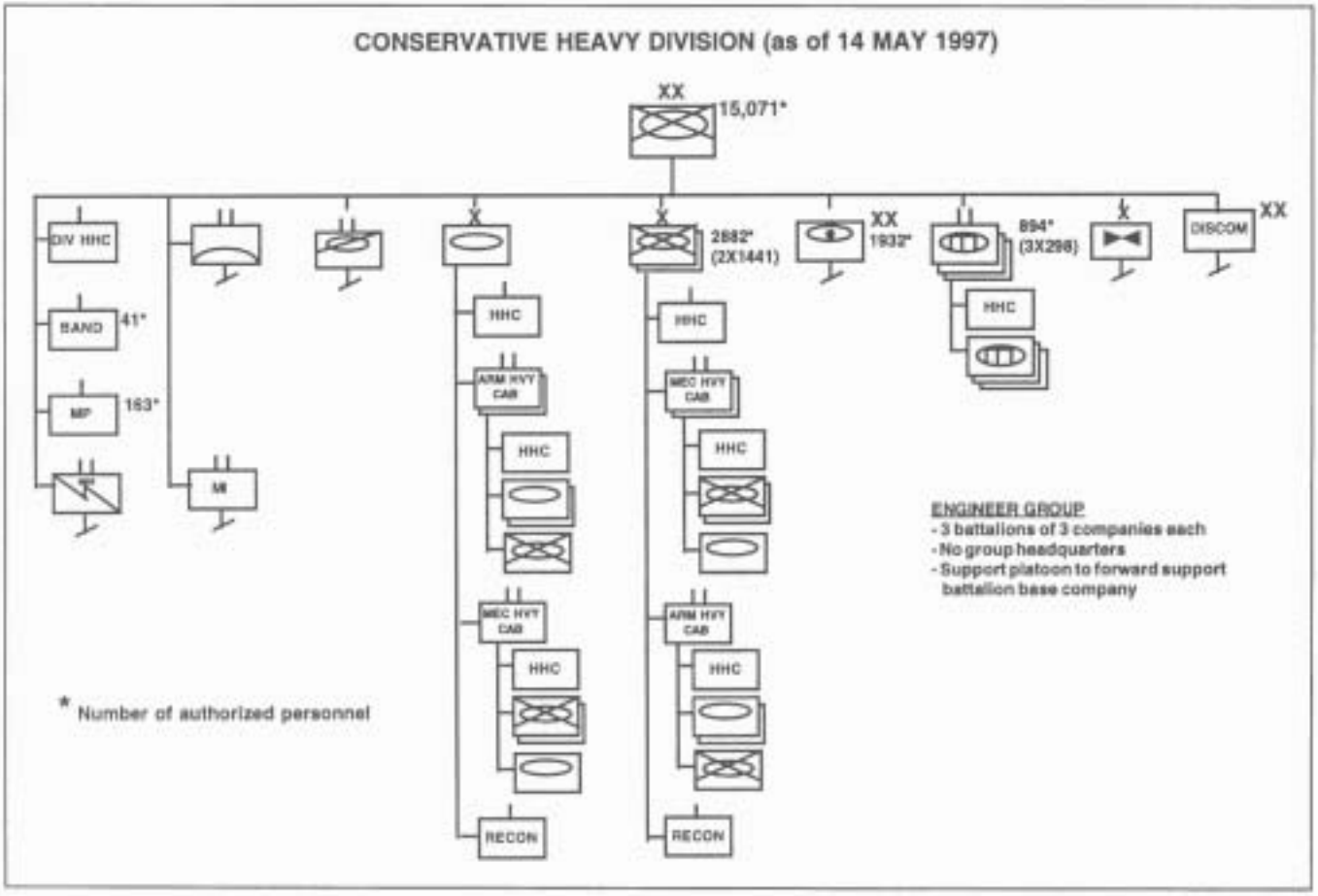
Engineer Qualification Tables	
Number	*Title*
I	Individual/Crew Weapons Qualification
II	Leader Demolitions and Mine Qualification
III	Individual Demolitions and Mine Certification
IV	Individual Demolitions and Mine Qualification
V	Preliminary React to Contact
VI	Preliminary Training Course
VII	Intermediate Certification Course
VIII	Intermediate Qualification Course
IX	Advanced React to Contact
X	Advanced Training Course
XI	Advanced Certification Course
XII	Advanced Qualification Course

Heavy Division Engineer Redesign

By Vern Lowrey

The engineer force structure is evolving to support the Force XXI heavy division.The conceptual heavy division engineer design includes Bradley fighting vehicles, Grizzly breachers, and Wolverine heavy assault bridges. The design also includes some fixes to the current heavy division engineer battalions, such as the addition of an S2 officer, a battalion maintenance officer, and a robust engineer reconnaissance capability. The battalion will focus exclusively on support to obstacle breaching operations. Extensive reinforcement from engineers at echelons above division will be required for other engineer functions.

During the ENFORCE Conference, TRADOC announced a decision by the Army Chief of Staff to provide three engineer battalions in support of the three maneuver brigades in a "conservative heavy division" design (see chart below). This design does not include a separate division engineer brigade or group command headquarters. The conservative heavy division design will be used during the Division XXI Advanced Warfighting Experiment (AWE) at Fort Hood, Texas, in November. It and two other designs (strike division and brigadist division) will be analyzed by the TRADOC



Analysis Command (TRAC) before the end of September, as part of the Division Design Analysis, Phase III, process. The strike division design includes an engineer group that commands six engineer companies. The brigadist division design attaches an engineer battalion to the maneuver brigade but has no engineer brigade headquarters. TRAC will analyze only combat capability (not battle command). The Engineer School will attempt to provide TRAC with needed battle command insights observed during the Division XXI AWE. This AWE will determine the need to retain the engineer brigade command structure in the heavy division.

The heavy division will require the capability to acquire and use an increasing load of digital terrain data to support Force XXI operations. We identified the need to manage digital terrain data at both division and brigade levels to provide needed terrain analysis and terrain evaluation support for the Army Battle Command System. Current Force XXI experiments show that terrain analysis teams equipped with Digital Topographic Support System equipment are required at both the division and maneuver brigade levels.

Light Engineer Force Structure

By Peter Malley

Redesign of the light force structure was the main topic of discussion. Rather than make small fixes, we agreed to fix what is broken throughout the light force. By doing this, we will examine the total force requirement to determine units that are no long required or where missions may be reassigned to acquire "billpayers" to fix broken units.

Much discussion occurred when we displayed the engineer support structure programmed to light forces. All attendees understood the type of support units will receive when they go to war. We explained how doctrine drives their requirements in the total force and that we will correct the doctrine if necessary.

We discussed changes proposed by the light community and agreed to work with the 20th Engineer Brigade, Fort Bragg, to develop a concept for submission during the Force Design Update Process (scheduled for summer 1998). Engineer division commanders expressed concern about possible changes to the engineer light equipment company. They feel this unit is in good shape and should not change.

The Engineer School will continue to work with the 20th Engineer Brigade on proposed changes to the light force structure.

ACE and SEE Readiness

By Major Lewis Setliff III

The diverse audience included equipment users, commanders, and representatives from the Marine Corps, Theater Army Area Command (TAACOM), and the manufacturer. Our objectives were to—

- Provide commanders with systems to improve readiness.
- Update trends and acquire field input.
- Distribute a CD-ROM about M9 ACE maintenance.

We discussed initiatives in training, supporting, and operating the ACE and SEE that will increase their operational rates. We described current training requirements; maintenance techniques; and future initiatives on parts acquisition, operator and mechanic training, and doctrinal employment. Specific comments follow.

Training teams. The Army no longer funds maintenance and operator training teams—that is now a unit-level cost. Commanders reported that the teams are worth the cost and effort. While the operational readiness rate may drop immediately after a training team visit (due partly to increased knowledge of the operator or mechanic), overall rates soon should rise.

Schoolhouse focus. The Engineer School will remain focused on training and organizational support. Training includes required operator, mechanic, and sustainment training. Organizational support adjusts appropriate TOE/TDA levels to support equipment. We agreed that the organizational structure needs improvement and training needs frequent adjustments, but current initiatives adequately address these issues.

ACE CD-ROM. The CD-ROM for M9 ACE maintenance was demonstrated and issued to attendees. It was well received and should be a tremendous asset to units.

ACE system-unique parts. We must improve the readiness of this equipment and "pull" information from the user on why equipment fails. Users should complete in detail the data sheets that accompany parts orders so that materiel developers know why a piece/part failed (operator error, malfunction, or mechanical error). This information is critical. Units must document problems properly to weight the effort in resolving systemic problems. Materiel developers should apply the requirement for each part to meet the "form, fit, and function test," and those present agreed that user feedback will assist in this effort.

Local purchase of parts. Local purchases do not create a demand on the Defense Logistics Agency (DLA) and therefore adversely impact supply availability. DLA *must* be aware of our actual demand.

Reduced prescribed load list (PLL) initiative. Reduced PLL may adversely affect ACE/SEE readiness due to their low density and operational requirements. We must closely monitor parts availability and their effects on readiness and consider an exception to policy.

Special tools and equipment. The availability and function of special tools and equipment impact readiness. TAACOM will soon propose that special tools, such as those for the ACE and SEE, be part of a kit, outfit, or set.

Direct support (DS) maintenance operations. DS-level maintainers must not be left out of the loop for maintenance training, special tools, and enhancements such as the CD-ROM.

Integrated Concept Team (Combat Heavy)

By Major Shep Barge

This session described the purpose of the construction integrated concept team (ICT) and discussed the needs and desires of combat heavy and construction engineer units in the field. Major conclusions follow.

Procurement

- Most participants urged us to maximize the use of commercial construction equipment to accelerate the acquisition process and improve parts availability throughout the life of equipment.
- Participants agreed that the SEE is not suitable for combat heavy units. They want a sturdy, commercial backhoe in its place.
- Contractor/vendor support is necessary for any deployment. Interaction with vendors would be easier if all construction equipment was from the same company (however, contracting laws do not allow this). One participant noted that he was unable to use his International Merchant Purchase Authority Card (IMPAC) while deployed to Bosnia. The loss of this productive tool made it difficult to obtain repair parts for construction equipment.
- Units are frustrated that fielding plans for construction equipment often are lengthened because of the need to convert commercial manuals to Army standards. They agreed that new equipment should be fielded as soon as it is physically available, even if that means fielding with a draft manual. Participants agreed that paper manuals are still needed but that manuals on CD-ROMs should be distributed to encourage their use.



Palletized loading system transporter

Combat Developments

We discussed the concepts and particulars of upcoming construction equipment. The palletized loading system (PLS) received almost universal praise as a tool that will pay huge dividends for engineers (see photo). One dissenting opinion was concern that having the same PLS transport chassis as the rest of the Army would set up engineers to have their PLS trucks taken by the corps commander to support high-priority logistics missions. It was noted that the reverse is also possible: Engineers could receive assets from other units to help during high-priority engineer missions.

Bosnia Lessons Learned

LTC Mike Biering discussed his 6-month tour in Bosnia as commander of the 62nd Engineer Battalion (Heavy) and provided the following lessons learned:

- The deployment was complicated because the entire battalion is not stationed at the same location (split basing). SIDPERS (Standard Installation/Division Personnel System) reports were submitted to two separate installations for the entire deployment. Unit status reports and METL development should be improved to make it easier for geographically separated parts of a battalion to deploy as one cohesive battalion.
- E-mail systems between supported units and deployed supporting engineer units differ. A solution is to gather information about connectivity prior to deployment.
- Geotextile fabric continues to be extremely valuable for soil and road stabilization purposes.
- The 62nd Engineer Battalion sustained 24-hour operations because traffic and civilian movement were low during night hours. Despite the reduced visibility of working at night, the lack of traffic on the roads made night operations efficient.
- Reuse of materials from decommissioned base camps was a big success and reduced expenses in subsequent projects.
- Daily use and modification of risk assessments keep soldiers safe!

The interchange of information between materiel developers, field users, and Engineer School integrators is critical to providing timely and meaningful support. The results of this session will help maintain engineer effectiveness into the 21st century.

Bridging

By Captain Dan Guilford

The session opened with a brief introduction about the future of bridging. We discussed several doctrinal questions to help guide the development of future systems. The three most important questions were how to order replacement bridges, where to place unused components, and how to account for bridges. We came to a consensus on the first two questions and determined that the third requires further discussion.

The future of bridging incorporates units designed to emplace both fixed and float bridges. These units are no longer tied to their bridges; they can continue forward and maintain the momentum of the maneuver force. The PLS compatible bridge loads make this possible by enabling bridges to become commodities.

Engineers can manage bridges either by the total bridge or by individual loads (flatracks). Everyone agreed that we need the capability to order total bridging for corps and higher elements to provide bridges for the theater. Once in theater, units below corps level need the capability to manage bridges by loads. This capability allows planners to quickly order large quantities of bridges for transport into a theater while providing the flexibility to manage assets to a specific gap.

The group agreed that all components of any load used in construction should remain on site (to include flatracks). The potential exists to waste some assets when a unit uses only a few pieces from a load. However, as we replace those bridges with more permanent structures, units can easily inspect and repalletize the loads if all components are on site. This capability allows units to quickly place loads back into the supply system without an additional logistics burden.

We did not determine how to account for bridges. Whether during war or peace, engineers need an organization that tracks and is accountable for the location of each load and bridge. Units that install bridges will not remain at the bridge sites, and follow-on units probably will replace those bridges with more permanent structures. Units that install bridges lack the capability to maintain accountability.

One suggestion was for the multirole bridge company (MRBC) bridge park to maintain accountability for all bridges in a specified area. It was noted that the MRBC bridge park has limited assets and is not designed for that mission. However, the option exists for the maneuver commander to organize a bridge resupply point (such as a Class IV/V point) from internal assets. Another suggestion is to transfer accountability from the emplacing unit to the engineer headquarters responsible for that area and later task responsibility to the unit designated for main supply route maintenance. As units move, bridging assets would transfer to the replacement units.

The information gathered in this session will greatly assist efforts to palletize existing and future fixed bridges onto flatracks. We will continue to discuss doctrinal questions about bridging assets as they arise.

Countermine Concept

By Lieutenant Colonel Brigid Ockrassa

A diverse group of materiel developers, project managers, combat engineers, Marines, and allied officers gathered for a successful session. Each attendee was given a copy of the draft countermine concept document. Since most of the topics were new, discussion and feedback were minimal. However, attendees were favorably impressed by the scope and depth of the document and will provide comments to assist with the review process. The stated objectives for this session were to—

Explain the new countermine concept and develop advocates to aid in its implemention. The concept was developed by the TRADOC Countermine ICT, which formed in June 1996 to examine countermine issues and propose solutions. In the concept document, issues address the DTLOMS categories and the future operational capabilities of a force operating in a mined environment. The concept document is being staffed throughout TRADOC and is expected to be forwarded to Headquarters, TRADOC, in July.

Obtain input regarding the feasibility and completenss of new ideas in the concept. The participants' biggest concern was resourcing. The countermine concept calls for better equipment, expanded fieldings, increased training, and greater countermine responsibilities. This concern is not new, but it doesn't preclude the ICT from articulating the objective endstate, which is not resource constrained. The Army's ability to achieve that endstate will be influenced by fiscal constraints.

The Canadian representative compared our concept to one they are writing and intends to incorporate many of our ideas in it. The Marine Corps representatives liked the way the concept involves the entire Army and saw potential for this to influence all ground operations. They requested to participate in the countermine ICT and have become active members.

Session participants were given an in-depth presentation on ways to apply risk management to countermine operations, in much the same way that it is applied to aviation. Engineers

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the Slavonski Brod Crossing Site: a Multinational Effort in Bosnia

By Captain Anthony G. Reed

In May 1996, the two U.S. float bridges in Zupanja were removed from the Sava River, leaving only the repaired fixed bridge in Brcko, in the northeast sector, connecting Bosnia-Herzegovina to Croatia. To save several hours of driving time, Task Force Eagle (1st Armored Division +) tasked units to develop a crossing site to link Slavonski Brod, Croatia, with Srpski Brod, (formerly Bosanski Brod), Bosnia-Herzegovina. The new bridge site would improve efficiency for the Nordic/Polish (NORDPOL) Brigade's convoys and help set the stage for the redeployment of the Implementation Forces (IFOR).

This article describes the crossing site mission, which was one of many where engineer units worked together to provide a wide range of engineer support to Task Force Eagle during Operation Joint Endeavor.

The Mission

A Hungarian engineer (PMP) float bridge company was tasked to emplace the bridge, and the 16th Engineer Battalion (Corps) (Mechanized) was tasked to clear and proof three boat ramps where the bridge was to be emplaced. The 16th Battalion's B Company organized and controlled all required assets and coordinated with the NORDPOL Brigade and Bosnian Serb engineers to have the Serbs clear their mines before we proofed the area. Based on reconnaissance, we took the following equipment and personnel:

- A Panther, a remote-controlled M60 tank with mine rollers used to detonate all types of mines (see article on page 24).
- A miniflail, a small remote-controlled, tractor-like machine used to detonate antipersonnel mines.
- An M88 recovery tank, to recover the Panther and use as a control vehicle.
- Two squads of combat engineers with M113A3s, for detecting, marking, and destroying mines.
- Five-ton dump trucks, for hauling fill material.

On the southern shore of the river, the west, center, and east ramps were potential crossing points. Records showed that minefields were on or directly beside all three ramps. The center ramp was our first priority, since no mines were on it. We only needed to construct a 30-meter road to connect the ramp to an existing parking area, which would serve as a holding area for future convoys. The west ramp was our second priority, because it had the most gradual slope and was twice as wide as the others.

At the proposed crossing site, we occupied an abandoned fuel tank farm that consisted of one large building and a huge, fenced parking lot. The building was wrecked and uncleared, so we set up tents to live in and secured the area.

The Hungarian float bridge company was across the river in Croatia. Since Croatia is a nonaggressive state, the Hun-

garians built the bridge there and secured it parallel to the river bank.

The Hungarian float bridge is the Former Warsaw Pact PMP bridge. It is similar to our assault float bridge (AFB) except that the PMP is steel, while the AFB is aluminum. In addition, the PMP can be split in half lengthwise to double the span for one-way traffic, although this significantly reduces the bridge's military load class. The PMP is assembled in the water very much like the AFB.

Proofing

We began proofing with the Panther near the center ramp, which was in a field about 30 meters southwest of the parking lot. The entire field had to be proofed because of the way the Hungarians had anchored the bridge. Rather than use an overhead anchorage system, they had tied cables from the bridge to bridge trucks parked on the shore.

The Panther's brakes weren't strong enough (via remote control) to prevent it from slipping into the river while proofing the ramps, so we used the M88 recovery tank as a control vehicle at the top of the ramp and connected the Panther to it with cables. We eased the Panther about halfway into the water with the cables, then reeled it back. Maintaining substantial overlap, we moved the Panther over slightly and repeated the process.

We proofed the field several times to ensure that it was clear of mines. The only area we didn't proof initially was directly to the right of the ramp, because minefield records indicated that 12 TMA-4 antitank mines were there. Our orders were to wait for the Serbian engineers to destroy those mines. They placed a small block of explosive with a blasting cap and time fuse next to each mine and blew them in place.

The Serbs cleared the center and west ramps, and we cleared the east ramp. We visually located three TMM-1 antitank mines and one PMR-2A antipersonnel mine. We placed half a block of C4 next to each and blew them one at a time.

The Panther could proof in all the areas where mines were destroyed, so we didn't need the miniflail. However, in mud such as that encountered near shore, the Panther's desert-type mine rollers tended to push a mine around rather than trap it between two hard spots and detonate it. We found a TMA-5 antitank mine in the mud where the Panther's rollers had stopped without detonating it. Later, as we reeled the Panther out of the water, its track picked up another mine embedded in mud. Most of the mud and the mine fell onto the ramp. But when we moved over to make another pass, the Panther's track solidly wedged the mine against the concrete ramp, causing it to detonate. Damage to the Panther included the following:

- Two sets of road wheels, three road wheel arms, and a shock absorber and mount blew off.
- The torsion bar bent.
- The transmission housing cracked.

Four days later, the Panther was repaired to a fully mission-capable status, and we continued proofing.

In areas where we couldn't proof mechanically, we used mine detectors and probes and discovered three antipersonnel mines. During proofing, our soldiers wore their flak vest and BASIC (body armor set, individual countermine), which is Kevlar-lined protective pants, protective overshoes, and a reinforced face shield.

The Swedish explosive ordnance disposal (EOD) team, with its mine dog and bomb dog, marked the cleared paths through minefields and cleared the building in the parking area and a concrete bunker near the center ramp. They used colored fluorescent spray paints and wooden stakes to mark cleared footpaths through the minefields. Each color meant something different; for example, blue may mean that an area had been cleared by a mine dog, while red may mean it was probed by hand. This is a great technique because the proofing results are highly visible.

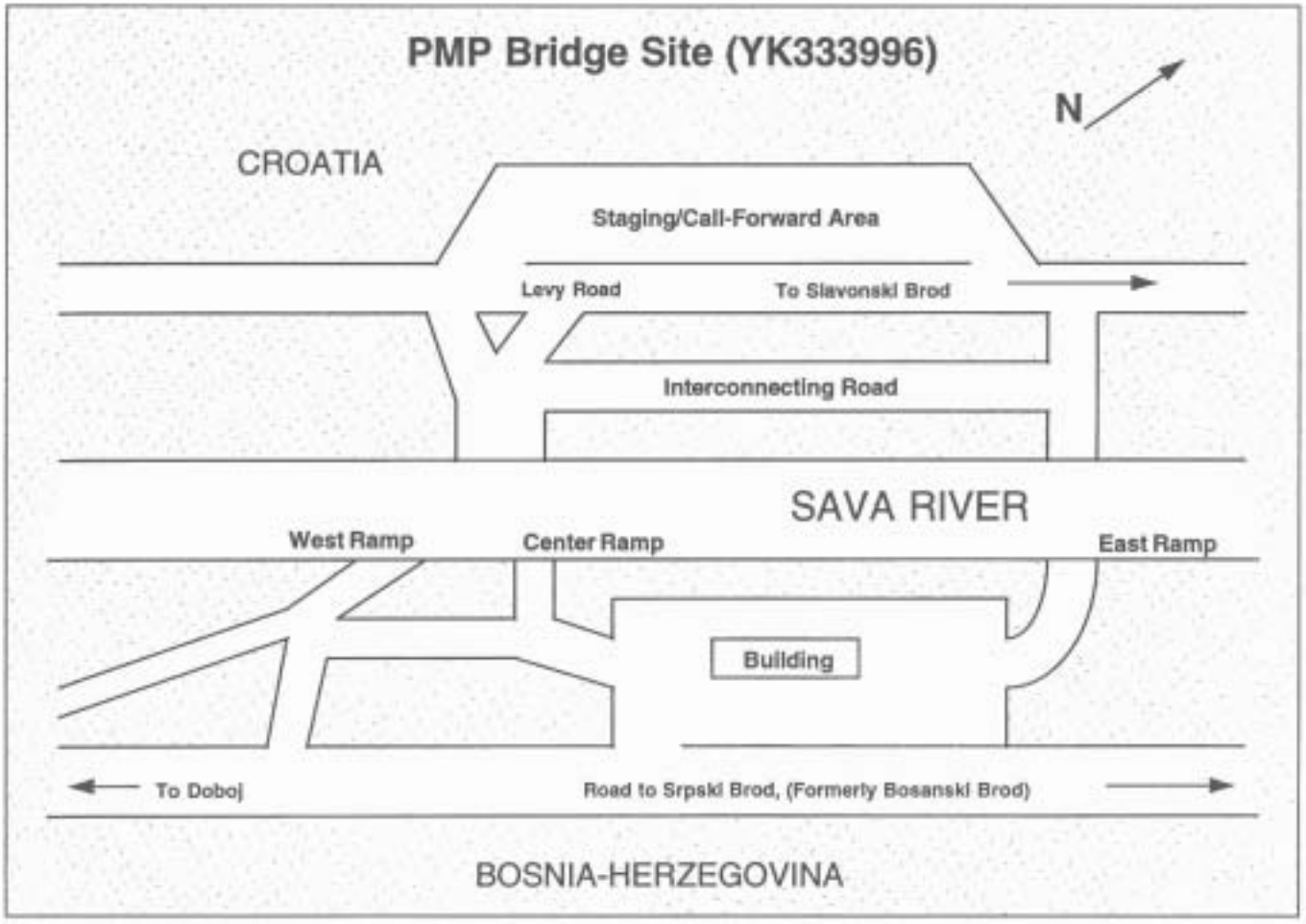
The Finnish EOD team removed small trees and brush from under the water to ensure a clear path to the west ramp. The team packed explosives into a U-shaped channel of aluminum, in much the same way as we make an expedient bangalore torpedo with a U-shaped picket. Then they floated out near the trees on a rubber raft and emplaced the charges in the water. Initially, they placed the channels of explosives vertically beside the trees, facing the trunks. Later, when most of the tree tops were gone but some roots remained, they laid the charges into the river bed and gently tamped them into the mud. This was extremely effective.

Bridging

When the center ramp was cleared and proofed, we emplaced the float bridge. Security was critical because the bridge site had to be protected from terrorist activity from both the southern and northern shores. It was the first time in four years that a bridge had been emplaced in this sector. Sabotage and a Serbian crossing into Croatia were two of our biggest concerns. Therefore, we reinforced the fence around the parking lot on the south side with triple-standard concertina wire and several manned gates. The north side was manned by Croatian police and Hungarian engineers. B Company engineers guarded the gates for the first five days until a Swedish mechanized infantry platoon assumed responsibility.

Although B Company engineers initially controlled traffic across the bridge, this responsibility soon was transferred to the 317th Rear Area Operations Center (RAOC), a small but extremely effective team. Fortunately, we worked well with them, because much of the traffic over the bridge was engineer vehicles.

We had to clear and proof the east and west ramps after the bridge was in place. We decided to do this while traffic crossed the bridge and close it only to detonate charges. However, it became increasingly difficult to coordinate all the proofing and demolitions with the large volume of traffic and the number of



visitors to the site. Then demolition operations became more complex as the Serbs and the Finns also began clearing. Again, the 317th RAOC worked with us to coordinate demolitions so as to maintain the safety of everyone involved.

Further Proofing

As the river receded, additional proofing was necessary on the newly exposed shore next to the ramps. We had to ensure it was safe in case a soldier disembarked near the bridge entrance or exit.

Explosions off the west ramp by the Finnish EOD team caused an underwater mine near the center ramp to detonate. So the Hungarians wanted us to proof with the Panther again, especially on the center ramp. We placed an armored vehicle-launched bridge (AVLB) over the water, then walked onto the bridge and lowered charges into the water on each side of the ramps. We detonated four such charges, but there were no more sympathetic detonations.

Horizontal Construction

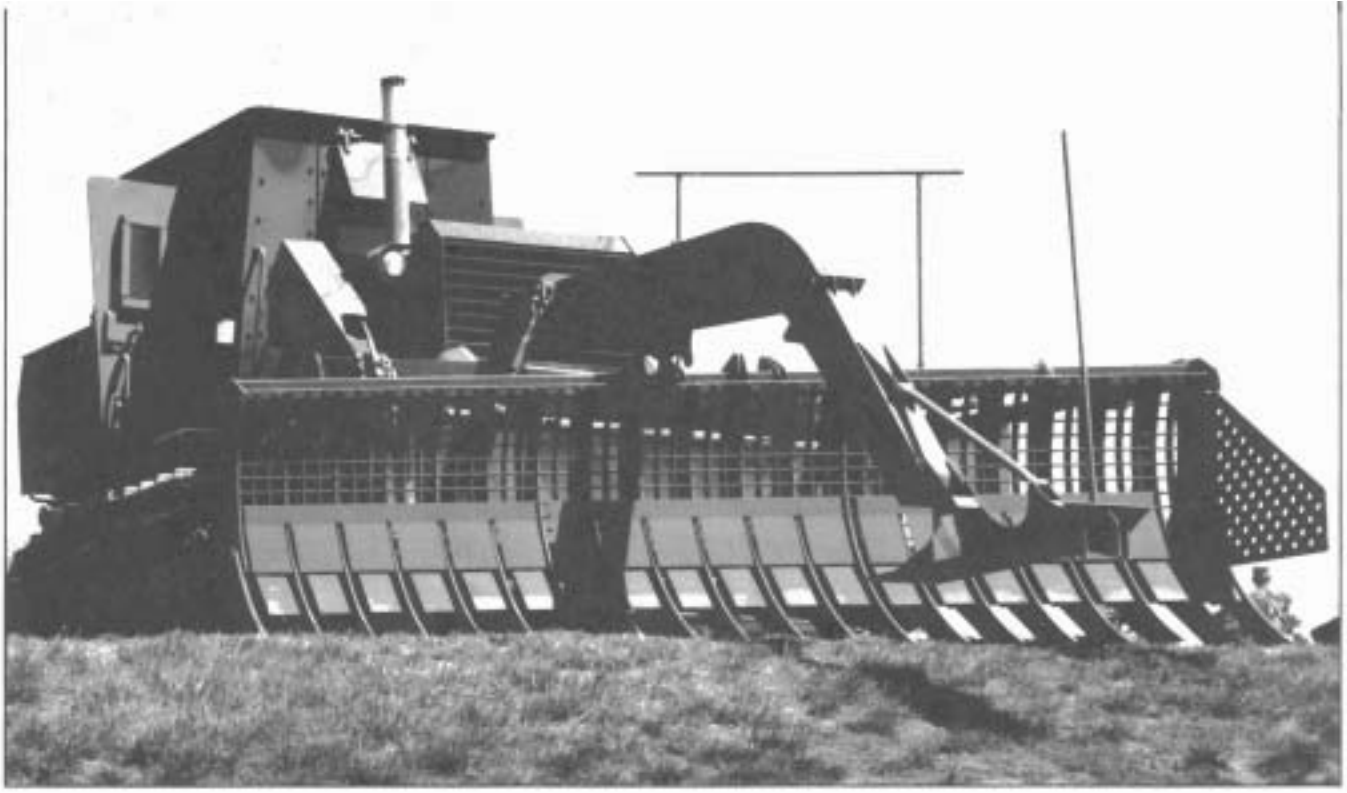
Since we controlled traffic across the bridge, we could combine the staging areas and call-forward areas.

North Side Layout. The north side of the crossing site needed an area to stage and call forward vehicles waiting to cross the river. Access to the site was via a narrow road surrounded by woods on top of an earthen levy. Three ramps, called the west, center, and east ramps, corresponded with those on the southern shore. The west and center ramps on the north side were so close together that a bridge could span from the southern center ramp to either of them (see figure). The 2d Platoon of the 535th Combat Support Equipment Company cleared and constructed a staging/call-forward area just north of the levy road, since the area had a separate entrance and exit. The platoon also connected all three northern ramps with a road wide enough to include a staging area for priority traffic.

South Side Layout. On the south side, the abandoned fuel tank farm, with access roads constructed by the 535th, could be used for a staging/call-forward area. Several enormous petroleum product and storage plants with extensive road networks and parking lots about three to five kilometers to the northeast would facilitate at least two staging areas.

Ramp Improvements. As the river continued to recede, it left a significant drop-off where the ramps ended. A platoon from the 535th hauled in large quantities of fill and

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Robotics Insertion Technology

By David G. Knichel

Engineers are leading the way into the 21st century by inserting robotics into many existing and soon-to-be-fielded systems. As a result, the Corps of Engineers will be the first ground robotics branch in the Army. Robotics are already being used by combat engineers in Bosnia and will soon be available to many more soldiers, sailors, airmen, and marines when the first robotic systems are fielded in FY99.

Background

Industry has been investing in robotics for most of the latter half of the 20th century. Robotics began with simple manufacturing tasks and has progressed to the sophisticated human-like android capabilities being developed in Japan. Robots offer efficiency, a replacement for human labors, and an opportunity to remove people from hazardous environments, such as environmental cleanup, space and underwater exploration, fire fighting, and military operations.

In the military, robots were first used by the German army in World War II. Simple remote-control devices for mine breaching protected the lives of their soldiers. Today, U.S. organizations are advancing robotics technologies in the Army. They include the Defense Advanced Research Project Agency, Army Missile Command, Army Research Laboratory, the Office of Naval Research, Sandia National Laboratories; universities such as Massachusetts Institute of Technology and the University of California at Berkeley; and countries such as Germany, France, Italy, and Israel.

Technology

The essential sciences to robotics include mechanical engineering (ME), sensor technology (ST), artificial intelligence (AI), and computer science (CS). ME allows robots to be mobile and perform tasks, ST allows them to learn about their environments, AI allows them to "think" and "make decisions," and CS allows them to process information. These sciences have made tremendous advancements in recent years, and a practical "thinking" autonomous robot may be a reality in the next decade. Until then, robots must operate in fixed-closed environments, such as assembly lines in industry, or humans must do the sensing, such as seeing and thinking, for them. The latter has been termed *teleoperation*.

Joint Development

In 1989, Congress directed the Department of Defense to consolidate its robotics efforts to improve efficiency, reduce redundancy of efforts, and accelerate robotics development. In 1994, the Joint Program Office for Unmanned Ground Vehicles (JPO-UGV) was established at the Army Missile Command's Redstone Arsenal at Huntsville, Alabama, as the singular managing agency for unmanned ground vehicles. To execute it's joint mission, JPO-UGV is commanded by a Marine Corps colonel who is supported by

Army program managers. In 1995, an agreement between the Army and the Marine Corps gave the Army the lead as the joint development agency for unmanned ground vehicles. As a result, the Robotic Technology Insertion Activity (R-TIA) was also established at the U.S. Army Engineer Center, Fort Leonard Wood, Missouri.

Insertion Technology

When the U.S. Army deployed to Bosnia in 1995, it encountered more than a million land mines. In response to this, R-TIA and the JPO-UGV developed a prototype remote-control system that could be inserted in turretless M60 tanks outfitted with Israeli tank rollers. The Army built six of these systems, which were named *Panther* (see article on page 21). Their usefulness quickly became apparent as did the need for a standard robotics kit.

In March 1997, the commandant of the U.S. Army Engineer School approved the insertion of teleoperation robotic technology on engineer equipment. The impact is that approximately 20 percent of all dozer-type systems will have teleoperation robotic capability. In addition, other robotic systems, such as an improved prototype Panther on an M1 chassis, have been developed by R-TIA and are being tested (see cover photo).

A robotic soldier assistant, called the Robotic Combat Support System (RCSS), is also being evaluated at R-TIA. RCSS is the ideal small robot for our reduced military force. With RCSS, one person can lift, transport, or do the work of several. This is possible because of its multitask attachments (including a minibucket loader, miniforklift, and hydraulic tool power cell) and its ability to clear mines (such as antipersonnel land mines). An improved prototype RCSS, with a mine flail capability, was sent to Bosnia on 17 June 1997. Older prototypes of the single-use miniflail system have been used in Bosnia since 1996.

User Appraisals

Today, R-TIA is combining a mix of robotic technologies with current and future vehicle platforms and allowing users to evaluate them in the development and preproduction phase. User appraisals allow the combat developer and program manager to get early user feedback from soldiers long before the systems go into production. Thus, problems are fixed before the systems are fully developed.

Fort Leonard Wood is an ideal location for the R-TIA joint service robotics appraisal site due to the presence of engineers from all services. Army, Air Force, Navy Seabee, and Marine Corps engineers have shown great interest in participating in the next round of robotics appraisals beginning 1 October 1997.

Conclusion

The robotic M60 Panther, which was fielded to the Corps of Engineers to clear land mines in Bosnia, is the most successful robotics ground vehicle to date. However, it is only the beginning of new robotic capabilities for combat engineers. Rapid developments in robotics insertion technology allow joint forces to upgrade the existing fleet of equipment for the 21st century at a much lower cost than replacing it. We have learned from Bosnia that inserting robotics technology gives commanders the capability of removing soldiers, sailors, airmen, and marines from the most hazardous missions in both war and host-nation assistance.

Mr. Knichel is the senior Robotics Systems Analyst at R-TIA. A retired combat engineer officer, he has worked with computers, artificial intelligence, and robotics for more than 10 years. Mr. Knichel designed some of the early robotics testing, such as the mine- and booby-trap-hunting ANDROS, deployed to Haiti to support the 10th Mountain Division. Mr. Knichel is a graduate of CGSC and has a master's degree in information systems.

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need tools to quantify the risks associated with mines and various countermine systems for their maneuver commanders. After a thought-provoking discussion, the audience expressed interest in developing an artificial intelligence system.

Conclusion

Breakout sessions are one of many opportunities for the Engineer Regiment to focus on important issues affecting the future engineer force. The 18th Airborne Corps engineers' quarterly video television conferences and the Engineer School's council of colonels provide other opportunities. As we expand our use of interactive media, we must continue to integrate issues into the regiment's strategic plan. The Engineer School's home page is a major conduit of information exchange, but nothing replaces face-to-face interaction and real-life examples. Thanks to all of you who took time to be part of the breakout sessions. Whether you attended the sessions or participate via interactive media, your contributions are valuable.

You can be part of the 1997 conference without leaving home by sending us constructive comments about the breakout sessions described above. Send comments to: Commandant, U.S. Army Engineer School, ATTN: ATSE-TD-TASS, Fort Leonard Wood, Missouri 65473-6650. The e-mail address is: Myerss@wood.army.mil.

Lieutenant Colonel Myers is chief of the Total Army School System, TRADOC, at the Engineer School, Fort Leonard Wood, Missouri. She previously served as executive officer, 1st Engineer Brigade and commanded C Company, 94th Engineer Battalion (Combat Heavy). LTC Myers holds a master's degree in business administration from National University, California.



Death of the CEV

When I wrote the article, "Death of the CEV" (*Engineer*, December 1996, p. 17), I hoped to provoke conversation and thought throughout the Corps of Engineers family. Well, that has certainly happened and then some!

I received a phone call that I must share with all of my fellow engineers. The caller was the Project Manager—Abrams Tank. He shared the following information with me after reading my article in *Engineer*. I found it interesting that the Project Manager— Abrams reads *Engineer*.

He briefed me about all aspects of building a CEV on an M1 chassis with very limited modifications to the turret and hull of the M1. He informed me that, because the M1 CEV (for lack of a better name) requires such limited modifications to the hull and turret, all necessary work can happen at the depot level. This would drastically reduce the time required to get the updated CEV to the field. He estimated that once given a "Go," it would take about one year to build and begin testing the M1 CEV. After a production decision, we could build quantity rapidly.

The 165 mm demolition gun will seat into the basic M1 gun turret area, because the M105 main gun breach and the 165 mm gun are the same. When installed, the firing system probably will increase the accuracy range of the round significantly. The only major changes required inside the turret are to update the ballistic computer and replace the ammunition stowage rack system. The NBC overpressure system is not on the basic M1 but could be added to it.

An existing Israeli blade could be attached to the M1 chassis to give the M1 CEV a blade capability similar to that of the M728 CEV. This blade has been tested for use with the M1 chassis and could be installed at the depot level.

Finally, an upgrade to the M1 heavy suspension system is possible without any modification to the hull. The upgrade of the suspension system will give the chassis the same mobility as the M1A1 heavy and the M1A2. This upgrade will allow engineers to receive suspension repair parts from any tank unit they support, thus solving some of our recurring maintenance problems.

The cost of about $900,000 for each M1 CEV prototype is minimal when compared with the cost of developing, testing, and fielding a new vehicle with the same capabilities. The ability to obtain repair parts and maintenance assistance from units the engineers support brings this engineer asset into the same vehicle generation as that of the maneuver forces.

The Project Manager—Abrams then informed me that the M1 hulls, the 165 mm guns, and the Israeli blades can be made available. So now, you ask, "When can we expect to get our 'new' CEV?" You will not believe the answer to this question: Probably never. The Engineer School is not looking to replace the CEV in this fashion, and we all know there is no move afoot to develop an M728 CEV replacement.

When told that the Engineer School appeared uninterested, I almost fell out of my chair! I cannot believe that we are not even considering this golden opportunity to replace a lost capability. As a combat engineer battalion command sergeant major, I also cannot believe that we never heard of this proposal in the field and still would not know about it if not for this concerned soldier reading *Engineer* magazine.

All right, engineers, let's get on the phone, computers, or any other communications resource and let our Engineer School know how we feel. We need to address any possible method for replacing our lost CEV capability.

Command Sergeant Major Timothy Chadwick
4th ID, 299th Engineer Battalion
Fort Hood

Engineer School's Reply

CSM Chadwick's letter regarding a replacement for the M728 Combat Engineer Vehicle (CEV) raises issues that need to be understood by every senior member of the Engineer Regiment. His points are sound, and he has obviously done his homework. I will not refute his views about the need for a better CEV, because we need that capability. The question is how to meet that need. I offer another perspective about why the Engineer School is not working on an Abrams CEV at present. There are two basic reasons.

First, the world has changed since the original CEV was developed. Then the Army was focused on fighting a major war in Europe. The anticipated enemy had massive formations of armored vehicles, and we were significantly outnumbered and outgunned in many areas. Our strategy was to defend, trading space for time. We supported that strategy by becoming the best in the world at countermobility operations. Bear in mind that we planned to fight on terrain generally of our own choosing with which we were totally familiar. We were very well prepared for that eventuality. Mobility operations and the requisite equipment to support them were secondary to that primary focus. As a result, the Army did not see an overwhelming need for a dedicated complex obstacle breaching vehicle, like the Grizzly. There was support for an engineer capability to reduce point obstacles, such as that likely to be encountered in urban areas or obstacles created by nuclear strikes. There also was a secondary need for a capability to create obstacles from a standoff position. The M728 CEV was developed for that combined requirement.

Since then, the world has changed dramatically and the U.S. Army's role and anticipated missions have changed as well. Now we must be ready to deploy into areas of the world where opponents own the terrain and have ample time to prepare deliberate defenses. Potential opponents have had an opportunity to learn from our experiences in Europe. They are intimately aware of our countermobility doctrine, tactics, and equipment. While that change was taking place, we were not funded adequately to develop and field an effective counterobstacle capability. If our forces had been required to breach a complex obstacle against a credible foe who learned from our Cold War experiences in Europe, the results would likely have been grim.

The second reason, touched on briefly in the previous paragraph, is money. We have two mobility systems approaching fielding, the Grizzly and the Wolverine. They will provide world-class capabilities that no one else has. In the current budgetary climate, it is extremely difficult to get authorization to start a new acquisition program. The senior leadership of the Engineer Regiment has agreed on a list of priority programs for the future. We are addressing as many programs as resources permit. Unfortunately, a replacement for the CEV is not one of them.

In the meantime, we are seeking other ways to solve the problem created by the retirement of the CEV. The situation is not hopeless, and the Engineer School has not given up! The challenges of reducing point obstacles and providing engineer support to the combined arms team in close or open terrain are well understood. TRADOC, with Headquarters, Department of the Army support, is aggressively working on a near-term solution. The most likely option is to mount a rubble-clearing blade on the Abrams tank. A modified 120 mm tank round has proven to be effective against certain types of point obstacles.

For the long term, we're exploring several methods of delivering a demolition charge from a standoff position. The Grizzly, with its robust blade and arm, can clear rubble. While we may not have both demolition and clearing capabilities on the same platform, we will continue to accomplish the mission.

It is always good to hear from the field, especially on issues of great concern to the regiment. Thank you, CSM Chadwick, for setting the stage for this discussion.

Colonel Robert J. Greenwalt, Jr.
Director of Combat Developments

Loss of Antipersonnel Mines

The M16 bounding antipersonnel (AP) mine is a very effective weapon when employed properly. Lately, it and similar nonself-destructing "dumb" mines have become the center of U.S. policy because of their postwar impact on civilians. This has resulted in restricting their use to the Korean peninsula (*Engineer*, December 1996, inside front cover). Considering that the United States has approximately 1.5 million M16s in stock, we have a financial obligation to taxpayers to consider upgrading the M16 with a reliable self-destruct fuse, rather than destroying millions of dollars worth of government property. These mines could be fitted with a "smart" fuse similar to one developed by the Italians for their Valmara 69 bounding AP mine, called the *VS-APFM1*. This advanced electronic fuse can be programmed to self-neutralize in up to 365 days. However, it should be noted that the need for long-term nonself-destructing mines in barrier minefields like those found along the DMZ in Korea will continue.

Alternatively, the M16 could be used as a command-detonated munition similar to the M18 claymore (within the restrictions outlined in the Convention of Conventional Warfare) or it could form the basis of a command-activated, close-in vehicle defense similar to the one fitted to the famous German Tiger tank. Such a system effectively protects tanks from dismounts in urban combat (which may become more prevalent in the near future) or other restricted terrain.

Considering that the U.S. military has not performed very effectively against dismounted opponents in the last 50 years (Korean Conflict, Vietnam War, and Somalia) and that bounding AP mines are very effective against such threats, we should make every effort to upgrade this valuable resource to make it politically acceptable. They are too valuable a resource to waste.

Major William Schneck
ADE, 29th Infantry Division (Virginia Army National Guard)

Engineer School's Reply

MAJ Schneck is correct in his position that the M16 antipersonnel landmine (APL) is an operationally effective weapon. Its battlefield functions are vital to the success of U.S. war plans. Unfortunately, APLs are politically unacceptable and, as the letter states, nonself-destruct APLs have been banned. The U.S. military has the charter to find an acceptable APL replacement—one that fills the operational niche currently filled by APLs but does not pose a lingering threat to innocents. The letter suggests two possible approaches, which I will address.

Add a self-destruct fuse to the M16. *The President's policy clearly articulates a goal to eliminate all APLs—not "dumb" APLs, not "smart" APLs, all APLs. Converting our nonself-destruct to self-destruct would violate the intent of the President's policy and be more fiscally irresponsible than simply destroying our current stock.*

Add a mechanism to make the M16 a command-detonated munition. *The Office of the Secretary of Defense is sponsoring a major, three-part study to find an APL replacement. It is a very comprehensive research project. In this unconstrained, brainstorming environment, we are considering all options across the DTLOMS (doctrine, training, leader development, organizations, material, and soldiers) domains. Options include lethal systems, nonlethal systems, expanding employment of currently fielded systems, increasing the force structure, and modifying existing mine stocks. To address MAJ Schneck's specific suggestion:*

- *The technical challenge of adding the control mechanisms that make APLs acceptable is not trivial.*
- *It is unclear what additional target verifications will be required to accommodate reduced visibility.*
- *The command and control and force structure implications of fielding this system are not obvious.*

A TRADOC-chartered integrated concept team is now analyzing the effects of current APLs and determining the most tactically sound employment of candidate replacements. Research confirms that APLs provide many benefits to the warfighter. MAJ Schneck's letter touched on just one use of APLs—defending a long-term border from a dismounted threat. In that role, the APL essentially is a "robotic sentinel," filling a role not easily duplicated. The Department of Defense has invested a lot of time, money, and energy into the task of finding APL alternatives that address all tactical employments. We have not acted unilaterally. We have solicited industry and academia for possible solutions and are working closely with nations that are seeking politically acceptable systems that replicate the operational functions of APLs.

Replacing the functionality of APLs has proven to be an elusive challenge. Some innovative technologies are beginning to emerge. The bad news, however, is that the most promising replacement systems tend to operate in a narrow set of conditions and address only a single tactical employment. These systems are very expensive and they are years from fielding.

Bottom line: While we have not found the answer yet, we are considering all relevant options in pursuit of an appropriate APL replacement.

Lieutenant Colonel Brigid Ockrassa
Special Countermine Project Officer
Directorate of Combat Developments

Infrastructure Preservation:

Extending Road Life in Remote Areas

By Major Robin L. Hagerty, George Mason, and Gil Mason

Recent humanitarian operations in remote areas of Africa and Bosnia have emphasized the need for a strategy to deal with road networks that cannot sustain enough logistics convoy traffic to support military operations. The traditional point of origin for equipment and materiel is a fixed seaport or airfield, with the final distribution point being at the end of an unimproved dirt road. This scenario requires repeated transloading of materiels as route conditions and topography change.

Unimproved secondary roads are commonly built for light- and medium-duty wheel loads, with construction consisting of minimal subgrade preparation overlaid with gravel. Normal maintenance for these roads consists of periodic blading and seasonal applications of new surfacing materials. The subgrade's compaction, strength, and drainage determine the frequency of maintenance needed to keep the road passable.

Initial road failure may be indicated when drivers complain about pot holes, surface rutting, and roughness. Road deterioration that causes vehicle vibration rapidly increases driver fatigue and limits the speed he can safely drive. At the same time, it accelerates vehicle maintenance requirements.

This article describes roadway deterioration caused by military transportation in remote areas and presents some actions that can extend road life.

Discussion

U.S. military relief missions often involve transloading supplies from large transport trucks onto smaller, Army series M923 trucks, which are better suited for use on unimproved roads. The repeated heavy-duty wheel

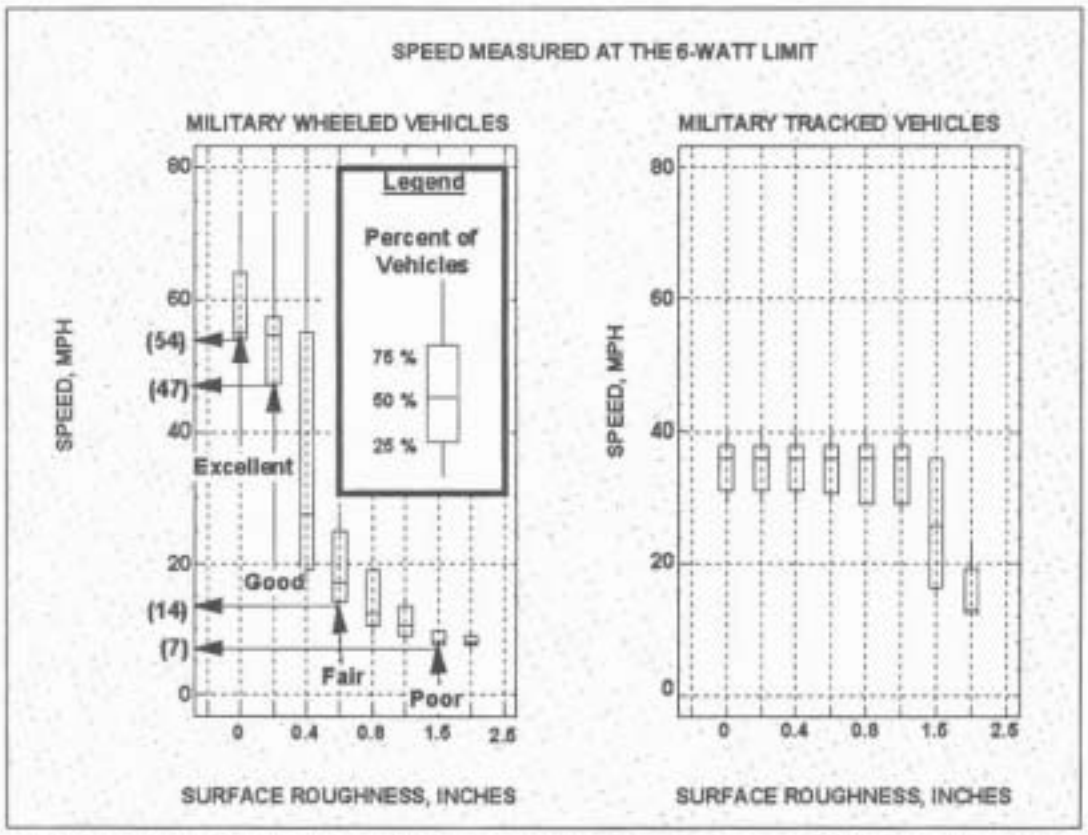


Figure 1. Relationship between vehicle speed and surface roughness of selected ride courses.

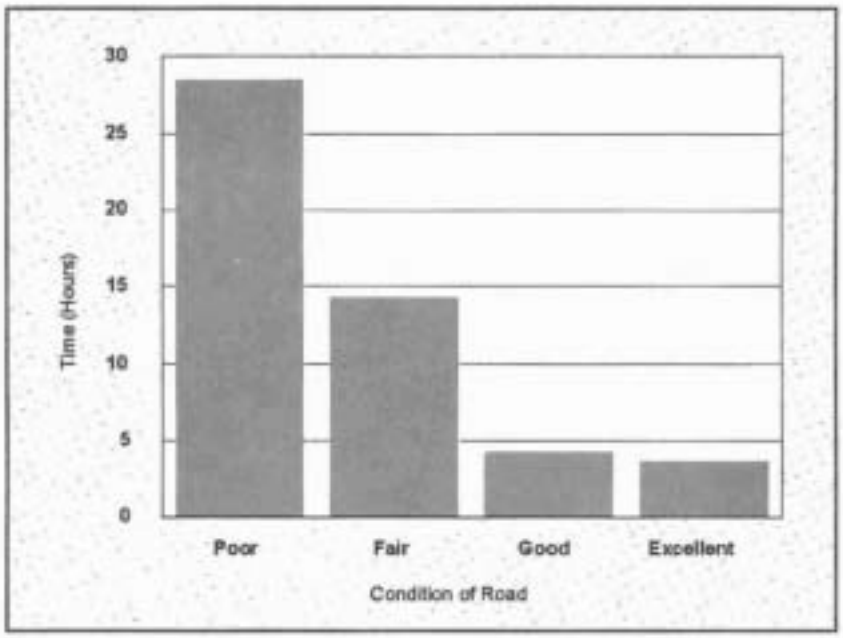


Figure 2. Estimated cargo movement time when speed is limited by road surface roughness.

loads from these trucks' bias-ply tires may immediately or cumulatively affect the roadway until deterioration makes it almost impassable. If tire pressure is high, the tire's ability to absorb many of the dynamic forces imposed by the vehicle traveling along an uneven road surface is limited. Thus, most of the dynamic force is transmitted directly down to the road and up to the driver.

Fatigue Level. The Human Engineering Laboratory at Aberdeen Proving Ground has taken the dynamic forces exerted on the driver over time and translated them into fatigue levels. Several vehicle-testing laboratories built courses to represent various levels of surface roughness existing in different areas of the world. Then military vehicles were driven over these courses, and on-board measurements were recorded. Vertical accelerations at the driver's seat (referred to as absorbed power) were averaged over time and defined in units called *watts*. Further research determined that drivers normally did not operate vehicles for long periods (8 hours or more) at absorbed power levels of 6 watts or more.

Speed. Figure 1 represents the relationship of speed and surface roughness for military wheeled and tracked vehicles tested on various ride courses. The *x* axis in Figure 1 ranges from a very smooth segment of road (no undulations) to an extremely rough segment (approximatley 2.5 inches). Mason, Smith, Gray, and Ahlvin explain in detail this method of describing terrain and road surface roughness. [1]

Using Figure 1 as a means of estimating speed for convoys, four conditions were selected to demonstrate the effects of different levels of roadway deterioration on convoy speed. The average convoy speed is defined at the 1st quartile, or the point where 25 percent of the wheeled military vehicles tested is limited by surface roughness. Thus, a surface roughness of approximately 0 inch, with a corresponding average speed of 54 mph, represents extremely smooth roads in excellent condition. In the next quartile, roads in good condition are represented by a surface roughness of 0.2 inch, with a maximum speed of 47 mph. In the third quartile, a surface roughness of 0.6 inch, with most speeds reduced to 14 mph, represents roads in fair condition. Finally, a surface roughness of 1.5 inches, which may restrict vehicle speed to as low as 7 mph, represents roads in poor condition.

Wheeled vehicles were selected for the study since they normally comprise relief mission convoys. The doctrinal average convoy speed specified in FM 101-10-1, *Organizational, Technical, and Logistical Data*, is 40 km/hr (24.8 mph), which includes halts. The convoy is expected to travel 320 kilometers (198.4 miles) in 8 hours. Excluding time for stops, the vehicles will average speeds of 80 km/hr (49.6 mph). However, visibility, terrain, and road conditions often affect the average speed.

Figure 2 depicts the relationship between the increase in time required to transport supplies and the road condition. Calculations are based on the convoy traveling 200 miles with the speed restricted by the 6-watt fatigue maximum of the driver. Speeds given for the road conditions in Figure 1 are used to calculate the time required to move the payloads in Figure 2.

Soil Stress

Within the parameters of geotechnical engineering, it is convenient to view the subsurface soil stress as a function of stresses from—[2]

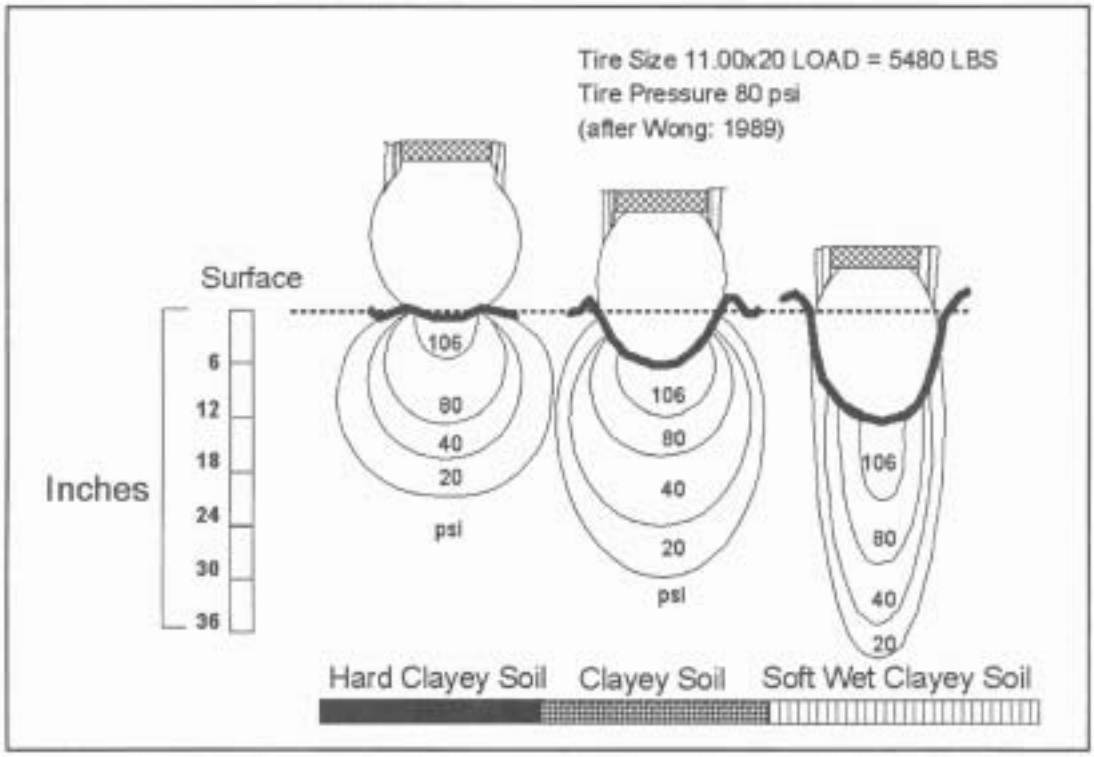


Figure 3. Pressure distribution under a statically loaded tire in various soil types.

- Soil and road surface weight (construction).
- Fluid pressures (weather).
- Externally applied loads (traffic).

Military transporters are primarily concerned with changes in road surface conditions that inhibit movement. Road deterioration normally occurs through interaction of the tire's footprint and the road's ability to absorb and disperse stresses imposed by traffic while maintaining its surface resiliency. Tire design helps the road retain some of its resiliency by absorbing part of the stresses. Without periodic maintenance, the road surface's ability to absorb load stresses is reduced, causing the surface and/or subgrade to fail. As failure continues, the road surface cracks and develops ruts. Rutting begins the chain of events that quickly makes the road difficult to travel at maximum speeds. As traffic accelerates, the deterioration process continues to increase and drivers must reduce speeds to prevent damage to vehicles, the cargo, or themselves.

Figure 3 depicts the distribution of radial stresses from a 5,480-pound tire load in various mediums. It shows the relationships between the passing wheel, its loading effects, rutting, and the dynamics of the passing shock wave as it penetrates the road's subgrade through different soil types.[3] The cross-sectional view shows the downward stresses caused by the wheel as it traverses the road and demonstrates how these stresses are dispersed and absorbed by the subsurface soil.

The figure depicts the shock wave from an M923 cargo truck with bias-ply tires and its cargo centered over the rear wheels. The calculated front-wheel load (worst case) represents the net vehicle weight of 22,515 pounds, combined with its rated gross cargo capacity of 10,000 pounds, and divided by six wheel locations.

Figure 3 shows how different soil types respond to the wheel load but does not specifically identify the stresses caused by vehicle speed. This figure also shows the relationship between soil subsurface strength and the tire's ability to penetrate deeper into the subsurface, thus increasing the severity of rutting with each additional vehicle pass.

Alternatives

Engineers can calculate the effects of wear on unimproved roads; however, many transporters lack a background in using these analytical methods. For field applications, convoy planners need an engineer-developed methodology that is based on scientific principles. It should be easy to understand and simple to apply.

The relationship between a wheel load and its interaction on an unimproved road are predictable. Therefore, the transporter has several alternatives for preserving road life. These include reducing tire pressure, vehicle speed, and vehicle weight.

Reduce Tire Pressure. This action increases the size of the tire footprint and decreases the transmitted wheel-load stresses. It more evenly distributes stresses over a wider

tire-contact area. However, we must exercise caution when reducing tire pressure. Total reduction must not exceed 25 pounds per square inch (psi) per tire. If the pressure reduction drops below 25 psi per tire, excessive tire deformation may occur, resulting in damage to the sidewall or inner tube. Reducing tire pressure also lessens the driver's discomfort from road surface roughness.

Reduce Vehicle Speed. In conjunction with reduced tire pressure, a lower speed assists in more even distribution of shock waves through the soil. Reducing shock waves helps preserve the drivers' comfort.

Reduce Vehicle Weight. Decreasing the vehicle load offers the greatest potential for extending road life while preserving the drivers' comfort. When planning throughput estimates in remote areas, transporters normally use the cross-country load weight, which is approximately 75 percent of the vehicles' rated capacity, as a base calculation. Reducing the estimated cross-country cargo load from 7,500 to 6,000 pounds reduces vehicular-caused road deterioration.

The best potential for retarding road deterioration is to use a combination of all three alternatives. This common-sense approach can be broken into several independent actions. Transporters should apply the alternatives in response to changes in weather and road conditions to extend road life and lessen potential damage to their trucks' suspension components.

Figure 4 illustrates the net effect gained from these alternatives.

- Situation I reflects no action taken.
- Situation II reflects reduced tire pressure.
- Situation III reflects reduced tire pressure and reduced payload.
- Situation IV reflects reduced tire pressure and a reduced payload of 1,500 pounds below the normal cross-country planning load.

Calculations are based on research conducted at the U. S. Army Engineer Waterways Experiment Station, using an Army series M923 5-ton cargo truck with a cargo weight of 10,000 pounds.[4] The wheel load was calculated using the vehicle's rated load capacity of 10,000 pounds and its manufactured empty weight of 22,515 pounds. As illustrated, Situation IV indicates the greatest potential for increased road life span. An interesting observation between Situations III and IV is that reducing the cross-country payload and reducing tire pressure significantly increases the life of the road.

Conclusion

The physical and political environments of a host nation influence the execution of military operations. Infrastructure limitations due to the remoteness of an area, combined with ever-changing political considerations, present unique challenges for our military forces. There is a direct correlation between road usage and road degradation and their effects on limiting convoy throughput operations. This correlation has significant influence on vehicle speeds, surface roughness, and vehicle maintenance. The alternatives discussed above are possible solutions to this problem. Reduced vehicle loads and tire pressures may potentially double road life. It is critical that military transporters understand the correlation between traffic and road degradation and between vehicle speeds and surface roughness.

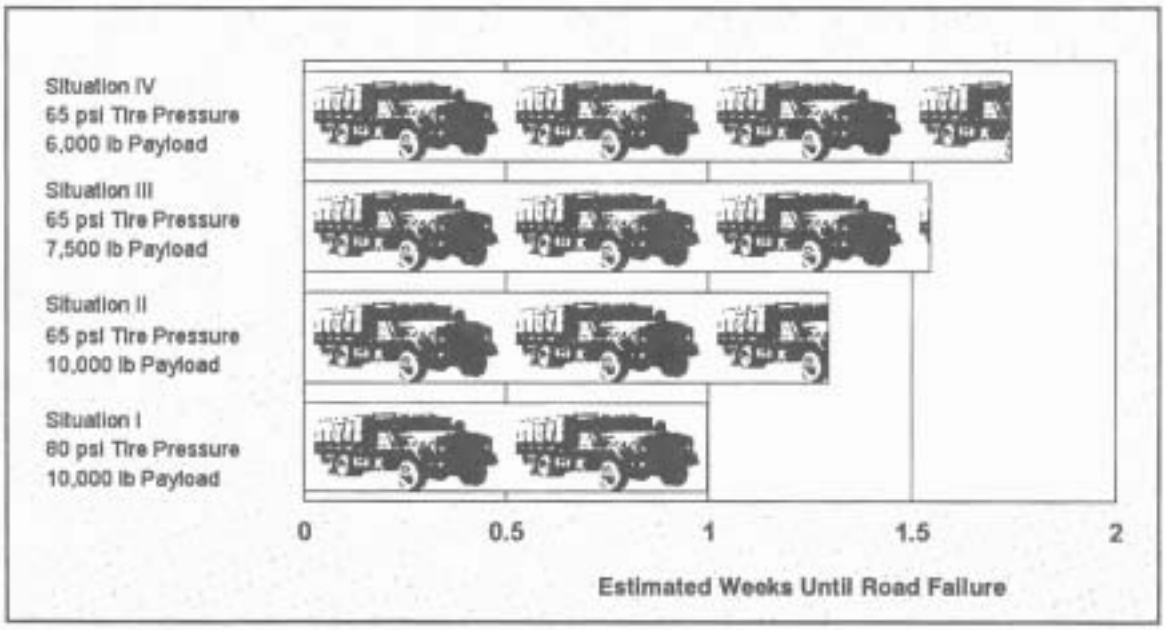


Figure 4. Estimated changes in road life based on vehicle configurations.

Engineers have limited assets for maintaining road networks. Therefore, military transporters must help reduce damage to roads in order to increase their longevity. As the focus of our force projections shifts toward humanitarian operations, more emphasis is placed on reducing overall operational costs and improving timely execution. Each member of the humanitarian team must strive to preserve the infrastructure while maintaining daily throughput operations.



Major Hagerty is deputy commander of the Nashville District, Corps of Engineers. She was previously stationed at the Waterways Experiment Station, Vicksburg, Mississippi. MAJ Hagerty holds a master's degree in civil engineering from the University of Texas at Austin and is a registered professional engineer.

Mr. Gil Mason is a researcher in the fields of military transportation and logistics for Applied Research Associates Inc., Vicksburg, Mississippi. He is a graduate of the Army Command and General Staff College and holds a master's degree.

Dr. George Mason is a registered professional engineer in the Mobility Systems Division, U.S. Army Waterways Experiment Station, Vicksburg, Mississippi. He holds a doctorate in civil engineering from Rensselaer Polytechnic Institute, Troy, New York.

Endnotes:

[1]Mason, G.L., R.P. Smith, M.W. Gray, and R.B. Ahlvin, "Development of a Terrain and Road Data Base for HML Transporter Concepts" *Technical Report GL-85-12*, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1985.

[2]Cernica, John N., *Geotechnical Engineering*, Holt, Rinehart, & Winston, Inc. 1982, page 156.

[3]Wong, J.Y., *Terramechanics and Off-Road Vehicles*, Elsevier Publishing, 1989, page 198.

[4]Barber, V.C. and N.R. Murphy, "Vehicle/Road Compatibility Analysis and Modification Systems, (VRCAMS)" *Technical Report S-73-13*, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. 1973

Acknowledgment: *The tests described and the resulting data presented herein, unless otherwise noted, were obtained from research conducted under the Research, Development, Testing, and Evaluation program of the U.S. Army Corps of Engineers by the U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Permission was granted by the Chief of Engineers to publish this information.*

(Continued from page 23)

lengthened the ramps so the float bridge's length could be adjusted to the water level.

Clean-Up Operations

After the Finns blew charges in the water to clear the foliage, they brought in an excavator to clean up roots and debris. To allow them to reach farther across the water, we laid out the AVLB so they could move the excavator onto the bridge. This was the second time we had used the AVLB in a nontraditional role.

The Finns had a bucket loader with a revolving street broom attachment, which we used to sweep the large parking lot. It is a very efficient and useful device.

Lessons Learned

Most important, we learned that engineers must maintain a wide variety of equipment to accomplish the myriad of tasks expected of them. This can be accomplished in two ways:

- Continue to task organize units as required to accomplish the mission. This may include equipment from other nations as well as U.S. assets.
- Tailor a battalion-sized unit to give it bridging, horizontal and vertical construction, and combat engineering capabilities. (Task Force Volturno is a good example of how successful a diverse engineering unit can be. See article on page 2).

We also learned that there is a continued requirement for better countermine equipment. The Panther with its desert rollers was helpful, but it often failed to detect mines. Until technology provides us with that "ultimate" piece of countermine equipment, we must continue to use every tool available to reduce and eliminate the mine threat in every situation we encounter.



Captain Reed is attending CAS3 and will attend the University of Washington this fall. Previous assignments include Commander, B Company, 16th and 54th Engineer Battalions; and XO/platoon leader (during Desert Storm), 1st Engineer Battalion. He holds a bachelor's degree in industrial technology from Southern Illinois University.

Asphalt-Mixing Plants:
Baghouse Operation Tips

By Staff Sergeant Jaime Barrientos and James E. Shoenberger

The U.S. military maintains a large volume of asphalt concrete pavement. In the Army alone, the volume exceeds 7,000 miles. Construction support units are responsible for asphalt concrete pavement construction for Army requirements, and these units possess a wide range of equipment, including an M081 Asphalt-Mixing Plant.

To avoid air pollution, controlling dust during asphalt mixing is a must. This article describes the function of and operational guidelines for a well-developed, efficient maintenance program for a baghouse, which is an air-filtration system that removes solid particles from the gas stream during asphalt mixing. This information will be especially useful to Army engineers involved in asphalt concrete mixture design or any pavement construction.

The U.S. Army Engineer School's 62H course, *Concrete and Asphalt Equipment Operator*, provides hands-on instruction on the M081 Asphalt-Mixing Plant, along with other construction equipment owned by units.

Introduction

Asphalt concrete is blended aggregates held together by asphalt cement. Aggregates make up 85 to 90 percent, by volume, of the mixture. The aggregate materials normally contain at least a small amount of moisture, which must be removed before the aggregates are coated with asphalt cement. At ambient temperature, asphalt cement is a black, semisolid, highly viscous material. When heat is applied, it becomes a liquid and less viscous. Heating the aggregates and the asphalt cement in an asphalt-mixing plant removes moisture and liquefies the asphalt cement so it will adhere to the aggregates.

The two main types of asphalt-mixing plants—batch and drum mixers—have similar basic components. A typical drum mixer is shown in Figure 1. Asphalt plants have a cold feed system to meter and deliver the aggregates to the plant. There the aggregates and asphalt cement are heated and combined into a homogeneous mixture. Among the emission control systems available that will capture particulate materials, the baghouse is the predominately used system. This method allows trapped aggregate fines to be returned to the mixture, thus minimizing changes to the original aggregate gradation. A properly maintained and operated baghouse system will remove almost all the fine aggregates from the exhaust gas stream, thus assuring that air quality requirements are achieved.

Baghouse Operations

Baghouse air-filtration systems operate by trapping small particles in a series of fabric filter bags, while hot exhaust gases pass through and are

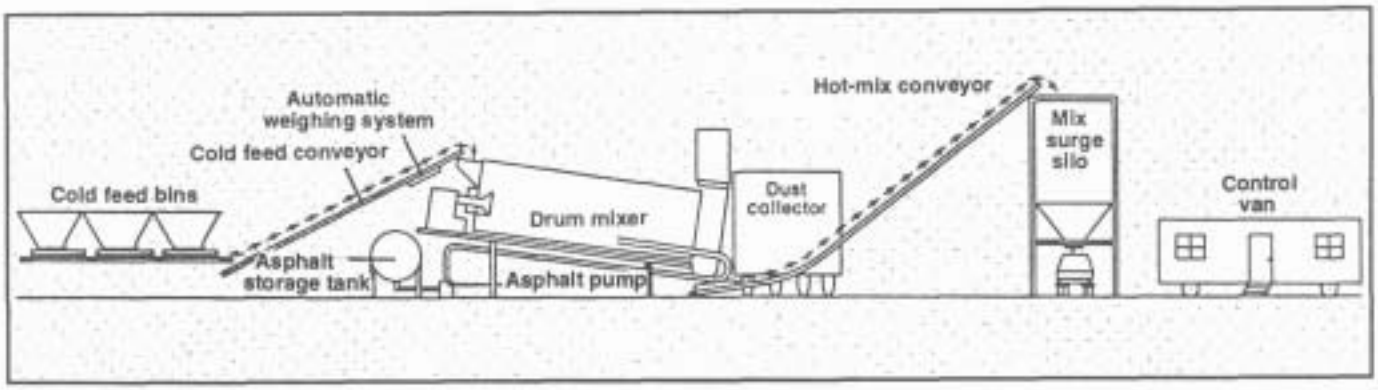


Figure 1. Basic components of a typical drum-mixer plant.

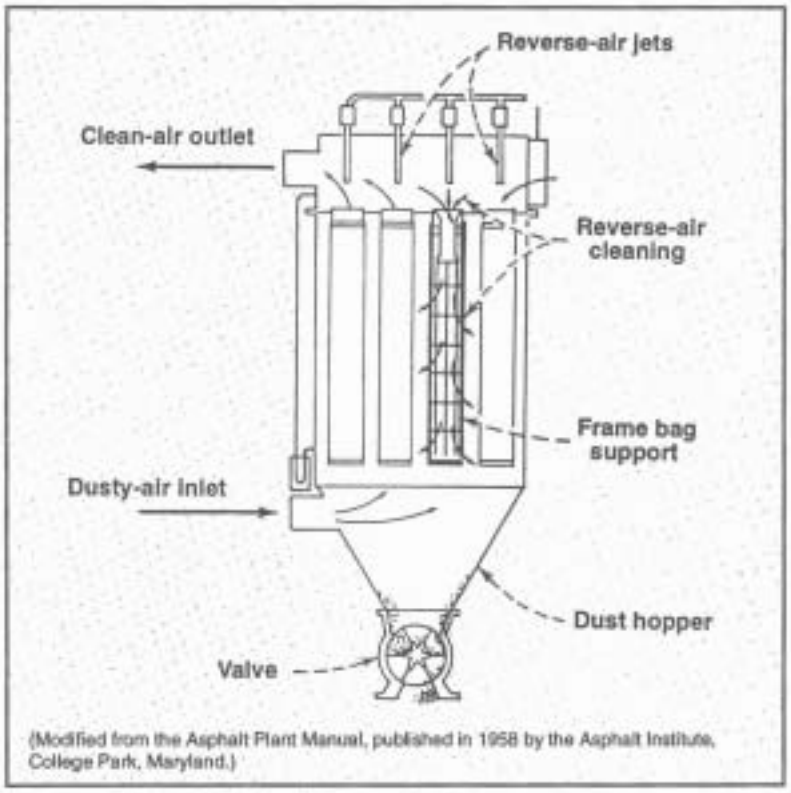


Figure 2. Typical layout of baghouse components.

expelled from the plant (see Figure 2). Most baghouse systems employ an expansion chamber or knockout box, which uses pressure differential methods to remove large aggregate particles from the air stream before it passes through the bags. The bags are attached to a circular metal framework in a series of rows or columns. As exhaust gases pass through the bags, the inside (or exhaust side) of the system contains relatively clean air. When operating properly, baghouse systems remove up to 99.9 percent of the fines in exhaust gases.

To ensure that a system continues to operate properly, the bags must be cleaned periodically. This is usually accomplished by shaking the bags, back flushing them with air, or by using a combination of these two procedures. If groups or rows of bags are cleaned simultaneously, the baghouse system can continue to operate.

The temperature of air passing through the baghouse is critical to its performance. Normally, the temperature of the exhaust gases should remain between 250 and 450 degrees Fahrenheit. If the temperature is too high, synthetic material in the filter bags will be damaged. The efficiency of the plant may be impaired as the temperature drops below 250 degrees Fahrenheit, which is below the dew point (the temperature at which vapor begins to condense). At higher levels of humidity, condensation accelerates. Therefore, the natural environment (climate and season) existing during the mixing process also affects baghouse performance.

The condensation of moisture flushed from the exhaust gases has two major effects on the baghouse:

- Moisture condenses on the filter bags, which causes particles to adhere to them and form an agglomeration that prevents the gases from passing through the fabric. This condition can starve the production process for combustion airflow, greatly decreasing baghouse efficiency. Also, the agglomeration that forms is difficult to remove, making normal bag-cleaning procedures impossible. As long as the exhaust gas temperature stays above the dew point, the exhaust remains a gas as it passes through the baghouse and exits through the stack.
- Metal parts of the baghouse corrode from sulfuric acid. It condenses out of the air stream when temperatures fall below the dew point. Condensation of the acid occurs at a higher temperature than water vapor, so the highest component dew point should be considered as the dew point for the exhaust gas stream.

Condensation is more prevalent during plant start-up, because the baghouse components are not hot enough to keep moisture and acid in the exhaust gas stream from dropping below their dew points. To ensure that the baghouse is properly preheated, the outlet temperature gauge should be monitored and no moisture (mixture materials) added until a satisfactory temperature level is reached. When water vapor is added to the gas stream as a result of the drying process, the gas stream temperature initially drops. A preheated baghouse will not allow the lower-temperature, moisture-laden exhaust gas vapor to condense into liquid. The following conditions will contribute to moisture development in the baghouse:

- Insufficient preheating
- Lack of adequate insulation
- Inadequate system purging after shut-down
- Introduction of moisture into filters through the compressed air-cleaning system
- In-leakage of moist ambient air

Note: A general rule of thumb is to operate the baghouse at 250 degrees Fahrenheit or higher and employ proper start-up and shut-down procedures. Keeping the temperature of the baghouse above the acid dew point will greatly minimize moisture and acid condensation.

The 62H course instructors recommend the following procedures to maintain and extend the service life of all baghouse components.



A soldier operates the M081 Asphalt-Mixing Plant from a control van. He is responsible for the operation and safety of the plant.

Start-Up Procedures

1. Preheat the system (without the drying aggregates) long enough to ensure that the components are hot. This phase may take 15 to 20 minutes or more. Note that gas going out may be hot even though the steel in the unit has not had time to heat up. If aggregates are introduced too soon, moisture from the drying process will condense on the cooler steel components and bags, causing the initial layer of dust to dampen and become impermeable.

2. After preheating the system, and without shutting off the fan, begin feeding the aggregates. If possible, start with a coarse mix so the amount of fine material collected in the baghouse is kept to a minimum. In addition, maintain a steady production rate for the initial start-up to build and maintain a good dustcake (light coating of fine aggregate). If possible, do not run full production for a few minutes to allow the dustcake to develop.

3. When feeding aggregates to the system, close the fan outlet damper to reduce the gas flow so the dryer "puffs" at the burner. At that time, slightly open the fan damper to stop the puffing. This setting will vent the dryer and minimize the amount of air required. At this point, fuel usage is minimized to near optimum conditions.

Shut-Down Procedures

After shutting down the operation, the air ventilation system will approach ambient air temperature and conditions as the heat generated from the process dissipates. Dew points will be reached and some condensation will occur. When moisture and acids form, they remain on the baghouse components until they evaporate or the process starts again. When nearing the end of a production cycle, use the following procedures to shut down the system:

1. Stop the feed to the dryer.

2. After the material is out of the dryer, switch the burner to low fuel or a lower firing rate and continue to run the dryer for 3 to 5 minutes. This "purging" action will ensure that any moisture-laden gases are evacuated from the baghouse and chemically active hot gases are not trapped in the baghouse as it cools through the acid dew point. Because purging removes these gases and the baghouse cools quickly, a minimum of condensation forms during the shut-down process.

3. Turn off the burner, but continue to run the fan for about 10 to 15 minutes to cool the system or until 160 degrees Fahrenheit is achieved. It often helps to continue the cleaning cycle during the cool-down period so that hardened or chemically active particles do not build up on the fabric. Stop the cleaning cycle when the measured pressure difference between the dirty and clean sides of the baghouse falls below 3 inches of water column (15.6 pounds per square inch).

4. Remove the material from the dust collector so the unit is ready for start-up the next operating day. Do not store hot moisture-laden dust in the hopper because it can create material handling and start-up problems.

Engineering Support

The recommended start-up and shut-down procedures detailed above are a part of the information available from the team of instructors at the 62H course at Fort Leonard Wood. Additional information on baghouse operations is available in Technical Manuals 5-3895-374-10 and 5-3895-374-2.

Staff Sergeant Barrientos is assigned to the 52d Engineer Battalion, Fort Carson, Colorado. He was previously an instructor/writer for the 62H course, 577th Engineer Battalion, Fort Leonard Wood, Missouri. SSG Barrientos holds a bachelor of science degree in engineering management.

Mr. Shoenberger is a research civil engineer in the Materials Analysis Branch, Airfields and Pavements Division, Geotechnical Laboratory, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi. He is a registered professional engineer in Mississippi.



The GPS Computer-Based Tutorial

By Major Guy R. Mallow and Edward A. Forman

The Global Positioning System (GPS) revolutionizes navigation and positioning capabilities and soon will be integrated into everything the military does. The engineer community must learn how this technology works, so they can take advantage of it.

"The map, compass, and survey equipment in use will not provide the location and navigation information to the degree of accuracy and responsiveness required to support the combat user of fielded or emerging tactical systems." (taken from a DoD required operational capability document, revised in 1991) The 1994 funding appropriations bill passed by Congress states, "Funds may not be obligated after September 30, 2000, to modify or procure any DoD aircraft, ship, armored vehicle, or indirect-fire weapon system that is not equipped with a Global Positioning System receiver."

Why the GPS?

The GPS could be referred to as just another device that answers the age-old question "Where am I?" However, a user can expect seven times better accuracy with a GPS receiver than with a map and compass. Because of its accuracy, the GPS has replaced all previous positioning systems.

Many current and future devices used by engineer soldiers will incorporate GPS technology. An example is the more than 70,000 precise lightweight GPS receivers (PLGRs) fielded to the Army. GPS technology also will be included in future minefield recording equipment such as the Digital Reconnaissance System and the Digital Map Reporting System. (See "Building a Minefield Database System," *Engineer*, December 1996, page 14.)

The Tutorial

The Army Global Positioning System Tutorial is a training tool developed to provide a nontechnical, operational perspective of the NAVSTAR (navigational, strategic, tactical, and relay) GPS. It is primarily intended for officers and NCOs responsible for planning and executing operations at theater level and below. However, any military personnel wanting to maximize the benefits of GPS for their mission, unit, and troops can use the training.

The tutorial consists of 13 modules designed to be viewed in sequence (see sidebar, page 37). The program incorporates lessons learned as GPS evolved from a developmental program to the operational fielding currently underway in all U.S. military services.

The Army GPS Tutorial shows how the GPS's diverse capabilities can be used to support any mission when you plan and conduct combat operations or operations other than war (OOTW). It delivers convenient GPS training that will increase your unit's mission effectiveness in targeting and navigating precision and accuracy.

The Army GPS Tutorial Modules

Module 1 - GPS Overview. Explains what GPS is, how it works, and what it can do for your unit. It details military applications (such as precise positioning and navigation, communication time synchronization, confident rendezvous, and common language in joint and combined operations) and GPS accuracies.

Module 2 - GPS Policies. Describes DoD and Joint Chiefs of Staff policies and guidance for military operations planners. For example, all services must employ militarily accurate GPS equipment to support their operations.

Module 3 - GPS Security. Describes how military receivers obtain the best accuracies and reduce exposure to electronic warfare (spoofing), cryptologic key loading requirements, and setting up an account for the cryptologic keys. The GPS keys are different than SINCGARS (Single-Channel, Ground-to-Air Radio System) keys.

Module 4 - Maps and GPS. Describes the complementary relationship between GPS and maps. It contains eye-opening lessons learned and important tips (such as *never* use a map for precise positioning or targeting; use the GPS). GPS coordinates are seven times more accurate than map coordinates. Failure to comprehend the new relationship of maps and the GPS can lead to confusion in the field, a lack of confidence in the GPS, and forfeiture of the precision provided by the GPS.

Module 5 - GPS Equipment. Describes current receivers and selected receivers being developed.

Module 6 - Survivability. Discusses threats to the GPS and countermeasures.

Module 7 - Interoperability. Characterizes the GPS contributions to battlefield interoperability and provides guidance on relationships between the GPS, maps, fire-control systems, command and control systems, and navigation sensors.

Module 8 - GPS Applications. Explains the diverse capabilities of GPS receivers and how military operations planners and field users can capitalize on those capabilities during combat operations and OOTW. The module reflects on GPS applications used by U.S. and allied operational forces since the late 1980s, as derived from operational evaluations, Operation Desert Storm, and other military operations. The module describes premission and postmission applications, as well as applications for situational awareness, battlefield preparation, targeting and fire support, close air support, air drop, communications, and navigation. For example, the GPS can function as a compass inside a metal vehicle.

Module 9 - Battlefield Implementation - Operations Planning and Execution. Presents a checklist with suggested actions for commanders and their staffs to carry out on the air/land/sea battlefield. Actions draw on operational experience with the GPS and are oriented toward theater and component staffs with responsibility to plan, execute, and control an operation. Actions can improve target accuracy and reduce the potential for fratricide.

Module 10 - The Future. Presents future applications of the GPS within the U.S. military services.

Module 11 - GPS Training. Lists DoD training support for the GPS. It includes PLGR training, GPS survey receivers, cryptologic key ordering procedures, points of contact, and training aids. The module shows the classroom setup for PLGR training.

Module 12 - Feedback. Provides a form to submit comments and recommendations.

Module 13 - Glossary and Terms. Contains more than 130 GPS-related terms and definitions.

Note: *A HELP key describes additional features in the tutorial.*

Obtaining the Tutorial

The National Imagery and Mapping Agency (NIMA) (formerly the Defense Mapping Agency), Saint Louis, Missouri, produces and distributes the Army GPS Tutorial. It is free to military units and can be ordered from NIMA through normal supply channels. Call the NIMA Order Fulfillment Department, DSN 287-2495 or (800) 826-0342, for assistance. When ordering, use your DoD activity address code (DODAAC) and request national stock number (NSN) 7644-01-416-4051. If you do not have a DODAAC, contact the NIMA Army Customer Support Team at DSN 570-3001 or (703) 264-3001.

The tutorial is on eight 3.5-inch discs. Minimum computer system requirements for using the program are—

- DOS Windows 3.x
- 486 PC
- 256 color VGA monitor
- 8 MB RAM

NIMA also has three GPS receiver emulators available. They are computer-based interactive replicas of the PLGR, the Trimble 4000SSE, and the Ashtech MD-XII. These emulators are still in the Beta versions but can provide valuable training. Order them using the same procedure as for the tutorial. The national stock numbers for these emulators are—

- PLGR Emulator 7644-01-416-4034
- Trimble 4000SSE 7644-01-416-4040
- Ashtech MD-XII 7644-01-416-4036

Other Resources

Additional information about the GPS is available on the Internet at the following sites:

- University of Texas at Austin -http://www.utexas.edu/depts/grg/gcraft/ notes/gps/gps.html
- U.S. Coast Guard - http://www.navcen.uscg.mil/gps/gps.htm
- NAVSTAR GPS Internet Connections - http://gauss.gge.unb.ca/ GPS.INTERNET.SERVICES.HTML
- National Geodetic Survey - http://www.ngs.noaa.gov/geodetic_links.html

Major Mallow serves as the survey team chief, Defense Mapping School, Fort Belvoir, Virginia, while assigned to the National Imagery and Mapping Agency's National Imagery and Mapping College. He previously served as regimental engineer, 75th Ranger Regiment, Fort Benning, Georgia.

Mr. Forman is the education advisor for the Defense Mapping School, Fort Belvoir, Virginia, as part of the National Imagery and Mapping Agency's National Imagery and Mapping College. He is a reserve Infantry lieutenant colonel assigned to the Army Materiel Command.

Introducing Terrabase II

By Captain Russell Kirby

"Our engineers must be terrain visualization experts so they can help the maneuver commander use the terrain to his advantage to win...The engineer's business is terrain, pure and simple. We own the ground."

Major General Clair F. Gill
Commandant, U.S. Army Engineer School

How do engineer officers become terrain visualization experts? One solution from the U.S. Army Engineer School is provided by Terrabase II (TB II) and an instructional CD-ROM. The CD-ROM provides transitional training on the capabilities of TB II and explains how to use digital terrain data to visualize battlespace. TB II and the CD-ROM will be available at no cost to military units in late September 1997. They will enable all officers, not just engineers, to understand, use, and obtain digital topographic products.

The following information provides a brief overview of the TB II software and CD-ROM. Basic knowledge of the TB II software is a first step toward visualizing terrain, but the applied tactical knowledge of the user is what really makes this software powerful.

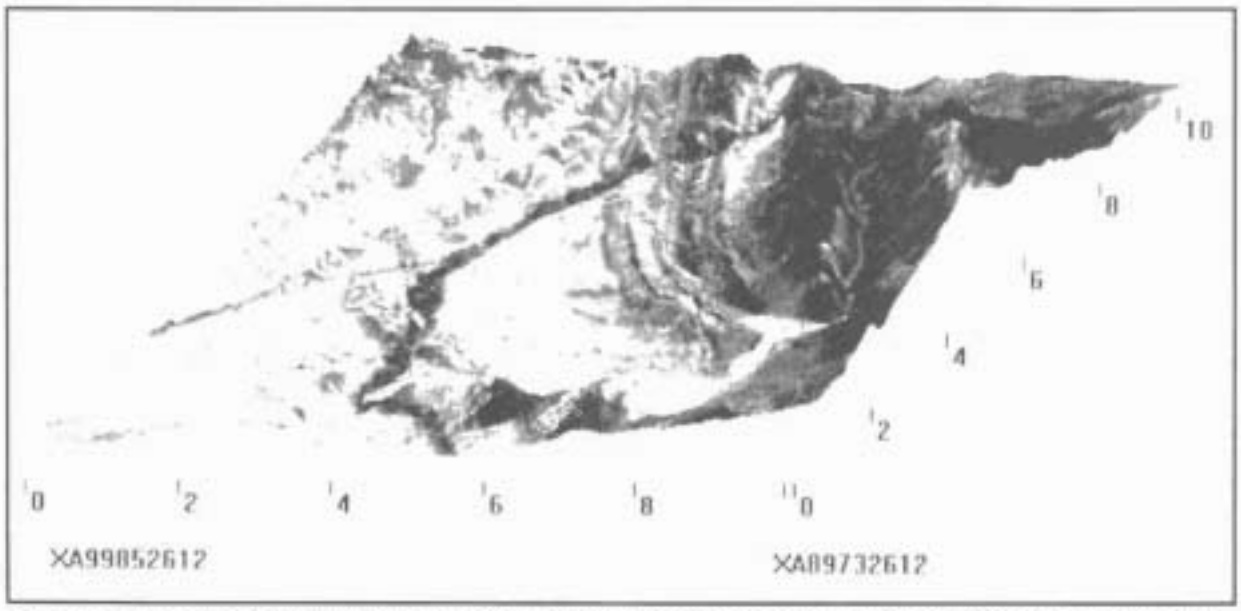
Background

The Terrabase program was written at the U.S. Military Academy in the mid-1980s and was the first automated terrain tool used by military occupational specialty (MOS) 215D topographic warrant officers and MOS 81Q terrain analysts. It allows the user to quickly analyze terrain data and provide warfighting commanders with tactical decision aids (TDAs).

Terrabase runs on IBM 286 computers, and its output is limited to dot matrix printers. The software has changed little since its development. Although it is still widely used at the brigade level and below, Terrabase does not take advantage of automation advances and many improved digital data sets.

Terrabase II

The Engineer School's Department of Tactics, Leadership, and Engineering, in partnership with the Terrain Visualization Center, researched available commercial and government-owned programs to find an updated terrain evaluation tool. None was found, but a government-owned terrain evaluation software package



Digital elevation model (DEM) data with SPOT satellite image draped over it. This image shows an area at Irish Canyon, Colorado.

called MicroDEM, developed by the U.S. Naval Academy, was suitable for tailoring into terrain visualization software. This powerful personal-computer-based package operates under Microsoft Windows and uses a variety of improved digital terrain data available from the National Imagery and Mapping Agency and the U.S. Geological Survey.

MicroDEM was demonstrated to senior leaders and approved for adaptation by Major General Gill on 16 December 1996. The Terrain Visualization Center at the Engineer School arranged for training development funds. Both the 20th Engineer Brigade at Fort Bragg, North Carolina, and the U.S. Space Command at Colorado Springs, Colorado, contributed funding to tailor MicroDEM into Terrabase II. The Naval Academy and the Engineer School worked together to develop the software.

The minimum requirement to run Terrabase II is a 486 computer with 16 MB of RAM and Windows 95. The program creates all the tactical decision aids of the original Terrabase. In addition, Terrabase II can—

- Change datums.
- Make elevation tints, slope tints, contour plots, lines of sight, 3-D views, reflectance maps, weapons fans, and visible area plots.
- Print to scale on any Windows-compatible printer or plotter.

The beauty of this software is that anyone familiar with Microsoft Windows can learn to use it quickly. Terrabase II will be included in the Engineer Officer Advanced Course beginning in July 1997. It can be taught in the same amount of time as the original Terrabase.

CD-ROM

The instructional CD-ROM can be used for distributive training for individuals or groups, such as for officer professional development or commanders' calls. The CD-ROM includes the following segments:

"Introduction to Terrain Visualization" provides an overview of terrain visualization. It includes map fundamentals, datums, grids, symbology, and accuracy.

"Request and Manage Terrain Visualization Data" provides examples and explanations of digital data products from the National Imagery Mapping Agency and U.S. Geological Survey. The examples are explained in bullet comments with an accompanying voice file to provide details. This segment describes the tactical use of each product as well as ordering information and price. This is the first time that a simple-to-use viewer has been available for digital formats from both mapping agencies. TB II makes it possible to import these formats.

Terrabase II Tutorial is a "battledrill" or "how to" version for creating tactical decision aids. These interactive/multimedia battledrills have pictures that show how the screen looks as the products are created. The tutorial is an easy-to-use aid that explains how to load the software and digital data, create TDAs, and save and print products.

Database includes data sets for each area of operation for the Engineer Officer Advanced Course practical exercises. A data set includes digital terrain elevation data (DTED), land satellite (LANDSAT) or Systeme Probatoire d'Observation de la Terre (SPOT) satellite imagery, controlled image-based imagery, and aerial photographs. Since all areas of the world do not have complete data, some of the sets are not complete.

Product Index is a list of digital products with "hot keys" that enable the user to choose to "view the product example" or "learn more about the product."

> *"Terrain visualization is a basic and fundamental leadership skill. ... A battle commander must understand how terrain influences every aspect of military operations. Terrain visualization is a component of battlefield visualization. It portrays and allows a detailed understanding of the background upon which enemy and friendly forces and actions are displayed."*
>
> TRADOC Pamphlet 525-41, *Topographic Support for Terrain Visualization, Operations Concept*

Conclusion

Terrabase II fills the terrain visualization requirement for engineers at the brigade level and below. The instructional CD-ROM educates engineers on how products look, their availability and tactical use, and how to obtain digital data. TB II software is not designed to compete with more advanced terrain analysis systems. Instead, it introduces some of the capabilities of larger systems and enables users to better understand these products.

The increased knowledge and computer capability officers gain from using Terrabase II will give them greater planning flexibility by providing a wide range of options for each mission. The TB II software and instructional CD-ROM enable engineers to become terrain visualization experts and truly earn the title "Masters of Terrain."

Note: *TB II will be available on the Fort Leonard Wood home page by late September. The CD-ROM will be reformatted and added to the home page by December 1997.*

Captain Kirby is a doctrine instructor/writer in the Department of Tactics, Leadership, and Engineering (DTLE), U.S. Army Engineer School. Previous assignments include G2 GEO Officer, Bosnia-Herzegovina Command, Sarajevo, Bosnia; platoon leader/XO, 29th Engineer Battalion (Topo), Fort Shafter, Hawaii; and Chief, Topographic Operations, DTLE, U.S. Army Engineer School. CPT Kirby holds a bachelor's degree in geology from Iowa State University.

Command Philosophy for Company Commanders

By Lieutenant Colonel Harry W. Christiansen (Retired)

Have you ever been in a unit where soldiers were unsure of the new company commander's expectations and his method of operation? The result is trial and error, second-guessing, and misdirected work efforts. In short, the unit spends most of its energy discovering the commander's intent, which detracts from effective mission accomplishment.

The solution is a well-developed and communicated command philosophy. If you are preparing for your first command, take time to develop a command philosophy. This philosophy tells how you will run the unit. It communicates your expectations of others and what they can except from you. It sets the conditions that allow subordinate leaders and teams to succeed. A command philosophy has four components—vision, values, leadership expectations and personal convictions. As a company commander, I used the command philosophy shown on page 41 and distributed it in a memo to officers, NCOs and soldiers in my company.

Vision

Vision provides a common focus for the unit's energy and sets priorities. It describes what the unit must be capable of doing at some point in the future and how to achieve that. To help develop your vision, educate yourself about the unit. Visit and talk with key members of the battalion and company.

First, meet separately with the battalion commander and command sergeant major. Learn their priorities and expectations for the unit, and get a copy of the battalion commander's philosophy. Spend time with the outgoing commander and the unit first sergeant. Ask about major issues and problem areas and the unit's strengths and weaknesses.

Other key individuals who can help are the battalion executive officer, the operations officer, and fellow company commanders. Finally, talk to the platoon leaders, platoon sergeants, and soldiers. As the recipients of your command philosophy, they are the ones who will get the job done.

Once you sift through and evaluate this information, you will have more than enough ideas on where the unit needs to go and what the soldiers think should be done. A shared vision, one that soldiers own and can relate to, will permeate the unit and influence all its endeavors.

In the figure, vision sets the direction. It tells soldiers where the unit is going and how it will get there. The vision is a journey, not a destination; it is something you are always striving to achieve.

Values

It is impossible to create a rule or policy to cover every possible contingency. However, members in a unit who share the same values will view the world and their work from a common perspective and act accordingly. Values express what is important to you and subsequently to the unit. They outline expectations of unit members and express what "we will do."

You have a professional obligation to live and uphold the Army's values and ethos as well as the soldier qualities outlined in FM 100-1, *The Army*. That FM is a good place to start developing your value set. To identify your values, follow the three-step process:

- List the characteristics, traits, and qualities you admire in leaders.
- Circle the qualities that reflect what is important to you and that reveal the kind of leader you are.
- Define those qualities as behaviors that you will demonstrate.

The values on page 41 are tools that tell soldiers what is important to the unit, and they guide everyday behavior. Your values must represent who and what you are. They must come from the heart.

Leadership Expectations

Leadership expectations describe specific responsibilities and fundamental obligations leaders have to their soldiers. This is your foundation for leadership action. Leadership expectations describe the leader's role in developing combat-ready soldiers and teams.

Think about the few critical principles that you feel are imperative for leaders to succeed. These essential rules are the cornerstones for your leadership philosophy. If you need some ideas, the 11 principles of leadership in FM 22-100, *Military Leadership*, are fundamental truths that have stood the test of time. Leadership expectations can be a series of phrases, statements, or a narrative.

The leadership expectations on page 41 outline obligations leaders have to their soldiers. Whatever you decide are your leadership principles, they should reflect how you lead and how you expect subordinate leaders to lead.

Personal Convictions

Personal convictions tell soldiers how you do business, answer frequent questions, and give

Command Philosophy

PURPOSE: To ensure that you know my expectations of soldiers and leaders in this company. This memorandum outlines my command philosophy.

VISION: The XXX Company has one purpose: We are a combat-ready force prepared to successfully execute our wartime mission while maximizing soldier survival. We will accomplish this by tough, realistic training focused on our mission-essential tasks.

VALUES: Even if you do not know exactly how to do something, if you know what is important to the company, you will do the right thing. The following values, or things that are important, will guide our daily actions:

- **Integrity.** We will be truthful and honest in all dealings with others. We will be responsible for taking action to do the right thing and ensure success.
- **Commitment.** We will approach our work through personal commitments that must be filled in spirit. We will focus our hearts and energy into successfully getting the job done right.
- **Caring.** We will help each other and take care of our own. We will concern ourselves with human needs and treat others with fairness and dignity.

LEADERSHIP EXPECTATIONS: Lead by example in everything we do and never forget that soldiers are the most important part of this company. Four obligations leaders have to soldiers are:

- **Educate.** Orient new soldiers to the company goals and values, and teach soldiers who want to grow.
- **Coach.** Empower soldiers to contribute to the company and build on the strengths of talented performers.
- **Counsel.** Lead soldiers to understand and overcome obstacles that get in the way of top performance.
- **Confront.** Tell soldiers when their performance is consistently below expectations and bring to their attention the consequences of continued unacceptable performance.

PERSONAL CONVICTIONS: These key points will help you understand how I do business:

- We are in this together—we are a team.
- Be sure that what you tell me is correct.
- Keep me informed—bad news does not get better with time.
- Good tries that fail are okay—only through risk is there growth.
- Where you spend your time shows what is important to you.
- I use the chain of command—NCOs are the vital link.
- Performance counseling ensures your expectations of others are clear—do it.
- OERs and NCOERs—officers and NCOs are paid to lead.
- Power down—If you can handle it, I will give you the controls.

soldiers a starting point. They can be your *dos* and *don'ts* or a mix of diverse topics. Personal convictions may include bits of wisdom or quotes you have retained over the years that reflect how you operate. They are key points to help soldiers understand you and your frame of reference or "where you are coming from." You can express personal convictions as a series of bullet-type statements or one-liners.

The personal convictions in the figure provide soldiers further insight on what they can expect from their commander. This component of your command philosophy covers topics important to you that are not covered elsewhere.

Walk Your Talk

A command philosophy has no specific format. It can be a one- or two-page memorandum, a series of bullets, or a graphic. Every soldier should receive a copy and should easily comprehend the philosophy.

A well-developed command philosophy allows you to concentrate the unit's energy by creating a shared perception of what the company is all about and how you will run it. *Vision* describes the company's future capability. *Values* outline what is important to the company. *Leadership expectations* are the foundation for leadership action. *Personal convictions* tell how you do business. Once you publish your command philosophy, soldiers will watch to see if your behavior matches your words—you must walk your talk.

Lieutenant Colonel Harry Christiansen (Retired) is a Strategic Change Management Consultant with Group Decision Support Systems, Inc., Washington, D.C. He commanded three company-level units and was a leadership instructor at the Infantry School. He holds a master's degree in organizational development.



CTC Notes

Battle Command Training Program (BCTP)

By Lieutenant Colonel Dave Snodgrass

The good news these days is that almost everyone at corps level and below is familiar with obstacle-control measures. The bad news is that confusion remains about when and how to use the measures and intents, and specifically, whether corps and divisions must have zones and where they must include intents with zones. The larger, more generic, question is when and how engineers should use zones.

Doctrinal answers to the specific questions are: No, you do not have to use zones, and no, you do not have to include intents. According to FM 90-7, *Combined Arms Obstacle Integration*, commanders use obstacle-control measures to simplify granting obstacle-emplacement authority and provide obstacle control. The overriding principle in our current top-down, permissive system is to "...ensure that subordinates emplace obstacles that support the higher commander's scheme of maneuver and that do not interfere with future operations." Obviously, if the higher headquarters does not want to grant that authority, they do not have to designate graphics. Further, FM 90-7 states that "...if the obstacle zone encompasses the entire brigade sector, another graphic is unnecessary. Commanders may designate the entire sector as an obstacle zone, with the unit boundaries defining the geographical limits of the zone." Additionally, FM 90-7 states that "...commanders can assign an obstacle intent to an obstacle zone, but they normally do not." Theoretically, established priorities help identify the obstacle main effort to subordinates without restricting their flexibility with specified zone intents.

The answer to the generic question of when and how we should use zones is more complex. Many engineer planners at division and corps levels feel they need to establish zones to focus subordinate efforts, estimate resources required, and show their commanders and staffs that they have integrated engineers into the plan. Unfortunately, these zones usually are large boxes that cover entire sectors, lack intents, and do little to focus anyone or integrate anything. To understand the disconnects, one must reduce the scale and return to the basics. As an observer/controller at the National Training Center, I saw the following methodology of engagement area design and construction validated through numerous rotations and units:

- Identify where the enemy is coming from and where it is going.
- Identify where you want to kill the enemy (or the desired effect).
- Identify the location of the shooter.
- Allocate the resources required to do the killing.
- Identify the location, orientation, and type of obstacles that will best enhance the effects of your killing systems and achieve the overall desired effect.

Units that used this methodology ensured they had a coherent defense with concurrently integrated obstacles that supported the maneuver plan, positions, and systems. Units that failed to use this methodology ultimately wound up with disjointed obstacles that had little or no impact on the battle or, worse yet, ineffective defenses developed around obstacles constructed independently (and sometimes before completion) of the maneuver plan.

In theory, planning at division and corps levels should be very similar:

- Identify where the enemy is coming from and where it is going.
- Identify when and where you want to mass your effects to do the most damage.
- Identify missions and required resources for subordinate units.

- Identify the location, orientation, and type of obstacle effects to best enhance your assigned weapons systems and the overall impact on the enemy.

Yet, division and corps planners almost always allocate sectors for their subordinates. They seldom provide directions on when, where, and how to mass unit resources and effects on the enemy. The lack of direction has critical results. When the division and corps fail to develop a fight based on a clearly defined concept that identifies subordinate unit purposes and how those purposes interrelate to accomplish the division's overall task and purpose, they tend to fight battles in pieces instead of in a coherent, complementary, and focused whole. The lack of vertical and horizontal nesting degrades a unit's ability to bring all weapons systems to bear on the enemy at a decisive point and time. If one subscribes to the engagement area design and construction methodology, how can the engineer planner design an obstacle plan that enhances the defensive plan if the division or corps commanders have not clearly defined the purposes of subordinate units and how they are integrated to focus power?

The engineer planner's first responsibility is to identify the disconnect to maneuver commanders and staffs and seek a clear, articulate, *maneuver* vision of the battle, stated in maneuver terms, that will convey to subordinate commanders how each subordinate piece supports the whole. When this information is provided, the engineer planner can and should develop obstacle-control measures that support the operation. If we know *who* and *where* the unit plans to fight, we should be able to design a relatively small, targeted, and useful zone to support the fight. We also should be able to assign it an intent that supports higher maneuver commander's concept of the fight. This is critical when planning and preparation time are restricted. When a unit has limited time to establish a defense, the higher headquarters should be more prescriptive with the maneuver and engineer plans in order to focus the engineer effort—and not designate entire sectors as obstacle zones. This action will restrict the flexibility of subordinate commanders. But it will also eliminate options that take time to evaluate, focus the resources of both higher and lower headquarters, and allow the unit to spend the maximum time available in executing the obstacle plan.

Alternatively, if the corps or division fails to develop a clear, focused plan of defense that designates the killing ground and how subordinate units complement each other, the best option may be to designate the entire sector as an obstacle zone, with unit boundaries defining the geographical limits of the zone. In this case, tell subordinate units that they are defending in sector and that their sector is an approved zone. Instead of creating redundant and essentially useless permissive control measures, focus on restrictions that the higher headquarters require to maintain obstacle control and that support future operations. Restrictions may include obstacle-restricted areas for counterattack avenues, reserve demolition targets that support specific tactical operations, types or duration (for FASCAM) of obstacles in specific areas or on specified routes, etc. Let subordinate units develop their own obstacle-control measures based on the specified restrictions. Then, if required, draw zones around the subordinate units' graphics to conform to the doctrinal obstacle numbering system and unit tracking and reporting procedures. Allocate initial resources for planning based on sector priorities, the usable widths of the avenues of approach across the sector, and a disrupt planning factor. This procedure gets the logistics system energized and materials moving, gives subordinate units a number to start planning with, supports the initial (24-hour plus) requirements, and allows for future refinements.

We engineers have achieved success in our initial battle to familiarize maneuver commanders and get all units using obstacle control graphics and intents. The harder battle now facing us is to refine how and when we should use, and more importantly should not use, these new-found tools. When used properly, these tools minimize the unnecessary restrictions that we place on subordinate units and help streamline the planning and preparation of successful battles.

Lieutenant Colonel Snodgrass is the staff engineer for the multinational force in the Sinai Peninsula. He previously served as the engineer observer/controller for the Battle Command Training Program at Fort Leavenworth, Kansas.



Joint Readiness Training Center (JRTC)

By Captain John C. DeJarnette

Effective FM radio communications are essential to properly synchronize engineer operations in support of maneuver units. Two emerging techniques using SINCGARS effectively improve engineer command and control. The first involves engineer platoon FM communications, and the second is the engineer "conference call" daily update.

Engineer Platoon FM Communications

At the JRTC, engineer platoons are routinely required to operate continuously on three FM radio nets: the platoon internal net, the supported maneuver commander's net, and the parent engineer unit command net. These are minimum requirements for commanders to control and synchronize the efforts of their supporting engineer units.

Successful engineer platoons employ the following communications technique or a variant of it:

- Engineer squads operate on the engineer platoon net. This technique allows the engineer platoon leader to control the platoon members' work and also provide regular updates on the tactical situation within the battalion area of operations.
- The engineer platoon sergeant deploys with a dual-net-capable vehicle. He operates on both the engineer platoon net and the engineer company command net. Dual-net capability allows him to remain current on the status of the platoon's mission and respond to routine traffic from the engineer company command post. When the platoon leader is needed on the engineer company command net, the platoon sergeant calls him on the platoon internal net and directs him to the engineer company command net. While engineer platoon sergeants currently are authorized only single-net capability, most find an additional radio to deploy with, mirroring the authorization in tank and mechanized infantry tables of organization and equipment. Dual-net capability for the engineer platoon sergeant greatly improves command and control at both the engineer platoon and company levels.
- The engineer platoon leader uses his authorized two-net capability to monitor both the engineer platoon internal net and the supported maneuver unit command net. This capability allows him to control the engineer platoon and be responsive to the maneuver commander. A key benefit of monitoring the maneuver command net is improved situation awareness. Dual-net capability enables the platoon leader to track the actions of the maneuver companies and their enemy contacts. Consequently, he can provide timely and accurate tactical updates to his squad leader and provide guidance to the maneuver battalion command and tactical operations center. This technique allows the engineer platoon leader to better perform his dual role as platoon leader and task force engineer.

Engineer Company "Conference Call" Update

Successful engineer company commanders use two daily conference calls on their command net as a synchronization tool. The calls generally are scheduled during lulls in the rotational brigade's battle rhythm, typically about 0600 and 2000 hours. The net control station initiates a call for all platoon leaders, the brigade engineer, the executive officer, the first sergeant, the supply sergeant, and the maintenance team chief. Each section updates the commander with changes regarding their combat power (personnel, key leaders, critical equipment), supply status (Class I, III [package], V, IX), operations during the last 12 hours and anticipated operations during the next 12 hours. Each session usually takes from 3 to 5 minutes. The brigade engineer provides an overview of the friendly and enemy situation across the brigade and any anticipated mobility and survivability requirements. The company commander then provides planning and execution guidance to the platoons.

This update improves the situation awareness of the commander, platoon leaders, brigade main engineer cell, and brigade rear engineer cell. It also serves as a basis for revising the engineer estimate for future operations planning. In the most proficient units, squad leaders monitor the daily updates in order to clearly understand the commander's intent and gain information on enemy and friendly activities across the brigade area of operations.

The conference call, coupled with the engineer platoon sergeant as a control node, are excellent tools to synchronize engineer operations.

Administrative Notes

- LTC Brooks will remain the senior engineer observer/controller at the JRTC for the next year.
- JRTC has finalized the Exercise Rules of Engagement for Air VOLCANO employment. The VOLCANO control supply rate remains at 720 canisters (two loads) per rotation, regardless of the delivery platform. Exceptions to this control supply rate are managed by the commander, 21st Infantry Division, with input from the assistant division engineer. Units are encouraged to deploy with their M87 training canisters in order to fully exercise their VOLCANO loading battle drills.
- Continue to send us questions and recommendations about mobility and survivability operations and techniques. The commercial telephone number is (318) 531-0266/0282 (DSN 673-0266/0282). The e-mail address is: brooksje@polk-emh2.army.mil.

Captain DeJarnette is an engineer observer/controller at the Joint Readiness Training Center, Fort Polk, Louisiana.



National Training Center (NTC)

By Captain Ed Mead

The NTC provides an excellent opportunity for combat engineer company commanders to plan and execute company-level combat engineer missions. For some company commanders, the NTC is their only opportunity to get intense company-level training with the brigade combat team they support. This article describes some recurring trends observed at the company level from units rotating through the NTC. Although some trends change from quarter to quarter, the following trends were observed frequently during the past two years.

Combat engineer companies are not proficient in how to maneuver and employ weapons systems as a unit or as part of a larger maneuver element.

Discussion

- Even though possessing a significant amount of fire power, units have no fire-control measures for M2s, MK19s, AT4s, or attached M1A1 tank plows or rollers.
- Units do not understand mounted or dismounted movement formations at company and platoon levels.
- Units fail to plan for actions on contact.
- Units are unable to effectively integrate into combined arms breaching operations. Engineers are especially weak at commanding the breach force when called upon to do so.

Recommendations

Combat engineer leaders must incorporate the strategies described in FM 5-71-2, Appendix E, and FM 71-123, Chapters 3 and 4, in their leadership development training. Additionally, they should incorporate force protection training in every training event. Leaders should ensure that some company collective maneuver training is planned and executed each quarter.

Knowledge of FM 90-7, Combined Arms Obstacle Integration, is weak. As a result, units fail to effectively integrate obstacles with fires.

Discussion

- Units do not understand mobility corridors and avenues of approach or their fundamental relationships to the target, location, and effects of tactical obstacles.
- Task forces do not develop a conceptual obstacle design for company team commanders and engineer platoon leaders to help them visualize the obstacle layout within the group or the quantity of resources required.
- Task forces seldom produce a modified combined obstacle overlay (MCOO). This product is essential to help visualize enemy avenues of approach.
- When siting obstacles, units do not understand how to integrate obstacles and fires to achieve the desired effects.

Recommendation

Engineer commanders should conduct officer professional development classes on obstacle planning and siting for their habitually associated maneuver units. Each combined arms exercise (command post exercise, map exercise, terrain exercise without troops, etc.) should include a rock drill that focuses on siting obstacles. Company team commanders and engineer platoon leaders should be key players in these rock drills.

Combat service support and maintenance operations at the engineer company level continue to need improvement. Units do not always report classes of supply to the company tactical operations center.

- Company LOGPACS brought forward from the brigade support area are configured to provide only Classes I and III, not all classes of supplies and services required by line platoons.
- Inadequate time management for maintenance shutdowns during continuous operations often cause a steady decrease in operational readiness rates.
- There is a lack of discipline in subsystems preventive maintenance checks and services for night vision devices, machine guns, individual weapons, and communications equipment.

Recommendation

The engineer company first sergeant must be involved in developing and briefing paragraph 5 of the operation order. Company commanders and platoon leaders must ensure they plan for and conduct precombat inspections, including combat service support and maintenance checks. Commanders must plan for and incorporate combat service support training in every training event.

Captain Mead is an engineer observer/controller at the National Training Center, Fort Irwin, California.

The Engineer Reconnaissance Platoon:
Overcoming the Lack of Engineer Reconnaissance Assets

This is the second in a series of articles about the roles of NCOs in an engineer battalion of a heavy division. The first appeared in December 1995. This article builds on ideas proposed by Major Douglas McNeese and Captain Steven Creighton (*Engineer*, August 1996, p. 14) and provides further clarification.

By Michael W. Sayer

It was two hours prior to LD (line of departure) for the armored brigade's deliberate attack. The commander arrived for the prebattle update, and each staff member briefed him on the status of his area. The scouts had located and reported some obstacles in the area but had not specified their orientation, composition, length, depth, or type before losing contact with the brigade. The staff engineer could not give more information, because communications with the engineers sent to gather engineer-specific obstacle intelligence failed early in the evening. The enemy identified additional engineers, who left at 2400 hours in their M113 Armored Personnel Carrier, and engaged them with direct and indirect fires. Due to the lack of information concerning enemy obstacles and disposition of his forces, the brigade commander had to inform the division that his unit was unable to conduct a deliberate attack but would conduct a movement to contact. He was not confident of the brigade's ability to fully accomplish the mission. The lack of battlefield intelligence, primarily the lack of mobility and countermobility information, degraded the brigade's capability to fight and win.

The Problem

Variations of this scenario occur during training at the National Training Center (NTC) with disturbing regularity. Scouts often fail to provide leaders with specific mobility/survivability Battlefield Operating System information. Brigades require solid obstacle intelligence to successfully attack.

In maneuver battalions—

- Scout platoons lack experience with mobility/survivability tasks and the data required for complete reporting.
- Scouts have too many tasks specified in the operations order.
- Mobility/survivability tasks generally receive too little emphasis during unit training.

In engineer battalions—

- A scout capability is lacking on the modified table of organization and equipment (MTOE).
- Soldiers tasked with gathering obstacle intelligence usually lack scouting experience.
- Training and equipping engineers tasked with reconnaissance is not standardized.
- Communications capability within the force is poor.

The Solution

These are serious problems, but a solution is within reach that is both simple and difficult: Place an engineer scout platoon within the divisional engineer battalion. The solution is simple in that assigning personnel to such a platoon and equipping it can be accomplished quickly. The difficulty lies in finding the bodies in a shrunken force structure to support it and then training these soldiers to accomplish their mission.

Most combat engineer companies pick a team to perform as engineer scouts. The team's training is usually haphazard and is not conducted in conjunction with the brigade S2 section's training of other scouts in the brigade. While the team members probably are highly motivated young soldiers and well-trained engineers, the lack of formal training in reconnaissance operations lessens their overall capability.

Only one position in the current heavy engineer battalion MTOE has anything to do with reconnaissance—the reconnaissance noncommissioned officer (NCO). This position requires a military occupational specialty (MOS) 12B30, combat engineer staff sergeant. He receives no special training and often lacks reconnaissance experience and the equipment necessary to perform this duty. Frequently, he is part of the battalion intelligence section and works for the intelligence NCO, MOS 12Z50, who is a combat engineer master sergeant. As currently structured, any reconnaissance effort on the part of the heavy engineer battalion comes from the line companies. They must give up squads for this mission, which means that those squads are unavailable for other offensive and defensive missions.

One active heavy engineer battalion is working to incorporate a dedicated reconnaissance section—the 299th Engineer Battalion, from the 1st Brigade, 4th Infantry Division. As part of the Advanced Warfighting Experiment, the 299th is seeking ways to add new technologies to the tactics needed for Force XXI. The unit has organized a reconnaissance section of two teams under

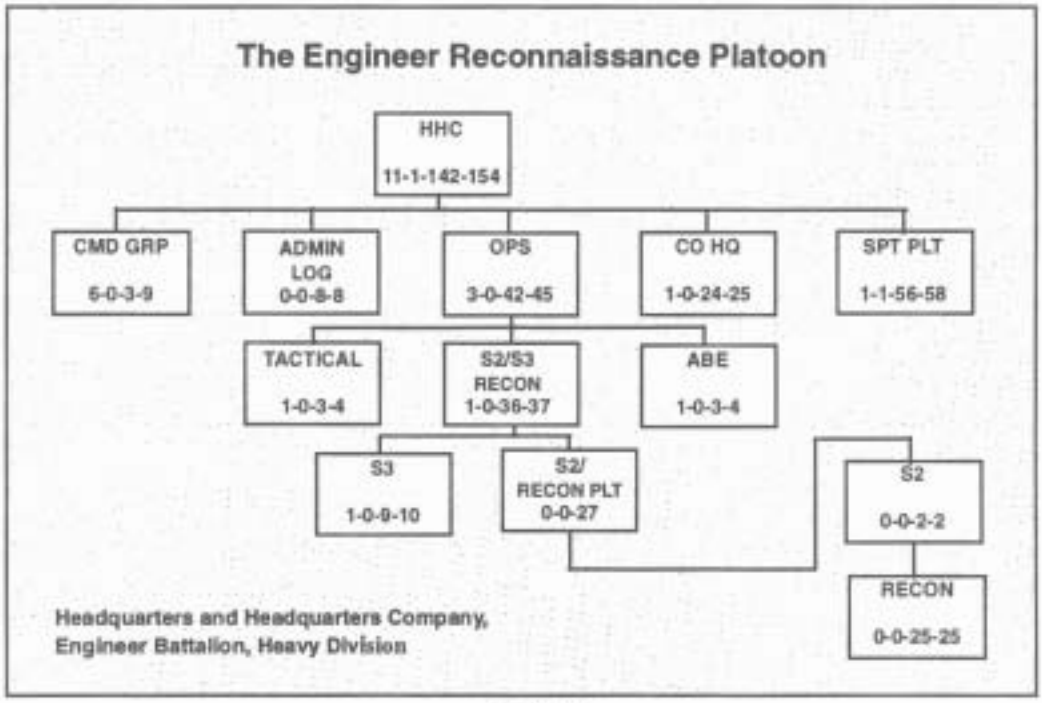


Figure 1

battalion control. While this is a good starting place, it cannot cover the entire brigade sector. With two teams attempting to gather information from three task force zones, the effort is too little and the information probably will be received too late.

Reconnaissance Platoon

A recommended solution is for the engineer force to assign and equip an engineer reconnaissance platoon within the Headquarters Company S2/S3 section. The platoon would work for the S2 under the reconnaissance NCO (Figure 1).

Organization and Equipment. By placing the unit in the S2/S3 section of the heavy engineer battalion, command and control of the platoon is at the proper level. The S3 ensures that the unit has adequate resources for training, and since the platoon is organic, the S3 knows the capabilities and limitations of each squad when he conducts the planning and orders process. Additionally, each squad can be broken down to the habitually associated task force in a direct-support role when the mission dictates. In this configuration, the brigade order must specify that the task force and engineer company pass the proposed tasking of the squad to the engineer battalion for required support. The squad would seldom, if ever, be attached to or placed under operational control (OPCON) of the task force.

The purpose of having the intelligence NCO in the chain of command is to ensure proper training and required coordination with the brigade and task force S2s. The intelligence NCO is the platoon leader and assists the reconnaissance NCO in developing training schedules, gathering materials, and ensuring that all training meets applicable standards. Each squad associates with a specific task force to increase interoperability and build teamwork. The intelligence NCO, in conjunction with the reconnaissance NCO, is the liaison to each task force for training and determines personnel allocations within the platoon.

The engineer reconnaissance platoon is a 25-person unit that includes the reconnaissance NCO as platoon sergeant and three squads of eight engineer scouts. Two four-person teams make up each squad, with the squad leader acting as the A Team leader and an engineer sergeant acting as the B Team leader. The senior enlisted soldier is the gunner, and of the two junior enlisted soldiers, one is the engineer scout and the other is the driver. The reconnaissance NCO position changes from that of a staff sergeant to a sergeant first class, with the position coded for ranger-qualified NCOs. The squad and team leaders and the gunners also should be ranger qualified (Figure 2, page 49). Each team operates in an M1044 HMMWV. This organization provides one engineer scout squad to each task force in the brigade, with each scout squad capable of working as two teams covering the task-force zone. If the situation requires, as for a dismounted approach, each team can break into two two-person foot-reconnaissance teams. This configuration allows greater saturation of the area and long-term (more than 8 hours) observation of objectives. Possible applications include:

- Inserting the team into the task force zone early to observe and report enemy defensive preparations.
- Positioning the team to report enemy movement to bring forward engineer-specific breaching or river-crossing equipment.

Engineer Reconnaissance Squad Equipment

Equipment	*Quantity*	*Remarks*
High-mobility, multipurpose wheeled vehicle (HMMWV), M1044	2	Supplemental armor provides crew protection from small-arms fire and artillery fragments.
Mounted on HMMWV		
Machine gun,.50-caliber, M2 or Grenade launcher, 40-millimeter, MK19	1	One vehicle has the M2, the other the MK19; allows both long-range and short-range indirect fires.
Short-range/long-range vehicular radio with dismount, AN/VRC-91A	1	Allows squads or teams to report from most locations within the brigade sector. Teams can conduct two-way operations, one using the dismount system from the AN/VRC-91A, the other the AN/PRC-119A.
Antenna, OE-254	1	
Loudspeaker, LS-671	1	
Intercom set, AN/VIC-1	1	Allows communication within the vehicle.
Combat vehicle crewman helmet	4	
Telephone, TA-1	1	
Control monitor, C-11291	2	
Precision lightweight global positioning system (GPS) receiver, AN/PSS-11	1	
Pneumatic boat, 3-person	1	For bridge and stream reconnaissance.
Camouflage screen and support system	1	
Mine detector, AN/PSS-12	1	For breaching or route reconnaissance.
Reeling machine with communications wire, RL-39	1	Supports outposts/listening posts.
Two-Person Team		
Individual weapon and ammunition	2	Either the M16 or M16/M203.
Night vision goggles, AN/PVS-7B	2	Support all night operations.
Manpack radio, AN/VRC-119A, or dismounted short-range radio, AN/VRC-91A	2	
Antenna, OE-254	1	
Telephone, TA-1	2	
Precision lightweight GPS receiver, AN/PSS-11	1	Supports split-team operations.
Compass, lensatic	2	Supports all operations.
Binoculars	2	Determines target position.
Sniper scope with laser	1	Determines target position.
Demolition kit	1	For breaching or route reconnaissance.
Clinometer	1	Measures elevation.
NBC equipment	2	

NOTE: *Team equipment load (minus personal load-bearing equipment [LBE] and spare clothing) is about 120 pounds.*

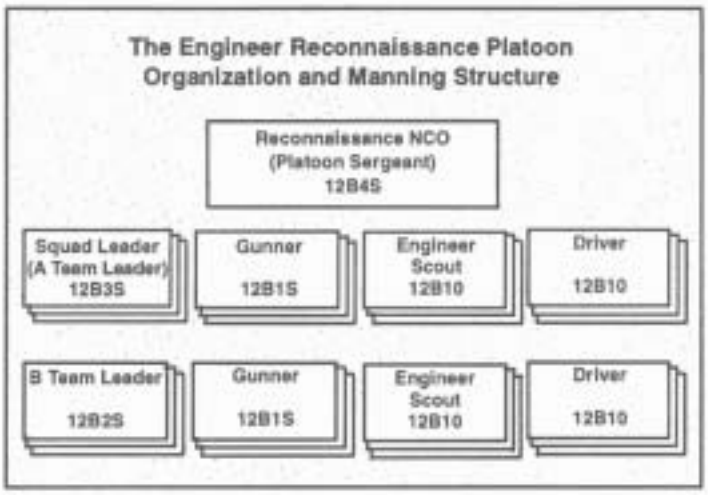


Figure 2

- Using the team as "deep eyes" for detailed engineer technical reconnaissance.

Equipment for the engineer reconnaissance squad is shown on page 48.

Training the Force. Placing the platoon under the S3 pays high dividends for training. During quarterly training briefs and regular training meetings with the brigade and task forces, the S3 verifies that engineer scouts are part of training events, particularly for lane training. Attending these events strengthens their habitual association and improves the level of training for all concerned. Joint training with the task force scouts reinforces standard techniques and procedures, improves reporting formats, and develops and formalizes policies within the tactical SOPs.

The engineer reconnaissance platoon can help train scout platoons within the brigade on the many engineer-related tasks included in their mission training plan task list. They can also help when scout platoons are scheduled to attend the Sapper Leader's Course. Because the prime emphasis of this course is on demolition skills and introductory patrolling techniques, this training will benefit the entire unit.

To be effective, a scout must train in small-unit tactics and techniques. Therefore, the MOS codes for senior platoon members (platoon sergeants, squad leaders, team leaders, and gunners) indicate that their positions should include ranger qualification. Normally this does not occur within heavy forces, but the requirements for dismounted obstacle reconnaissance and deliberate engineer reconnaissance obligate commanders to ensure that soldiers are as well prepared as possible. While this requirement uses scarce training dollars, the skills acquired will pay great dividends during operational deployments.

Manning Issues and Utilization. The S3 should carefully screen soldiers to ensure that only those best qualified are assigned to the scout platoon. Due to the difficulty of the mission, volunteers are the best choice. Random assignment to fill slots is a last resort.

Platoon sergeants are key to developing platoons. When selecting the platoon sergeant, the S3 places him on the battalion staff, where he has the primary mission of reconnaissance. When the reconnissance NCO selects soldiers to fill the platoon, he selects soldiers for reconnaissance missions, not for staff support. If the reconnaissance NCO is at the brigade tactical operating center, he can help the brigade S2s develop the reconnaissance and surveillance plan. Together with the engineer battalion S3, he develops a solid plan to cover the named areas of interest important to confirming or denying the templated enemy mobility/survivability information. By upgrading the duty position's grade from staff sergeant to sergeant first class, a more mature, experienced leader will be available to assist with all related operations.

When operating tactically, the engineer reconnaissance platoon is the logical choice for covering all mobility/survivability named areas of interest. While not limited to these areas, the reconnaissance platoon is the best qualified to report required information on them. These areas include obstacles on the battlefield as well as any deliberate engineer reconnaissance required within the brigade zone. Ideally, engineer scouts are a brigade asset, much like the combat observation lazing teams.

Scouts efforts are wasted unless the information they find is reported to all echelons. The operations order must specify which reporting nets the teams use and to whom they report. If the scouts are task organized under the task forces, reports must be passed to the engineer battalion to ensure that an accurate, brigade-wide picture of mobility/survivability data develops. The best choice for reporting intelligence is the operations and intelligence net, either at the brigade or task-force level. Teams normally do not report over the engineer battalion nets unless that is specified in the order. An exception is when teams operate solely in support of the engineer battalion; then they report either over the battalion command frequency or the company frequency.

Summary

By establishing and using a dedicated engineer scout platoon, the engineer battalion and heavy maneuver brigade gain a tremendous tool for gathering information. The flexibility, adaptability, and skills of the platoon provide a combat multiplier of the first order. The effects of these teams in the brigade reconnaissance fight are quantifiable and their benefits immediately apparent. While finding personnel to staff the platoon may be difficult, the benefits tremendously outweigh this difficulty. Only by getting these reconnaissance platoons up and running in every battalion can engineers overcome the shortage in reconnaissance expertise and set the conditions for successful battalion and brigade operations.

Mr. Sayer is a military analyst employed by Cubic Applications, Inc., which supports the Sidewinder Engineer Battalion Trainers, Operations Group, National Training Center, Fort Irwin, California.

Book Review



Hall, Gwendolyn Midlo, ed. *Love, War, and the 96th Engineers (Colored)*. Urbana, IL: University of Illinois Press, 1995, 319 pages.

By Dr. Larry D. Roberts, Command Historian, U.S. Army Engineer Center

In late September 1941, Second Lieutenant Hyman Samuelson reported to Fort Bragg, North Carolina, for duty with the 96th Engineer Battalion (Colored). A graduate of Louisiana State University with a degree in civil engineering, Samuelson was pursuing an advanced degree at Tulane when called to active duty.

The 96th was, like many units raised in the hectic days of mobilization prior to Pearl Harbor, a confusing composite of regular and reserve officers and enlisted men quickly brought into service with the minimum of training. As constituted, the 96th essentially was a general service battalion. These units were charged with construction duties, freeing the combat battalions to support the maneuver arms. In many instances, black engineer units were considered to be little more than labor battalions. Often they were short of the heavy equipment needed to meet their construction tasks. The overall lack of mechanical and technical peacetime training for many of the young black soldiers complicated the problem.

Gwendolyn Hall's book is, in reality, an edited printing of Samuelson's diary and the letters he sent to and received from his wife. This is one of the strengths of the work. Samuelson spent a lot of time describing his duties, the conditions he and his men labored under, and the tasks they accomplished. The book clearly shows the difficulties Samuelson had adjusting to the Army and the problems the 96th experienced both in training and during their service in New Guinea. As one of the first engineer units to arrive in New Guinea early in 1942, the 96th faced all of the problems of trying to perform engineer tasks in a primitive land, with little support and under the constant threat of air or ground attack. Limited recreational opportunities, including those imposed on the battalion because of segregation policies, often placed both officers and men under extreme personal pressure.

Through the diary and the personal letters, the reader can watch the maturation of a young man and the growth of an officer and leader. The letters to his young wife (they were married only a few weeks before he went overseas) show the personal stress of separation from family. Many of his letters, and hers, are filled with personal feelings of love, anger, and fear, which are seldom printed in histories or biographies. The diary also reflects his growing confidence as an engineer and the admiration he came to have for his men. In 1943 he wrote, "Before I die I must help stamp out this crazy idea that white man has about his superiority over the colored man." The diary and letters also show how his understanding of leadership grew as he took on increasingly greater responsibility in the unit, ultimately serving as company commander.

Hall's *Love, War, and the 96th Engineers* is really several stories in a single volume. It is a story of a young engineer officer at war in the Southwest Pacific in World War II. It is also a story of a husband separated, by the war, from his wife and family for almost three years. It is equally the story of the 96th Engineer Battalion, as told by a young officer who is fiercely proud of his men, their capabilities, and their accomplishments. Because the book contains these different accounts, it has value to a wide audience. Young officers will benefit from Samuelson's trials and tribulations as a young company-grade officer. The leadership approach he developed is worth consideration. Senior leaders also will benefit from this book. Samuelson was quite pointed in his diary about the relative merits of his superior officers. The views of a junior officer concerning the leadership, professionalism, and personal strengths of his superiors often make interesting reading. Finally, the book will be of value to families. Dora Samuelson's thoughts and feelings about him and the difficulties of their separation are clearly shown in the letters to her husband. Although the world and society of the 1990s differ from those of the early 1940s, the personal equation of human beings and their families has not changed.

There is little in this book for those preoccupied with technology or the often sterile analysis of tactics and strategy. This is a human story.

Note: Engineer *is seeking insightful reviews of books of special interest to military engineers. Contributions are welcome.*

ENGINEER DOCTRINE
PUBLICATIONS REDUCTION SURVEY

PURPOSE: The Training and Doctrine Command (TRADOC) has directed all U.S. Army schools to reduce the number of doctrinal publications by 20 percent and also reduce the content of doctrinal publications by 20 percent. This survey is a tool to request comments and recommendations concerning the feasibility of our consolidation plan to meet the reduction goal.

Unit _____ Name _____
Location _____ Commercial Phone No. _____
Activity _____ Fax No. _____
Duty Title _____ E-mail _____

Publications (*) under consideration for consolidation into one manual **(bold FM)** are indicated below. Using a scale of 1 to 5 (1 = the most acceptable for consolidating), please rank the logic of each planned consolidation and how well each will meet your needs.

Number	*Title*	*How logical is the plan?*	*How well will it meet your needs?*
1.	**FM 5-170, Engineer Reconnaissance** *FM 5-30, Engineer Intelligence *FM 5-36, Route Recon and Classification	_____	_____
2.	**FM 5-250, Explosives and Demolitions** *FM 5-250, Explosives and Demolitions *TC 5-250, Demolition Effects Simulator *TC 5-6-14, How to Prepare a Target Folder	_____	_____
3.	**FM 5-446, Military Nonstandard Fixed Bridges** *FM 5-134, Pile Construction *FM 5-446, Military Nonstandard Fixed Bridges	_____	_____
4.	**FM 5-478, Construction Surveying** *FM 5-233, Construction Surveying *TM 5-232, Elements of Surveying *TM 5-235, Special Surveys *TM 5-237, Surveying Computers Manual	_____	_____
5.	**FM 5-420, Plumbing and Pipefitting** *FM 5-163, Sewerage *FM 5-420, Plumbing & Pipefitting	_____	_____
6.	**FM 5-474, Drafting** *FM 5-553, General Drafting *FM 5-581B, Construction Drafting *FM 5-704, Construction Print Reading in the Field	_____	_____

Number	*Title*	*How logical is the plan?*	*How well will it meet your needs?*
7.	**FM 5-426, Carpentry and Masonry** *FM 5-426, Carpentry *FM 5-742, Concrete & Masonry	____	____
8.	**FM 5-434, Earthmoving Operations** *FM 5-164, Tactical Land Clearing *FM 5-434, Earthmoving Operations	____	____
9.	**FM 5-436, Paving and Surfacing Operations** *TM 5-331D, Engineer Const Equip , Vol D *TM 5-337, Paving and Surfacing Operations *TM 5-337-1, Asphalt Plant Layout, 100T-150T	____	____
10.	**FM 5-432, Pits and Quarries** *TM 5-332, Pits and Quarries *TM 5-331C, Util of Engineer Const Equip, Vol C	____	____
11.	**FM 5-540, Cartography** *TM 5-240, Comp & Color Sep of Topo Maps *TM 5-243, Cartographic Aerial Photography	____	____
12.	**FM 5-424, Theater of Opns Elec Systems** *FM 20-31, Electric Power Generation in the Field *TM 5-760, Interior Wiring	____	____
13.	**FM 5-410, Military Soils Engineering** * FM 5-410, Military Soils Engineering * TM 5-545, Geology	____	____

Please explain why you think the consolidation will not work for any particular publication. Return completed survey to: Commandant, U.S. Army Engineer School, ATTN: ATSE-TD-D-WC (Lucius Warrick), Fort Leonard Wood, Missouri 65473.

This survey is available on the Internet at http://www.wood.army.mil/DDD/ddd.htm

DOCTRINE PUBLICATIONS SURVEY

PURPOSE: To better serve your needs for engineer doctrine manuals, the Doctrine Development Division of the Directorate of Training at the U.S. Army Engineer School requests your responses to the following questions:

Unit_____ Name _____
Location_____ Commercial Phone No. _____
Activity_____ Fax No. _____
Duty Title_____ E-mail _____

1. Does the current engineer doctrine hierarchy meet the needs of the field?
___YES.
___NO. If no, please state why.

2. Is engineer doctrine accurate in reference to how units operate in the field?
___YES.
___NO. Why?

3. Is engineer doctrine relevant to current missions required by engineer units?
___YES.
___NO. Why?

4. Does current engineer doctrine meet the needs of the entire engineer community?
___YES.
___NO. If no, what area(s) is missing?

5. Do you have access to the engineer home page digital doctrine?
___YES.
___NO.

If yes, circle the average number of accesses you make monthly.
(1 2 3 4 5 6 7 8 9 10 Over 10)

Circle the home page references that you most frequently use.
FMs STs TCs ARTEPs GTAs Lessons Learned

(File location of the homepage is http://www.wood.army.mil/DDD/ddd.htm)

6. Use a scale of 1 to 16 (1 = most useful) to rank the following manuals as to their usefulness:

___FM 5-34, *Engineer Field Data*
___FM 5-7-30, *Brigade Engr & Engr Co Cbt Opns*
___FM 5-71-2, *Armored TF Engr Combat Opns*
___FM 5-71-100, *Division Engr Combat Opns*
___FM 5-100, *Engineer Operations*
___FM 5-10, *Combat Engineer Platoon*
___FM 5-100-15, *Corps Engineer Operations*
___FM 90-7, *Combined Arms Obstacle Integration*
___FM 5-103, *Survivability*
___FM 5-104, *General Engineering*
___FM 5-105, *Topographic Operations*
___FM 20-32, *Mine/Countermine Operations*
___FM 5-250, *Explosives and Demolitions*
___FM 90-13, *River-Crossing Operations*
___FM 90-13-1, *Combined Arms Breaching Opns*
___FM 5-71-3, *Brigade Engr Combat Opns(Armor)*

ENGINEER UPDATE

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

Fort Leonard Wood Electronic Addresses. Electronic mail that formerly went to users at *wood-vines.army.mil* has been changed to *wood.army.mil*. Mail addresses for users at *wood-emh1.army.mil* have been changed to *emh1.wood.army.mil*. For example, *doej@wood-vines.army.mil* becomes *doej@wood.army.mil*. POC is the DOIM Help Desk, -4357.

Fort Leonard Wood Web Server. Effective 15 July, the Fort Leonard Wood web server has a new look. Our name changed to reflect the Maneuver Support Center (MANSCEN) mission, a "topical" information layout provides easier navigation, and expanded coverage reflects our partnership with the Ozark community. Check us out at http://www.wood.army.mil. An electronic comment form is on the home page. POC is Greg Adank, -5368.

Department of Training and Doctrine Development (DOTD)

Field Manuals (FMs) Distributed. The following field manuals are scheduled for distribution this summer:

- FM 5-499, *Hydraulics,* is scheduled for distribution in August. This manual is a guide for personnel who operate and maintain military equipment using hydraulic-powered control systems.
- FM 5-424, *Theater of Operations Electrical Systems*, was distributed in June. It is a training guide for engineer personnel responsible for planning and executing construction in a theater of operations.
- Change 1 to FM 5-410, *Military Soils Engineering*, was distributed in June. This change incorporates applicable geologic information from TM 5-545, *Geology,* and supersedes the technical manual.
- Change 2 to TC 5-400, *Unit Leaders' Handbook for Environmental Stewardship,* was distributed in July. This change explains the terms "used oil" and "waste oil" and describes appropriate handling and disposal methods.

These manuals are on the Engineer School's Publications Page: http://www.wood.army.mil/DDD/PUBS/pubs.htm. POC is Lucius Warrick, -4115.

Updated Experimental Forces (EXFOR) Special Texts (STs). Special texts for company-, battalion-, and brigade-level EXFOR were updated in June based on the Advanced Warfighting Experiment (AWE) conducted in February. The revised STs will be used during the division-level AWE scheduled for November. They are on the Engineer School's Publications Page on the World Wide Web: http://www.wood.army.mil/DDD/PUBS/pubs.htm. POC is CPT Joe Birchmeier, -4115.

Staffing of FM 5-34. The draft of FM 5-34, *Engineer Field Data*, will be staffed to the field for comment using a combination of paper copies and the Internet. The draft was posted on the Engineer School's Publications Page (see above address) in June. Paper copies were distributed in July. POC is CPT Joe Birchmeier, -4115.

Directorate of Combat Developments (DCD)

Global Positioning System (GPS). Users of the GPS are reminded that the system is not accurate enough for precise minefield recording. Using GPS as the only means of locating or recording minefields will lead to avoidable injuries and deaths. Soldiers and civilian personnel must follow

approved tactics, techniques, and procedures when navigating or working near any known minefield. POC is CPT Rick O'Donnell, -5644

Maneuver Support Battle Laboratory (MSBL)

Engineer Force Structure. The Engineer School and MSBL are decisively engaged in a fight to retain engineer force structure at the division, corps, and theater levels. Proposed heavy division designs remove the engineer command group (colonel). Possible reductions in corps engineer force structure are being discussed by the TRADOC Force Design Directorate. General Reimer is scheduled to reach a decision on 11 August concerning the theater support command (TSC) concept proposed by the Combined Arms Support Command, which would place the engineer command under the command and control of the TSC. We are seeking support from fellow Army engineers in all components, including military retirees, in these fights. We are also soliciting help from theater commanders in chief and other combined arms partners. If you can assist or have questions, please contact us. The e-mail address is lowreyv@wood.army.mil. POC is Vern Lowrey, -4082.

Unmanned Terrain Domination. Now that the Cold War has ended and U.S. forces are drawing down, the U.S. Army is reexamining the way it trains and fights. The Army of the future will be smaller but more technologically advanced. Potential adversaries will not go away and they, too, are advancing technologically. Therefore, U.S. forces must dominate battlespace while maintaining economy of force. An integrated concept team is developing a concept for unmanned terrain domination as a capability for the Force XXI Army. In accordance with Joint and Army visions, this operational capability will provide the commander total situational awareness, the ability to evaluate data received from unmanned sentries and develop courses of action based on that data, and the ability to employ tactics and unmanned systems to achieve desired objectives. If you can assist or have questions, please contact us. The e-mail address is chapmant@wood.army.mil. POC is MAJ Tom Chapman, -5820.

Engineer Personnel Proponency Office (EPPO)

Officer Restructure Initiative. General Reimer approved the Office of Personnel Management System (OPMS) proposal to restructure the officer corps' development system into a four-career-path system. The OPMS task force is focusing on restructuring branches and functional areas to implement the new system. The Engineer Branch has two key concerns: how to balance the large number of majors with the small number of branch-qualifying S3 and XO positions and if changes to current branch and command qualifications are necessary. For more information, refer to EPPO's home page: http://www.wood.army.mil/EPPO/eppo_hp.htm. POC is CPT Matt Zajac, -4087.

News and Notes

Environmental Partnering Workshop. Reserve 21-23 October 1997 to attend a workshop sponsored by the Society of American Military Engineers (SAME) at Fort Leonard Wood. The workshop, "Environmental Partnering in Engineering Operations," will focus on environmental solutions to military engineering challenges. It will look across service boundaries and open channels to academia, the private sector, and non-Department of Defense government agencies with proven solutions to engineering problems. POCs are MAJ Jack Drolet, (573) 596-0224, and LTC Sue Myers, (573) 563-4106.

Engineer School Directory

The following telephone numbers for the U.S. Army Engineer School allow callers to reach key offices. Commercial numbers are (573)563-xxxx and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Commandant
MG Robert B. Flowers
563-6116

Engineer Center Command Sergeant Major
CSM Robert M. Dils
563-6151

Assistant Commandant
COL(P) Edwin J. Arnold
563-7117

Deputy Assistant, Army Reserve
COL Michael K. Adams
563-4033

Deputy Assistant, Army National Guard
COL Harry L. Bryan
563-4034

Chief of Staff
COL Maynard S. Rhoades
563-6118

Directorate of Training (DOT)
Director, COL Philip F. Federle
563-4093

Allied Engineer Liaison Officers
Australian Army, LTC Phil White
563-6132

British Army, COL Phil Lilleyman
563-4018

Canadian Army, MAJ Paul Fleet
563-4017

French Army, COL Jean Lafargue
563-4027

German Army, LTC Helmut Bach
563-4029

Directorate of Combat Developments (DCD)
Director, COL C.M. Ferguson, Jr.
563-4076

Directorate of Maneuver Support Battle Lab
Deputy Director, COL Don T. Riley
563-4082

TRADOC Systems Manager
COL Edwin P. Janasky
563-4085

TRADOC Program Integration Office
Director, COL Robert S. Kirsch (as of October 1997)
563-4082

Department of Training and Doctrine Development (DOTD)
Director, LTC Dale A. Carr
563-4111

Department of Tactics, Leadership, and Engineering (DTLE)
Director, LTC James Koch
563-4119

Engineer Hotline
563-4098

Engineer Professional Bulletin
Managing Editor, Catherine Eubanks
563-4104

Engineer Personnel Proponency Office (EPPO)
Chief, Victoria Anthony
563-4087

Engineer Branch Safety Office
Director, Dennis Woolsey
563-4025

Garrison Commander
COL Timothy M. Daniel
563-4005

1st Engineer Brigade
COL Thomas G. Luebker
596-0224, DSN 581-0224

BRIDGE THE GAP

By Command Sergeant Major Julius B. Nutter
U.S. Army Engineer School

One Army, One Standard

To prepare the Total Army for the 21st century, TRADOC formed the Total Army School System (TASS). The system is designed to fix the problem of "nonstandardized" training for non-commissioned officers (NCOs) assigned to the Active, National Guard, and Reserve Components. In the past, NCOs attended Noncommissioned Officer Education System (NCOES) courses in either Active, National Guard, or Army Reserve academies. Because the courses for soldiers in the Active Component were considerably longer than those in the Reserve Components, training scenarios in the three academies differed significantly. Under TASS, the level of training NCOs receive will be more equal regardless of their component affiliation. TASS will minimize discrepancies by utilizing distance-learning media such as CD-ROMs, making courses available on the Internet, and conducting video-teleconferences.

To help standardize training, TRADOC established seven regions that cover the 50 states and seven territories. Under TASS, all initial entry training will continue to be conducted at the proponent schools, and reclassification training will be taught at a functionally aligned TASS school. Responsibility for combat arms training usually falls under the National Guard, while responsibility for combat support and combat service support falls under the Army Reserves. Although the Engineer Regiment is a combat arms branch, the Army Reserves have responsibility for engineer TASS training.

TASS is an integrated part of the training bridge between the Active, National Guard, and Reserve Components. The abutments of this bridge are built on seven regional training battalions. Structural members, such as partnerships, coaching, and leadership, are needed to span the gap. One of the Engineer Regiment's greatest challenges is to consolidate our resources and forge a true partnership that integrates the assets of each component to create one viable training organization.

What does this mean to the typical engineer NCOES candidate? Soldiers in both the Active and Reserve Components can attend the resident course either at Fort Leonard Wood or any regional school. For example, starting in October 1997, the Total Army Training System (TATS) course "Combat Engineer" (Career Management Field 12, Advanced NCO Course) will be configured with the following academic hours: The resident course at Fort Leonard Wood will have 343 hours. The regional course will have two phases spread over two years. The technical phase has 283 hours—150 hours of active duty training (ADT), 123 hours of inactive duty training (IDT), and 10 hours of distance learning. The second phase, common leader training, includes about 85 hours of common tasks. It is taught by the professional development battalions and at the U.S. Army Sergeants Major Academy.

TASS is the Army's system for training, and our readiness is tied to the success or failure of this system. Partnerships similar to those created in capstone units provide the right environment for success. As with any new system, TASS requires structural support from all engineer leaders and trainers. Unit leaders must start coordinating with the Reserve Component training battalions at least a year in advance of the training to ensure that all requirements are resourced. Command sergeants major must ensure that their NCOs verify Army Training Resource Requirements System (ATRRS) listings of courses with the regional school battalions. They should reverify the course 60 days prior to the course date to ensure that soldiers do not show up for courses that have been canceled but not annotated in ATRRS. Soldiers must ensure they are prepared to attend the course by being physically fit and familiar with the program of instruction.

Training the engineer force for the demands of America's Army in the 21st century must include efficiencies because of reduced resourcing. As leaders, you are responsible for getting your soldiers trained. Implementation of TASS ensures that all engineer soldiers are trained to a single standard. It provides efficiencies by allowing students to get MOS qualified without having to travel great distances. We must bridge our training gap and remain a viable part of the combined arms team.

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A stubby bulldozer driven by Navy Seabees puffs off an LST at Green Islands, Malaysia, during the invasion by Allied troops in February 1944.

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