ENGINEER

The Professional Bulletin of Army Engineers



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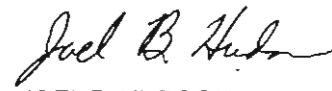
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Front Cover: *The diversity of U.S. Army engineers can be seen in these photos: (from top) ENFORCE color guard; soldiers from the 425th Engineer Detachment develop a well in Guatemala; a soldier passes a case of C4 explosives to another soldier at the Class V supply point in preparation for a cave demolition in Kosovo.*

Back Cover: *A skid-mounted well-drilling machine being used by engineers in England, with a 4-ton truck in the background. 25 April 1944.*

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Clear The Way

By Major General Anders B. Aadland
Commandant, U.S. Army Engineer School



The euphoria of a successful ENFORCE 2001 has still not worn off. The professional interaction with the great leaders from all walks of the Regiment reassures us that we are ready to embrace change, work as a team to achieve Army Transformation, and do whatever is necessary to support this great Army. Thanks to each and every participant (Active, Reserve, retired military, civilian, and contractor) for making ENFORCE 2001 such a professionally rewarding experience. We're also grateful to all the guest speakers who enriched our knowledge, challenged our paradigms, and stimulated our ability to see beyond current systems, technologies, and problems.



Among them, the Honorable Dr. Joseph Westphal, Acting Secretary of the Army, made a special farewell appearance to thank us for our support to the nation. U.S. Representative Ike Skelton expressed his pride in the ongoing training program at Fort Leonard Wood and the importance of the Army Engineers to the history of the nation and our Army. He committed his support to provide the Army with the resources it requires to stay strong and healthy. LTG (R) Max Noah was honored by the Regiment as the 2001 Gold de Fleury recipient and MG(R) Jack Waggoner was installed as the new Honorary Colonel of the Regiment. We thank these distinguished gentlemen for their great support to our Regiment and Army.

Our Regiment bids a special thank-you and farewell to two of our great leaders, warriors and friends—Major Generals Phil Anderson and Milt Hunter—as they retire from our ranks this summer. We look forward to their continued mentorship, now from a different segment of our network. Godspeed, Phil and Milt.

Let's not lose the ENFORCE 2001 momentum. As our examination of the Transformation issues revealed, we have much to do. This bulletin contains a follow-up to many issues we addressed during ENFORCE 2001, including a short report that summarizes the essence of the breakout sessions. Let's make sure that we captured all the key perspectives from the field and answered your questions. If you have additional comments concerning any of the breakout topic areas, please get them to us ASAP. It is essential that we continue to work each of these issues as paramount to the Transformation of the Corps's people, units, systems, concepts, and doctrine.

As you look over this bulletin, consider the immense diversity of our branch. Being an Army Engineer, a sapper, is not a boring, single-mission kind of occupation; take great pride in that. Just a few examples play out in this bulletin. Think of it: We perform combat-engineering tasks such as providing mobility, countermobility and survivability to the maneuver force; construct roads, ports, and airfields; build and improve the nation's infrastructure; drill wells and run pipelines; analyze and shape the world's terrain; provide disaster relief; and create power where none exists. As leaders in the Corps, we must continue to seek out and educate ourselves on what the Regiment's soldiers, civilians, and contractors can do. Ask yourselves—

- What can a well-drilling detachment do for me? What are the capabilities, organization, or resource requirements? How do I get them?
- What lessons can we learn from the 44th Engineer Battalion's and the 82d Engineer Company's Imjin River exercise?
- What changes to school- or unit-taught demolition tasks did the 16th Engineer Battalion sappers make to complete their cave demolition mission?
- How can we better integrate the Reserve Component with the Active Component? Take a look at the article from the 224th Engineer Battalion, Iowa Army National Guard, and see if you can apply that knowledge.
- Where should we be using simulations as a means to train Army Engineers? As we pursue our vast array of training missions, simulation becomes the tool of choice on an ever-expanding scale. However, we face many limitations in current systems that we are rapidly working to overcome. CW2 Mohn's article provides a discussion on real terrain effects versus the simulation of terrain effects within the Corps Battle Simulation (CBS) database. We still need to do more work to narrow the gap between reality and simulation effects for engineer units, capabilities, mines/obstacles, river-crossing operations, and other engineer missions within simulation models. This is worthy of your study and thoughtful consideration.

As we continue to ride the wave of change in our Army, we should look closely at the changes ongoing within the Engineer School and MANSCEN. This issue signals that time when transition is at its peak. Just to name a few of our outgoing heavy hitters, we bid farewell and thanks to: BG Ron Johnson, Assistant Commandant; COL Doug Hom, Deputy Assistant Commandant; COL Bill Pierce, TPIO-Terrain Data; COL Jim Rowan, Director of Training; COL Lou Best, Commander, 1st Engineer Brigade; COL Chuck Moldenhauer, Deputy Director, Maneuver Support Battle Lab; LTC Billy Tollison, USAES Chief of Staff; and LTC Harry Rossander, Doctrine Chief. We also extend a hearty "welcome aboard" to the inbound talent who now take over the following key positions: BG Randy Castro, Assistant Commandant; COL Pat Leake, Deputy Assistant Commandant; COL Bob Kirsch, Director of Environmental Integration; COL Jim Rowan, Commander, 1st Engineer Brigade; COL Dave Kingston, TPIO-Terrain Data; LTC(P) Jeff LaMoe, Director of Training; LTC Jeff Bedey, Department of Instruction; and LTC Tom Chapman, USAES Chief of Staff; LTC Bill Duddleston, Doctrine Chief. These are your new schoolhouse warriors. Add them to your list of key leaders in the Regiment—call on them, use them, embrace them, and talk to them about how we need to improve across DTLOMS as a combat arms member of the combined arms team.

Essayons!

Lead The Way

By Command Sergeant Major Robert R. Robinson
U.S. Army Engineer School



I want to start by thanking all of you, the leaders of our Regiment, for making this year's ENFORCE conference such a success. Your presence at our annual conference provides the information and insights we need to shape the Regiment and keep us viable during the Army's transformation process.

I thank all the command sergeants major/sergeants major (CSMs)/(SGMs) of the Active and Reserve Components for their assistance in resolving several issues and for their candid and open perspectives on how we ought to do business as engineers. I think the interaction between the CSMs/SGMs, the briefings from the Engineer Commands' (412/416) SGMs, and the updates from the sergeants major and the Engineer Branches and our own Engineer Personnel Proponency Office gave us a better indication of just how diverse we are and on the health of the Regiment.

I sincerely appreciate your involvement in the dinner we hosted for CSM Lugo. Your presence there, tokens of appreciation, and words of praise meant a lot to him and was, in my opinion, a great way to honor a soldier who has given much to our Army.

The Sergeant Major of the Army (SMA) was tentatively scheduled to visit Fort Leonard Wood during our ENFORCE conference, but he was called to testify before Congress. Instead, he visited Fort Leonard Wood from 22 to 24 May. During that visit, we were able to showcase some of the Engineer School, 1st Brigade, and engineer soldiers. He spent over 3 hours talking to engineer soldiers—permanent party and trainee—received a briefing on the Sapper Leader Course, and visited the "Million Dollar Hole" (TA 244) where he operated the deployable universal combat earthmover (DEUCE) and was given an overview and tour of the Engineer Equipment Maintainer's Course. Although a very short and condensed trip, he went away with a better understanding of what we do at Fort Leonard Wood for our Regiment. In a trip report to his boss, General Shinseki, the SMA reported that the soldiers and leaders of Fort Leonard Wood were well disciplined and enthusiastic about their duties. He also reported that the installation, as a whole, exuded a quality of life and an environment consistent with the highest Army ideals. That is a great report and testament of our soldiers at Fort Leonard Wood.

During the first week and a half of June, I visited our Engineer soldiers and units in Germany. Up front, I will say that things have changed dramatically since my departure some 20 years ago. My first stop was in Heidelberg, where I spent the evening with many of United States Army, Europe's, engineers at their annual Engineer Ball. Headquarters, Deputy Chief of Staff, Engineers, sponsored this year's event in the Heidelberg Castle—what more appropriate place could there be than a castle to gather engineers and celebrate their Regiment and its accomplishments.

The next day I was off to Giessen to visit the soldiers of the 16th Engineer Battalion, 1st Armored Division. There I spoke with the soldiers and noncommissioned officers (NCOs) of the 16th Engineer Battalion and watched first-hand as soldiers performed maintenance on their vehicles and equipment. Those soldiers were doing a great job and were completely engaged in the movement of the engineer brigade headquarters back to its old home in Giessen.

From there I went to Bamberg and visited with soldiers of the 82d and 9th Engineer Battalions. Upon arriving, I flew to the Combat Maneuver Training Center and watched soldiers from the 9th participate in lanes training with their brigade combat team. I sat in on an after-action review and listened to sappers address and overcome the challenges of being an integral part of a maneuver force. The next day I ate breakfast with soldiers from the 82d Engineer Battalion, had lunch with senior NCOs of the 1st Infantry Division Engineer Brigade, and finished the day in a professional development session (NCOPD) with NCOs of the engineer brigade. The soldiers in the 1st Infantry Division are tremendous and live and work in a great community where the emphasis on quality of life is evident.

I spent the last two days of my trip with soldiers of the 130th Engineer Brigade, whose headquarters is in Hanau. The brigade CSM, however, wanted me to start my visit in Vilseck, visiting the soldiers of the 54th and 94th Engineer Battalions. The 54th was in the middle of executing some of the best field training I have seen, conducting live-fire exercises as part of an event-driven scenario. The 94th was in the midst of recovery from a recent trip downrange and was hosting a training-management-review brief to the V Corp commander. I was completely taken off guard when I saw that the battalion headquarters was in the middle of the motor pool. What a novel idea and a great way to stay focused on one of the bigger challenges in our Regiment—MAINTENANCE. The following day, I went to Hanau and made my way through the motor pools of the 502d and 38th Bridge Companies and visited the different kasernes in the area. Although I was assured that the unit insignia worn by the soldiers of this great brigade DID NOT mean "We Work Weekends," this unit was hard at it during my stay there in Europe.

Bottom line is that I had the opportunity to see about a third of the Regiment's engineers doing what engineers traditionally do—performing superbly in support of our Army and our nation. The quality of life in Germany has changed dramatically. I couldn't help but be impressed by how the facilities, installations, and communities have improved, giving the soldiers who serve on the fringe of conflict the quality of life they deserve.

We have thousands of outstanding soldiers, leaders, NCOs, officers, and civilians who are giving impeccable support to the Army in Germany and superbly representing the Engineer Regiment. I am extremely proud of those soldiers and civilians for what they do on a daily basis, as I am of our entire Regiment for all that you do.

The 4th Annual CSM/SGM Fall Off Site Conference is scheduled for 24 to 28 September 2001, at Carlisle Barracks, Pennsylvania. Information concerning the conference is on the Engineer School Web site. I realize that these events—ENFORCE and the Off Site Conference—are difficult for many of our CSMs and SGMs to attend because of training calendars, resources, and home-station commitments as competing priorities. However, know that these are worthwhile events, important to the team building efforts of our Regiment. The Off Site Conference serves as professional development for the senior NCOs of our Regiment and helps to bridge the gap on important issues between ENFORCEs. Please support this upcoming event.

In closing I want to thank you all for the great service you provide to our Army and to the Regiment. I sincerely hope to visit the remaining units in our Regiment soon.

Engineers Lead The Way!



Military Water-Well Drilling

By Captain Tim Scarbrough and Captain Paula Lang

"Water, water, everywhere, nor any drop to drink."
—Samuel Taylor Coleridge

In recent years, especially since the attack of Hurricane Mitch on Central America, humanitarian civic operations have dramatically improved the quality of life for thousands of people in need. This aid came from international civic foundations, religious organizations, volunteers, and the U.S. armed forces. All four services use Active Component (AC) and Reserve Component (RC) service members to help refugees by constructing roads, schools, medical facilities, and housing and providing medical services and potable-water wells.

Well drilling is a viable, necessary engineer mission that provides potable-water sources for all combat, combat-support, and combat-service-support units, as well as civilians and humanitarian-support agencies. Although the Army, Navy, and Air Force all have well drillers, most of them are in the U.S. Army Reserve (USAR) and the Army National Guard (ARNG). The 28 well-drilling units in the U.S. armed forces are heavily employed in Europe, the Caribbean, Central America, and the United States, working closely with the U.S. Army Corps of Engineers (see table on page 8). To help explain the military well-drillers' world, this article addresses their roles, methods, and equipment; becoming a well driller; assignments; and issues and answers.

Well-Drilling Roles

According to U.S. Army Field Manual 5-484, *Multiservice Procedures for Well-Drilling Operations,* well-drilling detachments are combat-service-support assets that are usually at the corps or theater level. The units are tasked to supplement surface-water sources in two instances: when it is unnecessary or too costly to transport volumes of water or when groundwater wells are needed as a logistical backup in case of nuclear, biological, or chemical surface-water contamination by the threat. In addition to drilling wells, the units identify and compile data on surface-water sources, compile data using drilling logs and surveys for drilling-site identification, and restrict access to contaminated or dangerous well sites and seal the holes.

Well-Drilling Methods

Since a variety of geological formations—ranging from hard consolidated rock to soft unconsolidated sediments—may be encountered during well construction, several well-drilling methods have been developed. The most common methods are mud and air rotary drilling and down-hole hammer or percussion drilling.

Mud Rotary Drilling

This method uses a highly viscous "mud" to float the cuttings from the current drill depth to the top of the borehole. This fluid is recycled by using a series of catch sumps or mud pits and a pumping device to keep a constant flow down the drilling rod, up the hole, and out again. The mud—being based of clays, water, and other materials—also forms a filter-cake layer to provide a seal down the hole. This is the preferred method of well drilling for all the services.

Air Rotary Drilling

Similar to mud drilling, this method uses air instead of mud and is advantageous when it is inconvenient to use water for drilling. Air rotary drilling requires less time for well development but is more problematic due to its inability to support unstable geology and the frequent need to cool and lubricate the drill bit. This type of drilling requires a well-maintained compressor to produce the 3,000-feet-per-minute (fpm) minimum velocity to blow the cuttings up and out. A drilling foam may be used to enhance the air's ability to carry cuttings up and out.

Down-Hole Hammer or Percussion Drilling

This method involves crushing the teeth of the drill bit into the soil by impact. Pneumatic or compressed air is the delivery means to carry cuttings up and out. Used in extremely unfavorable conditions, such as extremely hard rock, this type of drilling is also used to drill shallow holes for loading explosives at quarries and other excavations.

Well-Drilling Equipment

The common, attainable well-drilling depth is 400 to 600 feet. A drilling system must be able to operate continuously to a 600-foot depth (threshold) or a 2,000-foot depth (objective). Geography and drilling history supports the need to go much deeper in desert regions in which groundwater levels are farther below the surface than in temperate regions. Mountainous terrain also requires a deeper drilling depth because groundwater only roughly follows topographic features, thereby making groundwater sources harder to reach. Temperate climates have a generally level topography and advantageous stratigraphies and are favorable for drilling wells less than 600 feet deep. Hilly terrain, arid climates, and poorer geology make it necessary to drill up to 1,500 feet to find water. Extremely arid areas, such as North or South Africa and Southwest Asia, typically require well depths from 1,640 feet to over 5,000 feet, depending on the water table and the degree of salinity.

The necessity of water sources, especially in desert conditions, mandates a system capable of long-term operation without failure. Drilling rigs must be equally functional despite frozen, temperate, or desert conditions because soldiers need water to survive and accomplish their assigned missions. When supporting humanitarian missions, especially following a natural disaster in which potable water is unavailable, both military and civilian personnel depend on these drilling rigs until the emergency ends or damaged utilities become operational.

Army

The current Army well-drilling and well-completion equipment consists of the 600-foot well-drilling system manufactured by the G.E. Failing Company (see Figure 1). It includes an LP-12 rotary well-drilling machine mounted on a Navistar 6 x 6 truck chassis, a support vehicle, and a lightweight well-completion kit that includes accessories, supplies, and tools. With the completion kit, a well can be drilled to a depth of 600 feet using mud, air, or a down-hole hammer with or without foam injection. With the addition of an auxiliary air compressor and a drill pipe, the 600-foot system can drill to depths of 1,500 feet and accommodate the 1,500-foot well-expansion kit. The drilling machine does not have to be modified when drilling with mud to 1,500 feet; however, additional equipment and more drill pipe are required to use the expansion kit.

Additional equipment with the LP-12 includes casing, elevators and slips, larger drill bits, and 900 feet of additional drill steel. This machine has a 32-foot mast, three-drum drawworks assembly, rotary table, mud pump, and an air compressor. The truck engine, through a power-take-off (PTO) subdrive, powers the components of the rig. A hydraulic system operates the leveling jacks, mast-raising cylinders, and breakout cylinders. The vehicle is also equipped with attachments to tie down and lift the vehicle during transport.

For United States Southern Command (SOUTHCOM) missions in Central America, air drilling is commonly used because of the volcanic geology. Mud drilling can fill cracks of deep geologic formations with the mud, causing a loss of pressure and a potential collapse of the hole. In extremely volcanic rock, little progress can be made with mud drilling. The current LP-12's air compressor cannot support air drilling because of its low pounds per square inch/cubic feet per minute (psi/cfm) (350 psi/1200 cfm), which is only adequate for mud drilling. It is also extremely difficult to deploy this equipment because minor to major disassembly is necessary to make it air transportable.

Air Force

Rapid engineer-deployable, heavy-operations repair squadron-engineer (RED HORSE) units have no organic

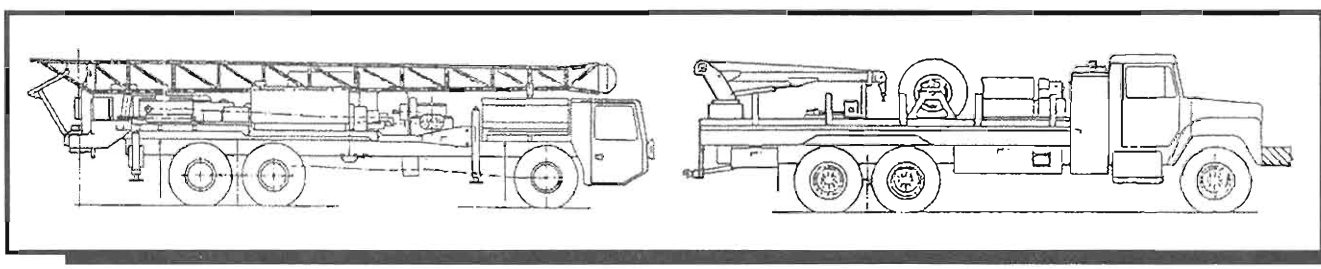


Figure 1. LP-12 well-drilling machine and support truck used by the Army

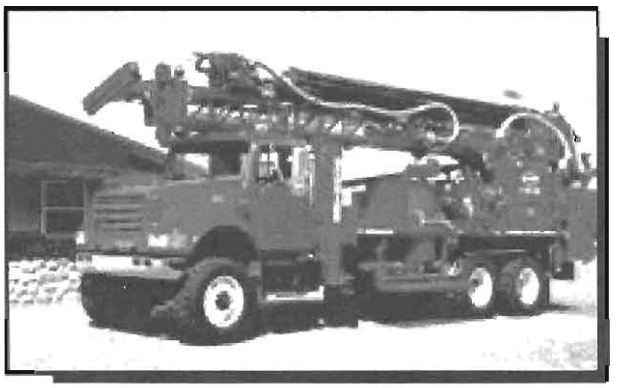


Figure 2. T450MII Rotadrill used by the Air Force

well-drilling equipment, so they commonly use rigs made by Schramm and Winter Reese. The Schramm T450MII Rotadrill is a top-head drive, truck-mounted drill rig engineered primarily for applications using combination mud rotary, air rotary, and down-hole hammer drilling methods (see Figure 2).

The truck engine provides reliable power for all hydraulic, mud, and air systems. Rugged top-head-drive rotation and efficient pipe handling mean high productivity on the job site and more time spent drilling. All functions are driven hydraulically by a PTO installed on the truck's engine, permitting a variety of mud pump, air, and accessory-system combinations. The T450MII is well suited for constructing water wells in unconsolidated formations, as well as monitoring well construction and environmental-drilling investigations using mud, air, and auger methods. One drawback to this machine is its size. Maneuverability and deployability are more of a problem because of the Schramm rig's length compared to rigs used by the Army and Navy. The Winter Reese rig is equally capable of drilling 1,500 feet, but it is scheduled to be replaced.

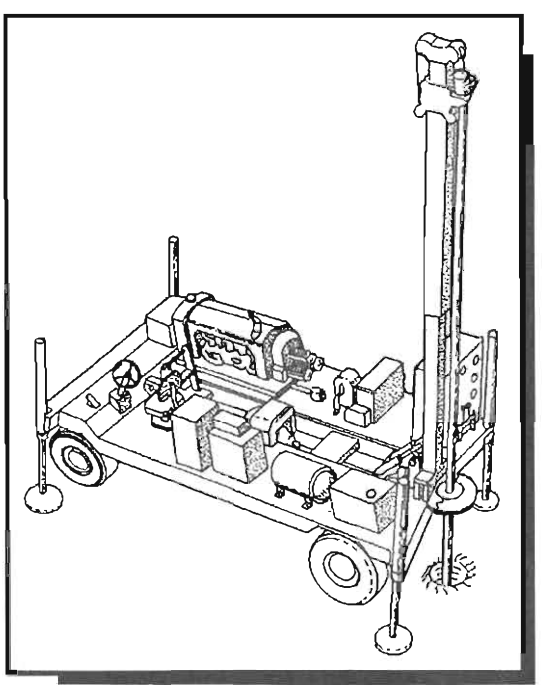


Figure 3. ITWD drill used by the Navy

Navy

The Navy's current well-drilling rig is the ITWD (ISO/Air Transportable Water-Well Drill) manufactured by Ingersoll-Rand (see Figure 3). The ITWD top-head drive rig is mounted on a 4 x 4 chassis and is capable of drilling up to 1,500 feet. It has 1,530 feet of drill steel along with 90 feet of collars as part of the collateral. The rig has no air compressor, but a down-hole hammer is included along with a 5 x 6 mud pump for mud drilling. The Navy has included a Sullair 750-cfm compressor as part of the well-drilling equipment. Common site problems exist, such as drilling below 1,000 feet. In addition, the rigs have a tendency to require rebuilding after less than 3,000 hours of operation. The ITWD's best feature is maneuverability. It is very portable and can fit into tight drilling sites due to its 19-foot 3-inch length.

Most well-drilling units deploy with electric- or hand-pump well-completion kits—an essential part of every well-drilling bill of materials (see Figure 4). The kits vary in size and capacity according to the well being drilled. In areas with an adequate power supply and a water-storage facility and/or delivery system, electric pumps are used. However, in rural areas with no electricity, such as in Central America, hand pumps are installed in wells.

Becoming a Well Driller

In the Army, well drillers are in a "low-density" military occupational specialty (MOS). They are construction-equipment operators (MOS 62J10) whose MOS training is

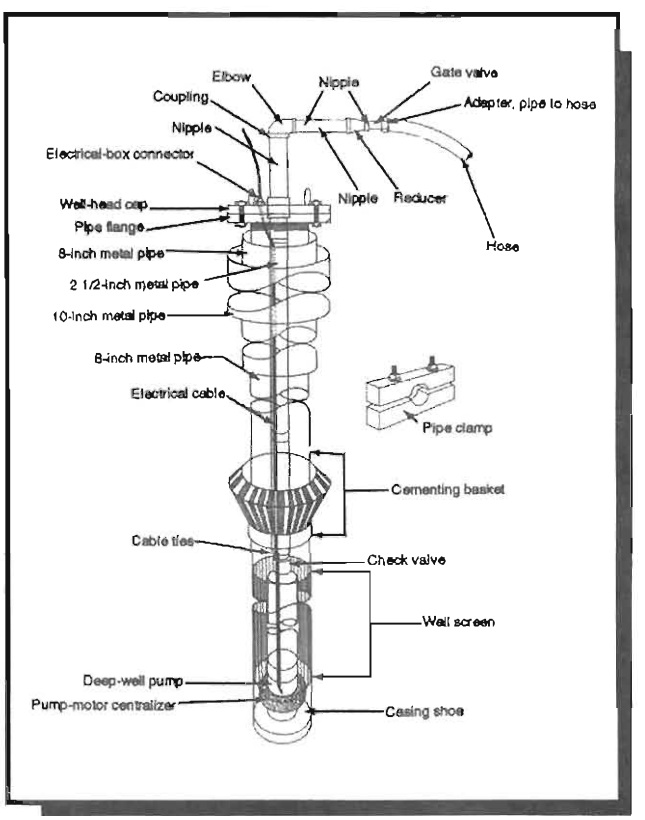


Figure 4. Standard electric well-completion kit



During the New Horizons 2000 exercise in Guatemala, soldiers from the 425th Engineer Detachment used the LP-12 drilling rig to set up the final well casing for a project in Panarama.

completed as advanced individual training (AIT) at the Maneuver Support Center, Fort Leonard Wood, Missouri.

The problem encountered in training well drillers is in acquiring the additional skill identifier (ASI). To be eligible to receive the ASI, a soldier must be an E-5 or E-4 (P) and complete the 6-week ASI C3 course. Although the course is very well-developed and qualitative, it does not train lower enlisted soldiers effectively because it is a leadership course, and soldiers graduating from AIT have only basic experience as leaders. Soldiers with more experience who reclassify into this MOS have fewer difficulties than new soldiers reporting from AIT.

The ASI C3 course consists of the following areas of study:

- General safety.
- Groundwater location.
- Geology.
- Drilling-equipment operation (most well-drilling rigs on the market).
- Well-drilling methods.
- Water-well design.
- Well development.
- Drilling terminology, charts, and tables.
- Troubleshooting methods.

Because the Navy is the proponent for water-well-drilling education for all three services, the ASI C3 course is taught at Port Hueneme, California, at the U.S. Naval Construction Training Center. There are no mobile training teams for RC soldiers at alternate locations.

Well-Drilling Assignments

Where are military well drillers going? The best answer is...*everywhere*! (See table on page 8.) Despite doctrinal policy stating that well drillers are a combat-service-support asset to corps or theater operations, these personnel are being used for installation and local-municipality support in CONUS and humanitarian aid OCONUS.

SOUTHCOM conducts an annual Nuevos Horizones (or New Horizons or NH) exercise, which provides valuable services to Central and South America and the Caribbean. During this exercise, soldiers from all four services not only receive important training but also provide much-needed end products—such as schools, clinics, latrines, roads, and wells—for the host nation. Military well drillers have been valuable assets to thousands, if not millions, of people in the SOUTHCOM area of responsibility.

Issues and Answers

In July 2000, staff officers from the 416th Engineer Command, Darien, Illinois, and the 439th Engineer Battalion, Bismarck, North Dakota, joined forces and hosted a well-drillers conference in Bismarck. The first of its kind, this conference was the start of a now widely distributed network of expertise and support from the Army, the Air Force, and the Navy. The ultimate goal of the conference was to bring to the forefront issues regarding personnel, training, and equipment.

Geologists and hydrogeologists from the U.S. Army Corps of Engineers Technical Engineering Center provided several excellent courses of study for drillers and their support personnel. In addition, valuable planning and advice was provided by the Maneuver Support Center, the U.S. Army Reserve Command, and the Naval Construction Training Center. As a result of the conference, and through help from the U.S. Army Engineer School, well drillers from all services now have online resources where they can study, share ideas, and ultimately bring themselves onto the theatre commander's radar screen as an invaluable asset. The Web site is *http://www.wood.army.mil/warrior/Well.htm*.

Water-Well-Drilling Units and Missions

Army

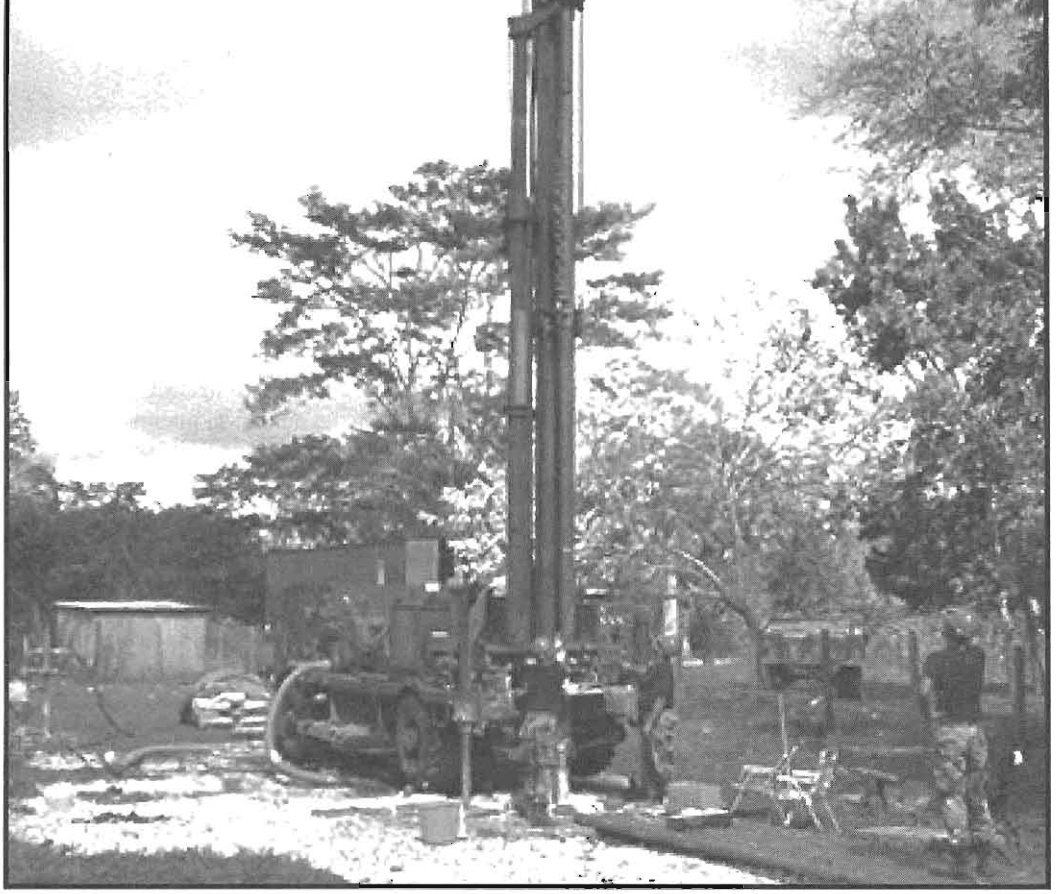
Drilling Detachments		Missions		
Unit/Location	Branch	Past	Present	Future
38th Engineer Detachment Fort Bragg, North Carolina	AC	Haiti; Panama; Fort Bliss, Texas; North Carolina	Guatemala	To be determined
247th Engineer Detachment New London, Connecticut	ARNG	Stones Ranch Military Reservation, Connecticut; Honduras	Stones Ranch Military Reservation, Connecticut	Nicaragua
257th Engineer Detachment Phoenix, Arizona	ARNG	Honduras	California	Nicaragua
269th Engineer Detachment Live Oak, Florida	ARNG	Camp Blanding, Florida	Camp Blanding, Florida	Camp Blanding, Florida
322d Engineer Detachment Kings Mills, Ohio	USAR	El Salvador; Fort Gordon, Georgia	Fort McCoy, Wisconsin	El Salvador
328th Engineer Detachment Montgomery, Alabama	USAR	Organized TY01	MOSQ, ASI C3; North Dakota	Belize
334th Engineer Detachment Montgomery, Alabama	USAR	Organized TY01	MOSQ, ASI C3; North Dakota	Belize
425th Engineer Detachment San Antonio, Texas	USAR	Pine Ridge Indian Reservation, South Dakota	Guatemala	El Salvador (tentative)
484th Engineer Detachment Montgomery, Alabama	USAR	Organized TY01	MOSQ, ASI C3; North Dakota	Belize
747th Engineer Detachment Missoula, Montana	USAR	Guatemala	Camp Grafton, North Dakota	ASI C3/ Central America (tentative)
775th Engineer Detachment Jackson, Tennessee	ARNG	Tennessee/California/ Kentucky; Honduras	Campo, California	Camp Shelby, Mississippi
916th Engineer Detachment Bismarck, North Dakota	USAR	Guatemala; El Salvador	Camp Grafton, North Dakota	ASI C3/ Central America (tentative)

Air Force

Drilling Detachments		Missions		
Unit/Location	Branch	Past	Present	Future
307th RED HORSE, Detachment 1 Barksdale AFB, Louisiana	AF-RC	El Salvador; Guatemala; Panama; Rosebud Indian Reservation, South Dakota; Haiti; Belize; Honduras; Texas	Gillis Long Facility, Carville, Louisiana	To be determined
307th RED HORSE Kelly AFB, Texas	AF-RC	El Salvador; Guatemala; Panama; Rosebud Indian Reservation, South Dakota; Haiti; Belize; Honduras; Texas	Gillis Long Facility, Carville, Louisiana	To be determined
819th RED HORSE Malmstrom AFB, Montana	AF-RC	Bolivia	Nebraska; Malmstrom Missile Field, Montana	Colorado
820th RED HORSE Nellis AFB, Nevada	AF-RC	Peru; Nicaragua; Korea; Belize; Nellis AFB Range	Guatemala; Nellis AFB Range	Europe; Nellis AFB Range
823d RED HORSE Hurlburt Field, Florida	AF-RC	El Salvador; Nicaragua; Panama; Haiti	Paraguay; Jamaica	El Salvador

Navy

Drilling Teams	Missions		
Unit/Location	Past	Present	Future
3d Naval Construction Battalion, 31st Naval Construction Regiment, Port Hueneme, California	Haiti; Jamaica; El Salvador; Thailand; Honduras; Crete	Sasebo; Japan; Indonesia; Bosnia; Jamaica	To be determined
2d Naval Construction Battalion, 20th Naval Construction Regiment, Gulfport, Mississippi	Souda Bay, Crete; Guatemala; Honduras, Jamaica	Bosnia	El Salvador



Soldiers from the 820th RED HORSE use a Navy ITWD drill at Porvenir, in Guatemala, during New Horizons 2000.

One issue discussed at the conference was the military's need for a new drilling rig that is self-contained and skid-mounted, with support and completion modules. The support or "tender" module should contain or transport all necessary tools, bits, pumps, casings, and drilling-support tools. The completion module should support mud, air, or percussion drilling, to include power-generation and air-compressor capacity for drilling 1,500 to1,800 feet. The separate major components should be portable, air transportable, and easily assembled or disassembled. When downloaded and assembled at a drilling site, the major components should be capable of completing or sealing a well without the need for external support. Drilling rigs produce wells despite sedimentary, metamorphic, and igneous rock. Casings and screens make it possible to produce well water despite loam, clay, and sandy soils. Currently, there is no command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) information-exchange requirement associated with well-drilling rigs.

A Valuable Asset

Well-drilling units are a valuable asset—both at home and abroad. To increase the value added of the engineer role as well drillers, leaders at all levels need to consider the following:

- Development of equipment supporting mobility constraints.
- Mobile training that supports the geographic dispersion of soldiers across the entire RC force.
- Lack of knowledge regarding bills of materials and geological data necessary for water-well drilling.

One Army engineer officer involved with well drilling in New Horizons 2001-Guatemala said about drillers: "The people in this region of the world can build structures well enough, but they cannot approach the long-term, quality-of-life improvement provided by U.S. military well drillers. In this area, as in most, water is life."

Captain Scarbrough is an active-duty project engineer for the 416th Engineer Command, Darien, Illinois. Previously the 416th's public affairs officer, he is the point of contact for issues on military water wells, alternative construction technology, theatre construction-management systems, and training management.

Captain Lang is an active-duty assistant S3 and well-drilling subject-matter expert for the 439th Engineer Battalion, Bismarck, North Dakota. Previously the 439th's S6 officer, she is also the point of contact for issues on military water wells.

References:

1. Field Manual 5-484, *Multiservice Procedures for Well-Drilling Operations*, 8 March 1994.

2. Charlie Brown, U.S. Army Corps of Engineers Mobile District.

3. Laura Waite, U.S. Army Corps of Engineers Mobile District.

4. Jim Smith, Maneuver Support Center, Fort Leonard Wood, Missouri, *ORD for Well Drilling ACAT IV*, dated 21 February 2001.

The MANSCEN Construct

By Mark T. Premont

Overview

The Maneuver Support Center (MANSCEN) has been officially activated since 1 October 1999, and the organizational design is proving to be a workable structure. The design is different from the typical U.S. Army Training and Doctrine Command (TRADOC) school organization because it not only places more than one school on the same installation, but those schools also share some organizational structure in a grid matrix management arrangement. This structure yields some unique opportunities and poses some interesting challenges. The dynamics of this restructuring will take years to fully unfold and develop, but the key characteristics are evident today. Like every new organizational structure, it is a work in progress. The structure is sound, in full operation, and learning new efficiencies every day. The organization is more complex in its conceptional form than many typical military organizations because the chain of command and the chain of responsibility are not aligned as simply as many tactical units. They are, however, set to provide the best capability with the least overhead.

The Genesis of MANSCEN

To understand MANSCEN, you must know how its organizational structure developed. The organization is the direct result of the Base Realignment and Closure (BRAC) Act of 1995. Through legislation, Congress approved the BRAC Commission's recommendation to close Fort McClellan, Alabama, and relocate the Chemical and Military Police (MP) Schools to Fort Leonard Wood, Missouri. Fort Leonard Wood was a somewhat typical TRADOC installation with one school—Engineer; a basic-training brigade; the Non-commissioned Officer Academy (NCOA) with the Drill Sergeant School (DSS); an advanced individual training course—Motor Transport Operator Course (driver's training)—from the Transportation School; affiliated courses for the Marines, Air Force, and Navy; several U.S. Army Forces Command units; and the usual support units that are typical on U.S. military installations.

Once the BRAC decision was official, serious discussion took place on how to organize once the Chemical and MP Schools moved to Fort Leonard Wood. The spectrum ranged from each of the three schools being totally independent with no shared resources to the full integration of the Chemical, Engineer, and MP schools into one large school, sharing all resources. The totally independent end of the spectrum was too costly in personnel. Even at Fort McClellan, the Chemical and MP Schools had shared one training brigade. The full integration end did not allow the schools to maintain and foster their own branch identity. Therefore, a careful study was made to determine which areas could be shared without significantly affecting the branch-identity aspect of school regimental operations. Another consideration was that each school's commandant was chartered as the proponent for his or her branch area of expertise. The new organization had to facilitate the commandants carrying out their proponent responsibilities. The decision was to create the organization as shown in the figure.

The Organization of MANSCEN

The commander of MANSCEN, a major general billet, is also the installation commander and the Engineer School Commandant. The Engineer brigadier general billet remained the Engineer School Assistant Commandant. Two traditional Reserve Component brigadier general billets were added to the MANSCEN command group, one for the Army Reserve and one for the Army National Guard. The MANSCEN Command Sergeant Major completes the command group.

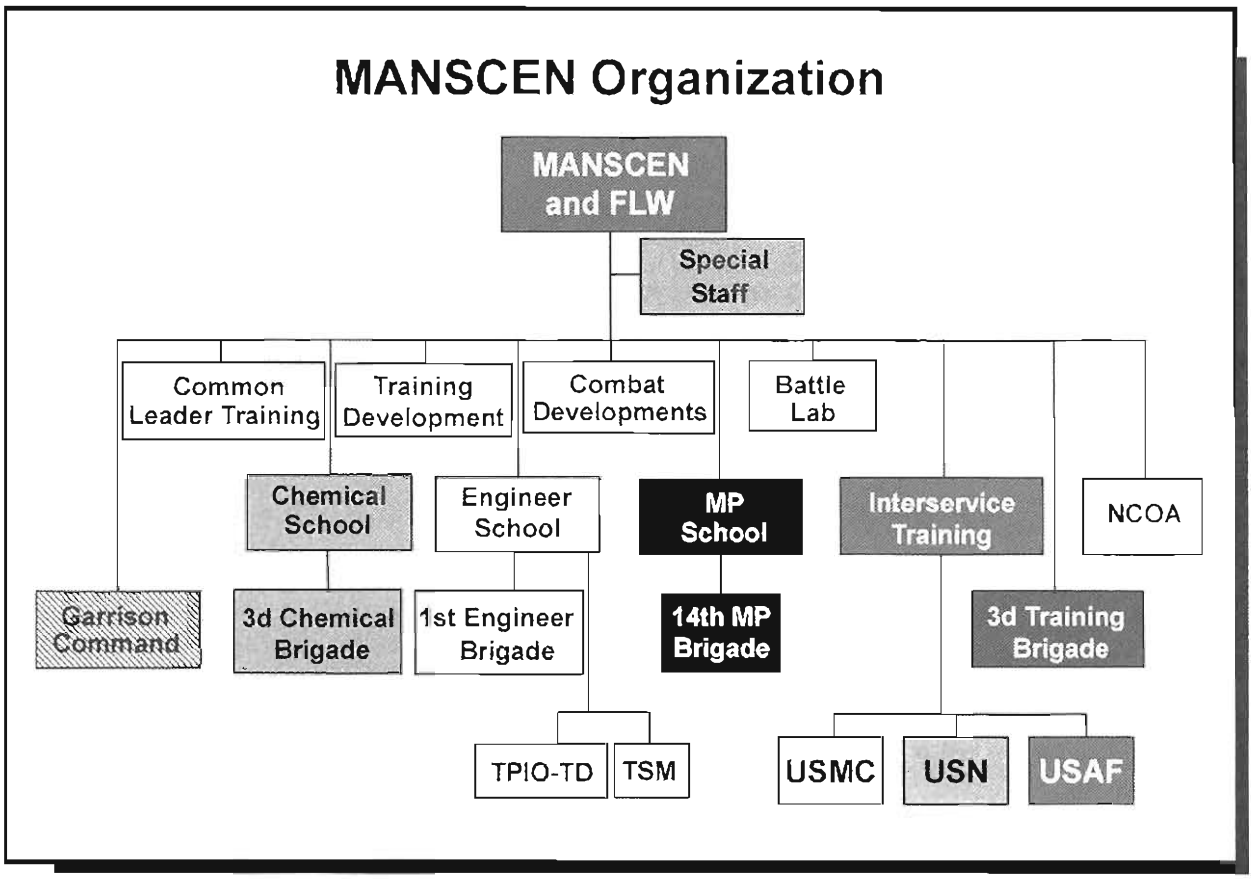
The MANSCEN staff organizations share responsibility with all three schools. Each of these organizations reports to the MANSCEN commander but has responsibilities to each of the school commandants for execution of its mission. The NCO Academy expanded to conduct the Noncommissioned Officer Education System for all three branches. Each school has its own training brigade. The interservice training presence increased; the Marine Corps presence grew to be the largest Marine Corps unit not on a Marine base, and the Air Force presence grew to be the largest Air Force unit not on an Air Force Base.

The Shared Organizations

Directorate of Common Leader Training (DCLT)

DCLT is responsible for MANSCEN-level instruction and instructional support. It—

- Teaches the common-core and shared tactical instruction to the officer and warrant officer professional development courses for the three schools.
- Operates the Single-Channel Ground-to-Air Radio System Communications Lab and the Fire Support Center as well as the Training Technology and Information Center.
- Manages the installation's library program, which includes the academic and community libraries.



- Conducts the Interservice Staff and Faculty Development Program, which certifies the instructors for the installation.
- Owns the Battle Simulation Center, which supports all constructive training simulations within MANSCEN and the Reserve Component, regionally.

Directorate of Training Development (DOTD)

DOTD develops training products and provides editorial support of doctrinal products for the three MANSCEN schools. It has four departments: Warrior, WARMOD, Warfighter, and Development Support.

- Warrior (Individual Training) develops and maintains the commandants' training strategies and provides analysis, design, and development of technically and doctrinally correct instructional courses and support materials for resident, nonresident, and distance-learning initiatives.
- WARMOD synchronizes and links Army modernization training with chemical, engineer, and MP force modernization. This includes ensuring development and procurement of system Training Support Packages concurrently with the materiel system.
- Warfighter (Collective Training) programs, manages, analyzes, and develops proponent unit/collective training products and training-support products; coordinates proponent Standards in Training Commission; and interfaces with internal and external organizations to ensure integration into the collective-training efforts for accuracy and completeness of products.
- Development Support provides technical and administrative services, support, and guidance on development of all MANSCEN and service schools' training and doctrinal products, including contractor-produced publications. It develops and assists other training developers with TRADOC-funded and contingency-based multimedia products—including instructors in their multimedia efforts—by assisting with embedded multimedia elements, to include recording and editing audio/video into various formats and delivery methods. This department also produces official publications and bulletins for worldwide distribution.

Directorate of Combat Developments (DCD)

DCD serves as the architect of the future for the MANSCEN schools. It—

- Integrates all combat-developments activities for the three schools not specifically assigned elsewhere. In this capacity, DCD develops operational concepts, validates operational-capability requirements, conducts the systemic analysis of requirements, and carries out all organizational development and force-design processes and materiel-development processes, including life-cycle management.
- Develops and defends modernization strategies and plans and integrates the budget process for the President's Objective Memorandum.

- Conducts modeling, simulations, and analysis for all MANSCEN organizations, including developing modeling and simulations requirements.
- Conducts ground-robotics test-bed activities to assess technology for the three schools.

Maneuver Support Battle Lab

The Battle Lab was the first shared organization formed in the stand-up of MANSCEN and is led by the MANSCEN commander. It tests and verifies, through experimentation, all aspects of doctrine, training, and organization for the three schools and works closely with DCD and DOTD in support of the schools.

Noncommissioned Officers Academy

This organization includes NCOA and DSS. The MANSCEN NCOA/DSS is the Army's largest NCO academy. It trains and educates selected NCOs to become effective leaders, trainers, role models, standard bearers, and drill sergeants. The academy is responsible for training soldiers for the three MANSCEN schools. Instruction includes basic and advanced NCO courses. The academy also trains a variety of different military occupational specialties (MOSs) in the Primary Leadership Development Course.

The DSS conducts a Drill Sergeant Preparation Course for all drill sergeant candidates assigned to Fort Leonard Wood, and it trains soldiers in a variety of MOSs to become drill sergeants. It also trains selected leaders, support cadre, and installation staff and contractors—who work in the initial-entry-training environment—in three different courses through its Initial Entry Cadre Training Course.

Summary

MANSCEN is still developing, but it has already demonstrated the power and efficiency that can be gained by integrating three related branches into one organization, each providing unique proponency capabilities, while sharing common ground across the doctrine, training, leader development, organization, materiel, and soldiers (DTLOMS) spectrum. MANSCEN proves that a single installation can support three Army branch schools, maintain the vitality of each school, yet achieve synergy among them where common issues and concepts exist. This design could be a model for the way TRADOC will reorganize through its own transformation effort.

Mr. Premont is the executive officer in the Strategic Planning, Analysis and Realignment Office at Fort Leonard Wood, Missouri. Previously, he was the deputy director in the Base Realignment and Closure Office at Fort Leonard Wood. He has a bachelor's from the U. S. Military Academy and a master's from the University of Missouri-Rolla and is a graduate of the U.S. Army Command and General Staff College.

Today's Engineer School

By Brigadier General Ronald L. Johnson

Change has become a way of life with the Army, the training community, and your Engineer School. In 1989, the Engineer School moved to Fort Leonard Wood, Missouri; in 1995, we began planning to receive two other schools. On 1 October 1999, the Maneuver Support Center (MANSCEN) and Fort Leonard Wood replaced the Engineer Center and Fort Leonard Wood. However, amid these changes, we continue to contribute to the evolution occurring in the Army, seek to influence TRADOC's planning for transformation among the schools, and produce concepts and products for the Engineer Regiment.

With all these things going on, and the fact that we have now been operating under the MANSCEN umbrella for nearly 2 years, we believe it is time to pause and give you an overview of what we look like now and how we are going about doing your business—the business of the Engineer School.

Essentially, the processes by which we produce concepts, materiel, organizations, doctrine, training, and soldiers have not changed. Many of the same people who were working within the Engineer School 2 years ago continue working to produce the same types of engineer products. However, some of these people now work within MANSCEN directorates.

The Engineer School has benefited from MANSCEN in a number of ways. We have access to advanced classrooms and computer labs and new and improved training facilities. We have learned some new processes and business practices from the staff of the Military Police and Chemical Schools. We believe our influence as a Branch has not been diminished; MANSCEN can serve as an amplifier of the Engineer School's requirements.

Undoubtedly, for those of us who work here, communication and lines of authority are a bit more complex than when we were a "stand-alone" school. However, we aspire to keep those things invisible to you and provide the same quality and quantity of products as were produced when the Engineer School was the "only kid on the block." As is pointed out in the closing paragraph of the following article, we still have great engineer people doing the work of the Engineer Regiment.

Brigadier General Johnson, former Assistant Commandant, U.S. Army Engineer School, is now commander of the Pacific Ocean Division, U.S. Army Corps of Engineers, Fort Shafter, Hawaii.

How the Engineer School Runs

By Jim Evans

NOTE: Recommend that you read "The MANSCEN Construct," on page 10, before reading this article.

Overview

If you read the above noted article, you should understand that the U.S. Army Engineer School is not an autonomous entity. It falls under the U.S. Army Training and Doctrine Command (TRADOC) and the Maneuver Support Center (MANSCEN) umbrellas. Thus, the Engineer School must strive to satisfy the needs of the Engineer Regiment through the funding and administrative procedures that TRADOC provides. It must also conduct its activities and produce doctrine, training, leader, organization, materiel, and soldier (DTLOMS) developmental products by relying on a combination of its internal resources and the resources available through MANSCEN.

The MANSCEN commanding general provides command and control for the Chemical, Military Police (MP), and Engineer Schools and Fort Leonard Wood. (He is dual-hatted as the Engineer School commandant.) The school commandants have direct responsibility over their branch-specific DTLOMS functions. Creating MANSCEN consolidated many functions which were previously embedded within each of the three schools. However, doctrine development, branch-specific training, and branch-specific personnel development continue to reside within the schools.

Branch personnel responsible for much of the "heavy lifting" of developing systems, developing training, and designing organizations were consolidated into MANSCEN organizations, but each of the three schools retains the responsibility for providing strategic direction and the right to approve or disapprove branch-specific actions. Before the beginning of each fiscal year, the "heavy lifters" propose a laundry list of activities they believe should be accomplished the following fiscal year. The school leadership reviews, refines, and approves the list. As the year progresses, the leadership may direct a reordering of priorities.

Inside the Engineer School

The figure on page 14 is a visual representation of the school's organization. The school's mission is to develop, train, and support the engineer force to provide maneuver engineering, force-support engineering, and geospatial engineering to Army, joint, interagency, and combined operations.

Commandant

The commandant is the engineer proponent. Proponency includes the following:

- Providing quality engineer-specific training.
- Developing leaders qualified to ensure mission achievement.
- Designing engineer organizations consistent with the Army's needs.
- Identifying and articulating engineer materiel requirements.
- Ensuring the recruitment and retention of engineer soldiers of the quality and quantity required by the Engineer Branch.

Assistant Commandant (AC)

The AC directs the operation of the school and exercises command and general supervision over all elements—listed below—assigned or attached to the school:

- Branch Staff.
- Directorate of Training (DOT).
- 1st Engineer Brigade.
- TRADOC System Manager (TSM)–Engineer Combat Systems (ECS).
- TRADOC Program Integration Office–Terrain Data (TPIO-TD).
- Directorate of Environmental Integration (DOEI).

Command Sergeant Major (CSM)

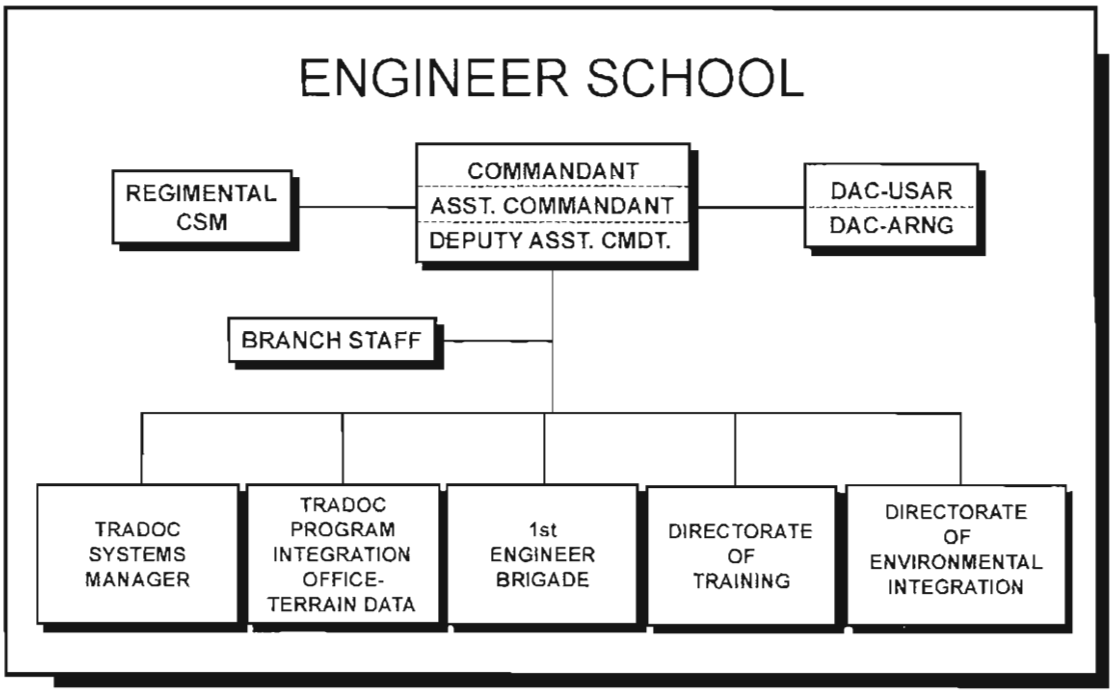
The school CSM is also the Regimental CSM. He serves as the principal enlisted assistant and advisor to the AC on all enlisted matters and manages the enlisted personnel within the school. He has direct oversight of engineer noncommissioned-officer (NCO) courses taught at the MANSCEN NCO Academy.

Deputy Assistant Commandant (DAC)

The DAC serves as the senior technical adviser to the commandant on engineer concepts, force structure, and materiel. He formulates policies, plans, and recommendations for administration of the Engineer School. He assists the AC and acts in the AC's absence.

Deputy Assistant Commandants—U.S. Army Reserve (USAR) and Army National Guard (ARNG)

The DAC-USAR and the DAC-ARNG oversee total-force integration. They ensure that Reserve Component (RC) needs are addressed by the schools and MANSCEN and participate in developing policies, plans, and programs influencing RC matters. They review engineer training and doctrinal materials for RC applicability and adequacy and assist in verifying training materials with RC units. They provide liaison among the Engineer School and TRADOC, the Combined Arms Center, the Chief of Army Reserves, the Army Reserve Personnel Center, the National Guard Bureau, the U.S. Army Reserve Command, the U.S. Forces Command, and RC units. They advise



active duty officers separating from service about RC programs and requirements, provide instruction on the roles and missions of the RC to classes conducted at the Engineer School, and advise Reserve students attending training.

DTLOMS Integration Board

This board provides oversight of the commandant's responsibilities as branch proponent. The board consists of the AC (chair); the DAC; the DAC-USAR; the DAC-ARNG; the Director of Training; the Commander, 1st Engineer Brigade; the TSM; the TPIO-TD; and the chief of the engineer division, Directorate of Combat Developments (DCD). The Engineer School chief of staff facilitates the board activities. The board—

- Integrates Regimental activities across DTLOMS.
- Provides leadership and guidance on—
  - Master training calendars for the Engineer School.
  - Engineer concepts.
  - Engineer doctrinal changes.
  - Priorities within the engineer 1-N list of equipment.
  - Major changes in training strategies.
  - Organizational changes.
  - Priorities within the Concept Examination Program, warfighting-lens analysis, and other processes.
  - Personnel-management policies.

Branch Staff

The chief of staff directs the actions of the branch staff and acts as executive officer for the AC. He provides taskings to entities inside and outside the school and acts as operations officer and G3 for the school. He monitors Engineer School resources and works in coordination with the Directorate of Resource Management to manage resources. His oversight includes the Operations Office, History Office, and Engineer Museum.

Operations Office. This office coordinates the school's administrative functions and advises the leadership on personnel, administrative, and policy matters. The staff serves as the school's interface with MANSCEN agencies, including the Public Affairs Office; the Directorate of Resource Management; the Directorate of Public Works; the Directorate of Information Management; and the Directorate of Plans, Training, and Mobilization. This office is the primary liaison between post protocol and the Engineer School for all visitors, foreign and domestic.

History Office. The Engineer Branch historian serves as the proponent for historical activities of the Engineer Branch and acts as the point of reference for the history of the branch. He advises the commandant on Army and TRADOC historical-program responsibilities and represents the commandant on matters relating to military history. The historian prepares periodic documented histories of the Engineer Branch dealing with significant mission-related activities. He develops and administers the historical source-document collection, including significant, unique, and rare printed and nonprinted material, as the corporate memory of the branch. He serves as a consultant and adviser for inclusion of military history into the curricula.

Engineer Museum. The director of the Engineer Museum strives to foster an appreciation for the history and tradition of the Corps of Engineers, Fort Leonard Wood, and the U.S. Army. He collects, preserves, documents, exhibits, and interprets

objects of historical interest pertaining to the history of U.S. Army Engineers, from 1775 to the present. He develops and conducts historical education and training programs for initial-entry-training soldiers, students, and permanent-party military personnel. He works with the museum counsel to collect, preserve, document, exhibit, and interpret objects of historical interest pertaining to the history of Fort Leonard Wood, from 1940 to the present.

Directorate of Training

The Director of Training manages and provides overall administrative services for engineer training, training and doctrine development, countermine training, humanitarian-demining training, and the engineer portion of the Armywide Doctrinal and Training Literature Program.

Following the director's lead, the DOT staff and the engineer personnel within the MANSCEN's Directorate of Training Development (DOTD) plan the engineer training strategy, develop leader and soldier training, and pursue Army Training XXI initiatives. The director serves as the course director for engineer officer courses and also serves as liaison with the DOTs of the MP and Chemical Schools. The director provides oversight to two relatively new entities—the Countermine Training Support Center and Humanitarian Demining Training Center. He leads the development and revision of engineer doctrine. He ensures the right quantity and quality of engineer soldiers through the Engineer Personnel Proponency Office and directs evaluation of training through The Army School System Division. Finally, he monitors the progress of workload accomplishment as outlined at the beginning of each fiscal year regarding the following actions. He directs corrective action relative to these actions or recommends required adjustments to the AC.

- Engineer training development.
- Engineer doctrine development.
- Engineer personnel proponency.
- Engineer training evaluations.
- Engineer officer training.
- Countermine and humanitarian-demining initiatives.
- Environmental training and doctrine development.

1st Engineer Brigade

The 1st Engineer Brigade consists of one U.S. Army Forces Command (FORSCOM) combat engineer battalion—the 5th Engineer Battalion (C) (M)—three TRADOC training battalions—the 35th Engineer Battalion (one-station unit training [OSUT]), the 169th Engineer Battalion (advanced individual training [AIT]), the 554th Engineer Battalion (the Engineer Officer Basic Course [EOBC], the Engineer Captain's Career Course [ECCC], and the warrant officer courses)—and one training support battalion—the 577th Engineer Battalion.

The brigade's formal mission is as follows: The 1st Engineer Brigade trains values-based and combat-ready soldiers, sailors, airmen, marines, leaders, and units for war. On order, it supports Reserve Component units, writes doctrine, and develops training concepts to support operations on all future battlefields. It is prepared to support contingencies, mobilizations, disaster plans, and to provide subject-matter experts worldwide.

The brigade trains AIT and OSUT soldiers in a variety of military occupational specialties—combat engineers, heavy-construction engineer-equipment operators, crane operators, engineer tracked-vehicle crewmen, carpentry and masonry specialists, divers, technical-engineering specialists, and engineer-equipment repairers. Depending on the specialty, soldiers can learn skills such as electrical wiring, surveying, computer-aided design, landmine warfare, combat-vehicle operation, and demolitions. Similarities in specific fundamental training within the Army, Air Force, Marines, and Navy allow students from all the services to train within the brigade.

The brigade is also responsible for teaching EOBC, ECCC, the warrant officer courses, and the highly demanding Sapper Leader Course. The EOBC focuses on preparing lieutenants to be platoon leaders, and the ECCC focuses on preparing captains for company command. The 28-day Sapper Leader Course focuses on small-unit leadership for combat engineers companies.

TRADOC System Manager (TSM)–Engineer Combat Systems

The TRADOC commander assigns systems managers to high-priority research-and-development projects and stations them at the proponent schools. Our TSM has responsibility for the Grizzly, Wolverine, Hornet, Raptor, Mongoose, and Standoff Minefield Detection System. He represents the Engineer School and the engineer soldier at all levels for system development, testing, and fielding, as assigned. He is the principal TRADOC/Engineer School interface with materiel developers, ensuring integration of doctrine, training, organizational concepts, and materiel requirements (logistics, training, leader development, soldier issues, and MANPRINT) on systems as assigned. He also sustains a close working relationship between TRADOC, the Engineer School, and partners in industry.

TRADOC Program Integration Office–Terrain Data (TPIO-TD)

TPIO-TD is the Army's centralized manager for coordinating and synchronizing all Army digital terrain-data requirements and for digital force development and training, experimentation, combat developments, training, and modeling and simulation. It also integrates terrain-data and geospatial engineering requirements for live, virtual, and constructive modeling and simulation for the training, exercises, and military operations; advanced concepts and requirements; and research, development, and acquisition domains.

The Terrain Visualization Center (TVC) director is subordinate to TPIO-TD and serves as the TRADOC proponent for geospatial information and services (GI&S). He supports the TPIO-TD on GI&S issues as the TRADOC representative on the Army Topographic Engineering Coordinating Committee. He and his staff provide services to a variety of entities at MANSCEN-and-above levels.

Directorate of Environmental Integration (DEI)

Through its DEI, the Engineer School serves as the Army proponent for the development, integration, and evaluation of environmental considerations into and across the domains of doctrine, training (military and civilian), leader development (military and civilian), organizational design, materiel development requirements, and soldier/civilian support. The DOEI was recently created to address this mission. It consists of three divisions: (1)Evaluation, Standardization and Synchronization Division; (2)Doctrine, Organizational Design and Materiel Development Division; and (3)Training, Leader Development and Soldier/Civilian Support Division.

School-Related MANSCEN Organizations

A variety of school-related MANSCEN organizations perform activities that serve all three schools:

- **DOTD** is responsible for the horizontal integration of training-development activities.
- **DCD** provides horizontal integration of combat-development activities.
- The **Maneuver Support Battle Lab** plans and conducts warfighting experiments related to maneuver support.
- The **Directorate of Common Leader Training** conducts all officer core training across the three schools. (Each school provides branch-unique officer training.) Course start dates are aligned so that this department can teach all common portions.
- The **NCO Academy** teaches NCO professional-development courses for all three MANSCEN branches. The commandant is a command sergeant major.

Summary

The Engineer School is a team of teams that provides the engineer doctrine, training, force structure, leader development, materiel requirements, and soldiers to meet the needs of the Army and warfighting CINCs today and in the future. It is a key member of the U.S. Army Maneuver Support Center team that addresses the maneuver support requirements of the Army as it lays the groundwork for transformation to the Objective Force.

Mr. Evans is the training-development-integration officer in the Directorate of Training at the U.S. Army Engineer School. He holds a master's in counseling from Central Missouri State University in Warrensburg, Missouri, and has completed postgraduate work in training technology.



Letter To The Editor

Facing the CSS Challenge

In the article "Facing the CSS Challenge" (May 2001 issue of *Engineer*), the authors concluded that the engineer support element (ESE) is insufficiently resourced and structured to adequately support the engineer battalion. I agree. To add to the argument, combined with the aging of the engineer fleet and the addition of the Wolverine to engineer battalions' modified table of organization and equipment, the ESEs cannot conduct recovery missions and maintain the fleet simultaneously. As experienced during recent field exercises and the division capstone exercise (DCX), recovery has become a full-time mission for the ESE. Also, those soldiers who man the recovery vehicles are too occupied to maintain the vehicles that they are supposed to support. When the vehicles cannot be fixed on-site, they need to be recovered. This results in a backlog of equipment at the unit maintenance-collection points that does not get repaired since the maintainers are still recovering other vehicles. Clearly, there was risk accepted in the ESE design by giving these soldiers dual responsibility, but risk has negatively affected the engineer battalion's ability to perform its mission. To support the engineer battalion, the ESE needs to be redesigned so that recovery and maintenance can occur simultaneously.

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Engineer School's Reply

Thank you for your comments. During the DCX, the engineer and the Combined Arms Support Command (CASCOM) units, as well as observers, agreed that there were significant problems with the ESE's ability to provide adequate battalions. It received official recognition as an issue to be resolved during the 4th Infantry Division's documentation action review team (DART) conference at Fort Hood, Texas, 21 to 24 May 2001. As a result of this status, TRADOC has directed the Engineer School and CASCOM to answer the following questions:

- *What is the minimum number of personnel required to support the engineer battalion—in terms of manpower requirements criteria?*
- *What is the correct structure for these personnel—platoon, section, or company?*
- *Who should the parent unit be—forward support battalion or engineer battalion?*

When these questions are answered, then the process to change the current design can proceed and a methodology to pay for any increases in personnel can be determined. The Engineer School and CASCOM have started the process of working together to answer TRADOC's questions.

Mr. Garry N. Hamlet
Force Documentation Analyst

Improving Soldier Performance With the AN/PSS-12

By Dr. Alan Davison, Dr. Jim Staszewski, and Mr. Glenn Boxley

Note: The information contained in this article does not represent a change to TM 5-6665-298-10, Operator's Manual for the AN/PSS-12 Mine Detecting Set. *The article provides some advanced techniques and training strategies that are now being included in the MOS 12B10 One-Station Unit Training Course at Fort Leonard Wood, Missouri.*

Formal tests over the last decade indicate that American soldiers using the AN/PSS-12 handheld mine detector and Army-approved techniques consistently find less than 20 percent of low-metal mines.[1,2,3,4] Too often this poor performance is rationalized by assuming that the detector itself is just not capable of detecting low-metal mines. Yet, at the same time, professional, commercial, civilian deminers throughout the world are using the same detector and have safely lifted thousands of mines. Because of this great difference in performance between soldiers and professional deminers, we set out to learn what different techniques the experts were using. We wanted to learn if these techniques could be taught in a practical amount of time to improve the detection capabilities of our soldiers so they could apply them to countermine missions. Most importantly, we wanted to know if our soldiers could approach the performance levels of professionals if taught their techniques.

A Comparison

The Army Research Laboratory, Human Research and Engineering Directorate Field Element, Fort Leonard Wood, Missouri, and Carnegie Mellon University, Pittsburgh, Pennsylvania, collaborated to investigate this problem. The science of cognitive engineering was first used to essentially get into the minds of professional deminers to learn how they detect mines. Their techniques and thought processes were then translated into procedures and drills that we believed would provide an efficient training program for soldiers. A training and test site was developed at Fort Leonard Wood, where an experiment was conducted to test the practicality and effectiveness of training soldiers to use the professional techniques. A second part of the experiment was an additional test of the same soldiers at Aberdeen Proving Ground, Maryland.

Initially, engineer soldiers were given a 1-hour refresher course by NCOs on standard Army techniques and were then tested using those techniques. They found less than 15 percent of the low-metal antipersonnel M14 mine simulants. They were then given 15 hours of instruction on the professional techniques and were retested. Their performance improved to a detection rate of 87 percent against the M14 mine simulants. The soldiers were then tested at Aberdeen Proving Ground against real mines that had been made safe without influencing their detection signature. In this test, the soldiers found 100 percent of the M14 mines.[5]

Some may wonder why a comparison was made between soldiers' performance following 1 hour of refresher training and 15 hours of training on expert techniques. When an AN/PSS-12, using standard Army techniques, is passed over a low-metal mine (or even held over one) that is buried at a doctrinally supported depth, the detector provides no warning tone that a mine is present. Thus, no amount of training using standard Army techniques could significantly improve performance.

This article describes the professional techniques that have been shown to dramatically improve soldiers' ability to find low-metal mines while using the AN/PSS-12. It also provides guidance on teaching the skills needed to use the techniques. Although our focus was on teaching soldiers better ways to find low-metal mines, these techniques are also applicable to the much easier to detect high-metal mines.

Professionals use the AN/PSS-12, and information gained from it, much differently than we have been teaching our soldiers.[6,7] Before going into a mined area, professionals learn what mines they can expect to encounter and develop a mental catalog of information describing the characteristics of these mines. From experience and knowledge, they understand the type of information—relating to the strength of signals and the size of their signatures or "footprints"—the detector provides to identify different types of mines. Then, during actual detection work, professionals use the AN/PSS-12 to develop the spatial image of the footprint they detect and then match the footprint obtained to the known footprints of mines. A match leads to a mine declaration. The procedures take some training but, in a few hours, soldiers can develop skills far beyond those currently being taught.

Note: A warning tone should ALWAYS be considered to be a mine until the operator has developed the detecting skills that enable him to be certain that it is definitely NOT a mine. This is no place to be playing guessing games. No matter what the level of operator skill, if in doubt, call it a mine.

Techniques

Soldiers must understand the basic capabilities and limitations of the AN/PSS-12 to be able to properly employ it. The detector emits a magnetic field symmetrically

above and below the detector head. When this field encounters metal objects, it induces currents in these objects. The larger the metal objects, the stronger the induced currents, and thus the greater distance at which the receiver component of the detector can pick up the induced currents. In practical terms, this means that the detector is able to detect high-metal mines from a distance of several feet, but low-metal mines can be detected from only a few inches (see Figure 1). If the detector head is not swept very close to a low-metal mine, the mine will not be detected.

Physical Setup

The AN/PSS-12 in the Army inventory is referred to by the manufacturer as an AN/PSS-12 Mod 2. Some design limitations of this model require that precautions be taken in the physical setup of the detector to get the best performance. The detector shaft is a telescoping pole composed of two pieces; the bottom piece is plastic and the top piece is aluminum. The cable that connects the head to the electronics unit is attached to the shaft with plastic clips. The first clip should be placed at the base of the shaft with a small loop in the cable between the detector head and the first clip. This allows some flexibility in movement of the head without damaging the connection of the cable to the head. Additional clips should then be placed along the plastic portion of the shaft to hold the cable away from the shaft. The top clip should be placed at the uppermost portion of the plastic section of the shaft. The cable should not be attached to the aluminum portion of the shaft because it may cause sensitivity to fluctuate.

The electronics unit is designed to either attach to a web belt or be slung over the shoulder using the shoulder strap. We recommend that the electronics unit be attached to the web belt so it will swing less. We also recommend that the cable length between the shaft and the electronics unit be held in the hand that is not operating the detector. If the cable is swinging around, it can hurt the detector's performance.

Initial Sensitivity Setting

Properly setting and maintaining the sensitivity of the detector is absolutely crucial to performance. Most soldiers adjust the sensitivity using the test piece provided in the kit. They hold the test piece so the metal component inside is 2 inches from the detector head, and then they adjust the sensitivity so they get a signal from the detector. This is a setup for failure! Once they put the detector in use, they sweep the head 2 or more inches above the ground. Thus buried low-metal mines are out of range of the electric field the detector was just set to detect, and there is virtually no chance of detecting a low-metal mine.

The test piece provided in the kit is an excellent device to hold near the detector head to determine if the detector is working properly. It should not be used to set the sensitivity by holding it in the air 2 inches from the detector head.

The sensitivity may be properly set in either of two ways. The best way is to have on hand the most difficult to detect type of mine that is expected to be encountered. Bury this mine at the deepest depth the threat is expected to have buried it. Place the detector head lightly on the ground directly above the mine, and then adjust the sensitivity so the mine can be detected with a clear warning tone.

As an alternative, if the threat mine described above is not available, bury the test piece vertically at the deepest depth the threat mine is expected to be encountered. (The depth of the metal component in the test piece is the critical issue.) Then place the detector head lightly on the ground just above the test piece, and set the sensitivity so that the test piece can be detected with a clear warning tone. Adjusting sensitivity with a mine or test piece buried in soil similar to where the detector will be used is very important. Otherwise, sensitivity setting is simply a guess. Different soil types and moisture content influence the sensitivity of the detector.

The process above describes the minimal sensitivity setting required. Anything less will result in missing a mine. If the soil allows, without producing a warning tone from the detector, the sensitivity may be set at higher levels. This theoretically yields a greater probability of detection at the cost of a higher false-alarm rate. The mission dictates the optimal setting of the sensitivity between just enough to detect the hardest to detect mine at the deepest depth to the highest setting the soil type will allow without generating a warning tone that could hide the tone indicating a mine. Due to time constraints, a tactical mission such as a combat breach may require a riskier, lower sensitivity setting. A higher sensitivity setting would be used during a non-time-constrained demining mission or clearing of a lodgement area or route.

Maintaining the Sensitivity Setting

A deficiency of the AN/PSS-12 Mod 2 is that its sensitivity drifts over time.[8] Professionals check the sensitivity frequently (nearly every

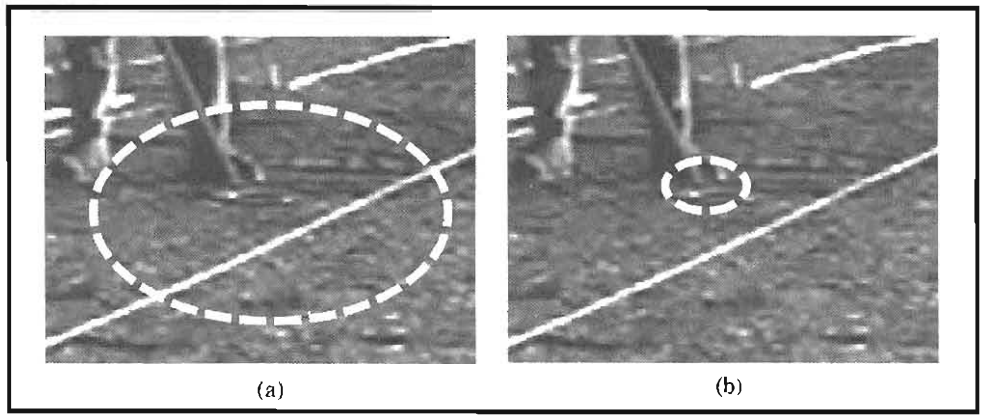


Figure 1. (a) The detector induces a large electrical field from a high-metal mine such as an M15 antitank mine or an M16 antipersonnel mine. (b) The detector induces a much smaller detectable field from a low-metal antipersonnel mine such as an M14.

0.5 meter of advance) and, if required, reset the sensitivity. During training, we taught soldiers to check their detectors' sensitivity every 1 to 2 meters of advance.

Setup for maintaining a consistent sensitivity level is made at the time of the initial setting. With the initial sensitivity properly set while using a buried mine or the buried test piece, the detector head is moved to a nearby place on the ground over a clear area. A metal object is then slid down the shaft of the detector until the operator hears the same warning tone that was emitted when the detector head was placed over the buried mine or test piece. At this point on the shaft, the soldier positions one of the plastic cable clips, which becomes the sensitivity marker clip. Now, after every 1 to 2 meters of advance in the mine lane, the soldier can simply move the same metal object down the shaft to the sensitivity marker clip and listen to see if the same warning tone is emitted. If the same tone is not emitted, the sensitivity knob can be adjusted up or down to replicate the desired signal. A useful metal object for maintaining the sensitivity is a common mason's trowel, which can serve other purposes when mine detection is ongoing (see Figure 2).

Sweep Techniques

As explained earlier, the electric field emitted by low-metal mines is very small—often less than the width of the detector head. Therefore, each sweep across the lane must overlap the previous sweep by about one-half the width of the detector head. Otherwise, a gap is left between sweep paths and a low-metal mine can be missed. Uneven sweep spacing was found to be a major problem, even among more experienced soldiers.

A training device developed by Dr. Herman Herman of Carnegie Mellon University recorded the movement of the detector head over the ground and played it back to soldiers so they could evaluate their own performance.[9] Any gaps in ground coverage were shown by the device, and soldiers could correct their sweeping flaws.

The movement rate of the detector head is also important. The operator's manual advocates a sweep rate of 1 meter per second.[10] However, if low-metal mines are the threat, this is too fast because the detector head can be swept directly over these mines without emitting a warning tone. The detector head should be swept no faster than about 1 foot per second.

Head height above the ground is the most important factor concerning sweep techniques. The operator's manual advocates sweeping with the head "not more than 2 inches above the ground."[11] The authors observed that soldiers sweep with the detector head a minimum of 2 inches above the ground and often—especially at the end of sweeps—swing the detector head much higher. These techniques ensure that low-metal mines are not detected. The detector head should be lightly floated on the ground surface. The closer the detector head is to the ground, the deeper the electrical field is projected and the greater chance there is to detect low-metal mines. Actual contact with the ground appears to improve the electrical coupling, thereby strengthening the electrical field.

Loosening the nut on the plastic bolt that attaches the detector head to the shaft makes it easier to maintain constant contact with the ground. This allows the head to pivot, and the head can then be lightly slid across the surface. The head essentially follows the variations in the surface. In low vegetation, a different technique is to keep the nut tight so the position between the head and shaft is fixed. Then, the detector head is lightly patted on the ground, each pat advancing no more than one-half the width of the detector head.

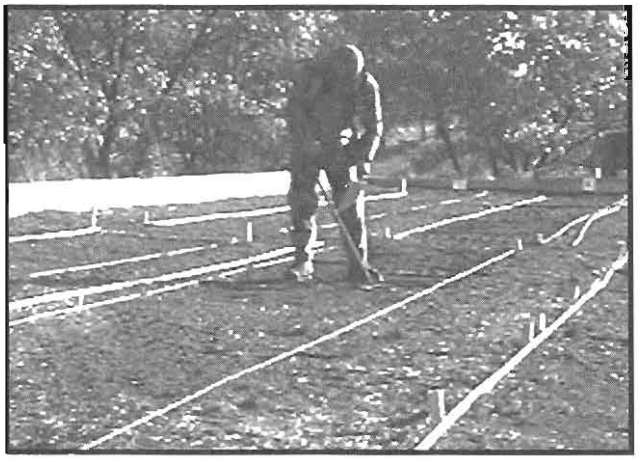


Figure 2. A soldier checks the sensitivity setting of the detector by feeling with a metal trowel for the edge of the electrical field. He is touching the tip of the trowel to the sensitivity marker clip.

In some instances, vegetation may prevent the detector head from getting on the ground. And we do not advocate pushing through vegetation to get the detector head on the ground. Different environments will require slightly different techniques, but the point is that if the detector head is not on or very near the surface of the ground, the detector is not going to help locate low-metal mines.

Practice

Just employing the proper techniques is not enough to successfully detect mines. As in developing any kind of skill, practice is required. And to support learning, a critical part of this practice is to provide soldiers with quick feedback on their performance. Our training program helped soldiers develop the skills of the experts by employing a series of drills, each building upon the other. Additionally, we found the process of mine detection to be one of precision. Failure to properly apply the techniques described accounted for most of the few mines missed during this research effort.

Edge-Detection Exercise

In this exercise, soldiers developed the fundamental technique to acquire patterns of information that signify buried mines. As mentioned earlier, professionals use the detector as a tool to develop a spatial image of the detected object in the ground. The soldiers were taken to specific locations where a mine simulant was buried. A plastic poker chip marker was placed on the ground directly above the mine simulant. Facing the poker chip mark from a predetermined orientation (each soldier was told to arbitrarily consider that the poker chip marking the mine was to his north), each operator would place the detector's sensor head on the ground in a 3 o'clock (east) orientation to the mark. Moving the head on a line perpendicular to the north-south line connecting the operator's center with the poker-chip mark, the soldier was to determine the point at which the detector sounded

off, while sweeping the head slowly in an east-west direction toward the mark. This position was marked with a small plastic golf-ball marker, and its distance to the target mark was measured and recorded by an observer (see Figure 3).

The type of mine was then revealed to the operator, as well as the distance measured from mine center to the "edge" mark determined by the operator. Each operator performed this exercise on five different encounters with each type of mine simulant (M14, PMA3, VS2.2, M15, and M16) for a total of 25 mine encounters.

Footprint-Development Exercise

This exercise introduced soldiers to the patterns or footprints that identify and locate buried mines. Soldiers repeated the previously described edge-detection technique from at least five different directions—for example, advancing the sensor head from different perimeter points (E, S, W, SE, SW) toward a target mark. For safety reasons, operators were told to move the head no closer toward the mine than was needed to establish an edge of the footprint. Each edge was to be marked, with all markers remaining in place until the task was completed. All center-to-edge distances were measured, recorded, and reported to the operators along with the identity of the buried target. Soldiers were instructed to describe the size and shape of each resulting pattern and compare and contrast the patterns obtained across trials. This helped develop a spatial image of the mine signature based on input from the detector. By familiarizing themselves with mine footprints, while also learning acquisition techniques, soldiers accumulated the knowledge needed to match footprints found later with those that identify mines and successfully find mines.

"Airborne" Technique Exercise

High-metal mines produce footprints that extend as far as 1 meter away from the mine's center. The purpose of the airborne technique is to locate the mine target within the extended footprint as accurately as possible and to avoid unplanned detonations caused by the sensor head contacting the prongs that trigger many high-metal antipersonnel mines (such as M16s or Valmara 69s). This technique involves fixing the sensor head so that it can be maintained in a position parallel to the ground surface while it is raised as high as 2 to 3 feet. By scanning the area within the footprint—and progressively increasing the height of the sensor head until small, upward or sideward, in-plane movements cause loss of signal from the AN/PSS-12—an operator can pinpoint the location of a buried mine by exploiting the tapered geometry of the detector's sensing field (see Figure 4).

Blind-Detection Exercise

After practicing the preceding techniques, soldiers engaged in a sequence of blind-detection tasks. Initially, these tasks began with each soldier being directed to a specific and bounded area to search. In each 1.5- by 1.5-meter cell, the task was to use the techniques taught to determine whether a mine was buried within the area's boundaries and, if so, to mark its location as accurately as possible. Soldiers received feedback on the accuracy of each detection before proceeding to the next cell. Each soldier then had the opportunity to resweep the area to familiarize himself with the target's footprint, especially if he missed the mine. After completing single-cell detection exercises, operators practiced blind search (with feedback) over progressively longer distances and time periods. The practice task progressed to cover 5-cell distances, then 10-cell distances, and finally an 18-meter test familiarization trial. Feedback on mine locations was provided on the conclusion of each soldier's training-lane sweep.

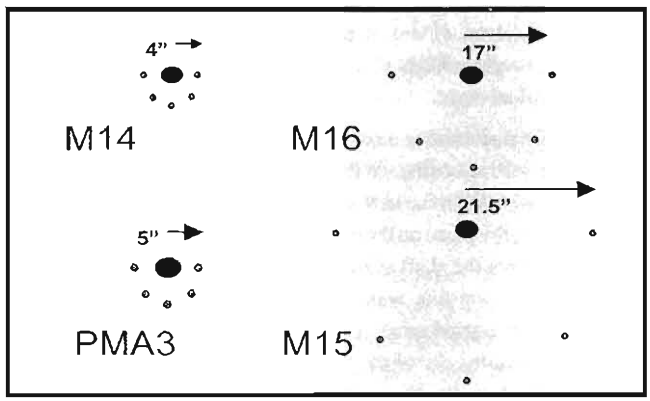


Figure 3. In the edge-detection exercise, the detector sounded off when the detector head was at the distances indicated for the various types of mines. Developing these points from multiple directions develops the patterns of footprints.

Training Requirements

We developed a training site that we hoped would optimize the training efficiency and, at the same time, be a facility that units in the field could practically replicate. Description of the training site is beyond the scope of this article, but we believe it played an important role in the training process.

Construction of high-fidelity simulants of low-metal mines was also a critical factor to support this research effort. Metal components



Figure 4. A soldier uses the airborne technique to accurately locate the center of mass of a large metal mine by using the tapered geometry of the electrical field.

were developed by the Program Manager's Office for Mines, Countermines, and Demolitions, Fort Belvoir, Virginia.[12] These very small metal components were inserted into hockey pucks to provide low-metal mine simulants. The simulants proved their merit when soldiers were trained on them at Fort Leonard Wood and later performed even better against the real mines at Aberdeen Proving Ground.

Use of bolts, nails, and other relatively large metal components as simulants are typically far too easy to detect and may perpetuate the continued use of improper detection techniques. The metal components used in the hockey pucks as carriers are an inexpensive and available source for high-fidelity, low-metal mine simulants.

Conclusion

The proliferation of low-metal mines over the past years has changed the techniques we must now use to successfully find mines. The old techniques were adequate for locating mines with high-metal content but are completely inadequate for low-metal mines. Many of the techniques advocated in this article, and validated by scientific research, were also described in an article in *Engineer* more than 6 years ago.[13] This research showed that gains in detection performance achieved by soldiers who received only 15 hours of training on the professional techniques resulted in more than a six-fold increase in performance on the hardest to detect mines. Most impressively, after being trained against mine simulants, the soldiers found 100 percent (63 of 63) of the hardest to detect M14 mines. The performance increase was so enormous (and statistically supported) that little doubt can be left about the validity of these techniques.

The professional techniques described in this article are only a part of mine-detection work, but we believe they can provide a critical supplement to other important factors of standard training, such as visual cue indicators and mine awareness. Training techniques must catch up with an evolving threat of low-metal mines. Employing standard Army techniques sets soldiers up for failure in a task that is swiftly and savagely unforgiving of human error.

The future promises improved mine detectors. The new Handheld Standoff Mine-Detection System (HSTAMIDS), which is progressing well, will offer two sensors. One will be an improved metal detector, and the other is a ground-penetrating radar sensor. Together, these sensors will provide soldiers information that may allow them to discriminate between mines and clutter. Assuming that soldiers will be properly trained, fielding this detector has the potential to provide a much greater capability to detect low-metal mines. For more information on the HSTAMIDS program, go to *http://www.wood.army.mil/TSM* or call (573) 563-4085.

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For more information on improving training with the AN/PSS-12 detector or setting up an effective training and test site, or to suggest ways to further improve the techniques described above, please contact one of the authors.

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Endnotes:

[1] U.S. Army Test Report, "AN/PSS-12 Metallic-Mine Detector," U. S. Army Test and Experimentation Command, Fort Hood, Texas, July 1991.

[2] W.C. Schneck, "Countermine in OOTW: Operation Restore Hope," a presentation to the U.S. Army Engineer School, Fort Leonard Wood, Missouri, 19-20 December 1994.

[3] U.S. Army Test Report, "Early Developmental Test/Early User Test and Evaluation of the Handheld Standoff Mine-Detector System," 1998.

[4] James J. Staszewski, Alan Davison, "Mine Detection Training Based on Expert Skill," *Detection and Remediation Technologies for Mines and Minelike Targets V*, A.C. Dubey, J.F. Harvey, J. T. Broach, and R. E. Dugan (Eds.), *SPIE Proceedings*, Volume 4038, pp. 90-101, 2000.

[5] Ibid.

[6] Ibid.

[7] James J. Staszewski, "Information Processing Analysis of Human Land Mine Detection Skill," Detection *and Remediation Technologies for Mines and Minelike Targets IV*, T. Broach, A.C. Dubey, R.E. Dugan, and J. Harvey, (Eds.), *SPIE Conference Proceedings*, Volume 3,710, pp. 766-777, Orlando, Florida, 1999.

[8] Y. Das, and J.D. Toews, "Issues in the Performance of Metal Detectors," Conference Proceedings of UXO FORUM '98, Anaheim, California, 5-7 May 1998.

[9] H. Herman and D. Inglesias, "Human-in-the-Loop Issues for Demining," T. Broach, A. C. Dubey, R. E. Dugan, and J. Harvey, (Eds.), *Detection and Remediation Technologies for Mines and Minelike Targets IV*, SPIE Conference Proceedings, Volume 3,710, pp. 797-805, Orlando, Florida, 1999.

[10] TM 5-6665-298-10, *Operator's Manual for the AN/PSS-12 Mine Detecting Set*, Headquarters, Department of the Army, 21 February 1992.

[11] Ibid.

[12] Project Manager - Mines, Countermines and Demolitions (Countermine Division), Scientific & Technical Report, Simulant Mines. http://www.uxocoe.brtrc.com/Technical %20Reports/sim-richard %20ess/SIM percent20Mines %20Report.htm, 21 October 1998.

[13] Captain Lawrence M. Chirio, "Lessons Learned: Kuwaiti Demining Operation," *Engineer*, August 1994, pp. 25-28.

An Engineer Perspective of the JCF–AWE

By Lieutenant Colonel Scott F. "Rock" Donahue and Major Timothy E. Griffith

The Joint Contingency Force-Advanced Warfighting Experiment (JCF-AWE) is the Army's latest experimentation process for the light forces, and the culmination of the experiment occurred at Fort Polk, Louisiana, from 1-20 September 2000. During this time, the 1st Brigade Task Force, 10th Mountain Division (Light), Fort Drum, New York, was taking part in Rotation 00-10 at the Joint Readiness Training Center (JRTC) at Fort Polk. The Army's 4th Infantry Division, Fort Hood, Texas, spearheaded the digitization process and created the environment for the subsequent transformation to the Interim Brigade Combat Team (IBCT). The tactics, techniques, and procedures (TTP), lessons learned, and equipment from the light experiment were forwarded to the IBCT, which is currently being fielded at Fort Lewis, Washington.

This article presents the engineer perspective of the JCF-AWE and focuses on the digitization of light engineer forces, specifically the concepts tested, the results, and the lessons learned from the 41st Engineer Battalion's support to the 10th Mountain Division during the experiment. The purpose of the article is threefold:

- To highlight the JCF-AWE training objectives and the employment of engineer-modernization initiatives.
- To provide a summary trend analysis for each of the engineer initiatives.
- To discuss the road ahead for "harvesting these insights" and continued experimentation and modernization of light engineer forces.

Background

The 10th Mountain Division deployed a division assault command post to the JCF-AWE to provide digital command and control (C2). The command post included the assistant division engineer cell and a section of topographic engineers from the 30th Engineer Battalion (Topographic), Fort Bragg, North Carolina.

The engineer elements in the 1st Brigade Task Force were a task-organized sapper company (A/41st Engineer Battalion) composed of two light sapper platoons and a mechanized engineer platoon, 2/C/299th Engineer Battalion, Fort Hood; an assault-and-obstacle-platoon section consisting of eight small emplacement excavators (SEEs) and six deployable universal combat earthmovers (DEUCEs) from headquarters and headquarters company; a task-force engineer planning cell in the 3-17th Cavalry Squadron, 10th Mountain Division; a task-force engineer planning cell in the command-post exercise battalion Task Force 1-32 Infantry, 10th Mountain Division; a T3 dozer section from the 326th Engineer Battalion, 101st Airborne Division (Air Assault), Fort Campbell, Kentucky; and a section of topographic engineers from the 30th Engineer Battalion.

The 41st Engineer Battalion approached the experiment as a training event driven by the mission-essential task list that incorporated emerging technologies and TTP. The JCF-AWE was a tough, complex, and challenging exercise that enriched and engaged our philosophy to build on new and emerging technologies and war-fighting capabilities. The battalion's objectives were to—

- Become a more lethal, versatile, survivable, and sustainable light engineer force, capable of providing premier combat-engineer support to the combined-arms team.
- Conduct tough, realistic, and innovative training to standard, supplemented with experimental TTP.
- Develop bold and adaptive leaders for the joint experimental process.

Before the JCF-AWE, the 10th Mountain Division conducted new-equipment training, field-training exercises, command-post exercises, computer-training sessions, and contractor meetings/refinements. Since many of the challenges and processes leading up to the deployment could not be predicted, leaders were required to be flexible and willing to take calculated risks in the experimentation process.

JCF-AWE Objectives

The overarching objectives of the JCF-AWE were to—

- Improve the effectiveness and efficiency of joint command, control, communications, computers, and intelligence (C4I) through digitization, enhanced communications, and joint interoperability of systems, processes, and procedures.
- Enhance the capability and conduct of JCF operations within urban and complex terrain.
- Enhance the capability, conduct, and planning of early-entry operations for the JCF.

The experiment attempted to use knowledge-based digital systems to increase the lethality, survivability, and tempo of operations to assist our Army in winning the nation's wars. The Army is continuously analyzing and rethinking how and why it operates and whether it is using current and future technologies to their greatest potential. The analog processes used 10 years ago (and still today) must be questioned as to their applicability and efficiency in the digital environment.

The JCF-AWE also developed tactical and experimental objectives that were nested within the overarching objectives.

Tactical Objectives

The tactical objectives, which supported four primary missions (entry operations, search and attack, deliberate defense, and military operations in urban terrain [MOUT]), were to—

- Execute tactical deployment and redeployment activities.
- Execute movement to contact/search and attack.
- Execute an attack on a built-up area.
- Perform combat-service support and sustainment.
- Provide force protection.

Experimental Objectives

The experimental objectives, which supported the initiatives in the division assault command post as well as the brigade C2 nodes, were to—

- Test core systems and initiatives under field conditions that replicate the JRTC rotation.
- Assess the impact of lessons learned on tactical-operations-center operations and architecture.
- Test and refine the data collectors' plan.
- Test and refine the contractors' support plan.
- Gain initial feedback on the performance of core systems and initiatives.
- Provide after-action reviews that enhance future JCF-AWE collective training.

Engineer Initiatives

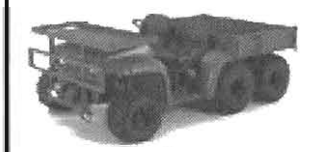
The 41st Engineer Battalion tested 11 engineer initiatives and a general C2 initiative—the Maneuver Control System (MCS)-Light computer system in the command posts and its connectivity with the Force XXI Battle Command Brigade and Below (FBCB2) platforms in the vehicles. The experimentation and evaluation strategy for each of the engineer initiatives was coordinated with subject-matter experts and contractors from numerous agencies. Each organization had strict guidelines and Battle Lab directives to ensure that the systems were tested and evaluated against three criteria: effectiveness, survivability, and suitability.

The initiatives were evaluated throughout the experiment according to their frequency of use. Initiatives like the M-Gator, skid steer, and high-mobility engineer excavator (HMEE) were evaluated daily, while some initiatives like the urban robot (URBOT), T3 dozer, and lightweight mobile obstacle breacher (LMOB) were evaluated only during the MOUT phase, which occurred during the last 2 days of the experiment. A summary trend analysis of each of the initiatives follows:

The **M-Gator** (Figure 1) provided the entire brigade combat team with a significant mobility asset that was used extensively in casualty evacuation during an attack in the MOUT phase of the rotation. It was a great combat multiplier that significantly enhanced our ability to move short distances over rough or swampy terrain. The following minor design improvements were recommended:

- Increase the vehicle's top speed (currently 17 miles per hour).
- Field with a tilt trailer for transport and support.
- Replace Fiberglass®/plastic with reinforced aluminum.
- Develop an adapter kit for litters.

Note: The U.S. Army Infantry School is working the Operational Requirements Document (ORD) for this vehicle, which will be known as the Lightweight Utility Mobility Enhancement System (LUMES).



Characteristics

- Is a 6x4, two-seat, small tactical/utility vehicle.
- Has a 1.87-cubic-foot hood equipment tray and 14.4-cubic-foot rear cargo box.
- Hauls or tows a 1,400-pound payload.
- Has an 18-horsepower engine.

Figure 1. M-Gator

The **skid steer** was also a success story. We augmented our formations with two competing models: the Melroe Bobcat® Model 763 (Figure 2), a rubber-tired vehicle with steel tracks that could be manually installed over the tires if necessary, and the Caterpillar® ASV Model MD-2810, which had full-time rubber tracks for propulsion. The system has seven attachments: a picket pounder, clamshell bucket, auger, backhoe, pavement breaker, closed bucket, and forklift. The skid steer allowed units to start priority-position construction before the SEEs and DEUCEs arrived. Recommendations to improve the skid steer's performance include the following:

- Remove the rear bucket.
- Field a track-over-tire system for best results.
- Field with a tilt trailer for easier transport and support.
- Increase ground clearance for the Bobcat model.



Characteristics

- Drives pickets and posts, pounds nails and spikes, excavates positions and shelters.
- Has easily changed attachments for many tasks.
- Lifts palletized materials and creates/reduces obstacles.

Figure 2. Skid Steer

The **mini-mine detector (MIMID)** (Figure 3) was one of the best pieces of equipment tested during the JCF-AWE. The MIMID is based on the AN/PSS-12 handheld mine detector but is collapsible and more compact and has an improved package carrier. The MIMID is only an interim test system since the Maneuver Support Center's Directorate of Combat Developments has now decided to field the Handheld Standoff Mine-Detection System that detects nonmetallic and low-metal-content mines. The benefits identified for the MIMID are that it—

- Can be put into operation quickly.
- Is very effective in finding the center of mass of the object.
- Has a smaller search head, which saves time by decreasing the need to probe wide areas.
- Is easily transported and lightweight.
- Uses less of a battery's life than the AN/PSS-12.



Characteristics

- Is one-piece, manpackable, and lightweight.
- Is collapsible.
- Can be carried on load-bearing equipment or in trouser pocket.

Figure 3. MIMID

The **HMEE** (Figure 4) is comparable to the SEE, but it digs faster because of its larger bucket and increased power. The HMEE was very reliable during the entire JCF-AWE. It always stayed mission-capable and was an integral part of the brigade's defensive effort. However, the HMEE's stature limited its mobility in restrictive terrain. Recommendations to improve the HMEE are to—

- Add rollover protection.
- Add HEMMT-type outriggers for stability.



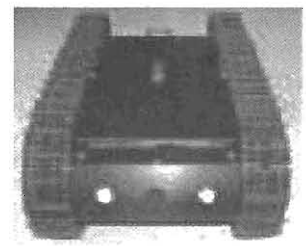
Characteristics

- Used for ditching, trenching, loading, and other related engineer missions.
- Is safe at up to 65 miles per hour on unimproved roads.
- Provides better cross-country mobility and digging capability than the SEE.

Figure 4. HMEE

The **URBOT** (Figure 5) is a good concept but needs refinement as an engineer initiative. It was very effective on its tether or within 100 meters. URBOT missions were limited to the MOUT reconnaissance phase and thus were relatively narrow in scope. It was also useful for finding trip wires. The following improvements will increase the URBOT's applicability for more missions:

- Increase its speed.
- Increase its durability.
- Mount a digitized photo capability and an infrared camera/zoom on the chassis.
- Increase the battery life so that it can operate longer between chargings.

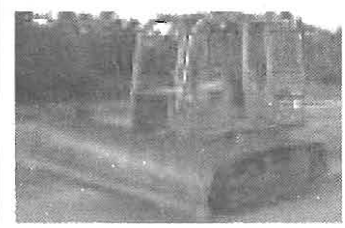


Characteristics

- Is manpackable (weighs less than 40 pounds).
- Operates for more than 2 hours on one charging.
- Has a line-of-sight range of more than 100 meters.

Figure 5. URBOT

The **T3 dozer** (Figure 6), like the URBOT, is a concept that the engineer community should continue to refine and improve. During the MOUT phase of the JCF-AWE, the T3 showed potential for unmanned breaching and clearing operations in built-up terrain. The system is too slow (its top speed is about 10 mph), and the camera should be upgraded since the digital images sent back to the operator were of poor quality. There were also problems when operating the T3 at distances more than 20 meters away. It is billed to be capable of remote operation at 1,000 feet, but we had difficulty anytime line-of-sight was lost.



Characteristics

- Clears obstacles without risk to soldiers.
- Is video teleoperated.
- Removes rubble and other large obstacles.
- Is CH-47 transportable.

Figure 6. T3 Dozer

The **Volcano (Light)** (Figure 7) was another success story. It is extremely mobile and lethal, and the high-mobility.

multipurpose wheeled vehicle (HMMWV) chassis reduces the system's signature while increasing its survivability. This scatterable-mine system uses the same canister as the regular Volcano but with only 20 canisters (half rack) instead of 40. Suggested modifications for the Volcano (Light) are to—

- Reinforce the HMMWV frame since it is hauling a heavy load of mines.
- Incorporate some type of rapid-reload capability into future versions.



Characteristics

- Is a derivative of the Volcano that has been adapted to the HMMWV.
- Has a single half rack with a capacity for 20 canisters (120 antitank mines or 300 antipersonnel mines).
- Can lay 277 by 35 meters of disrupt or fix minefield.

Figure 7. Volcano-Light

The **LMOB** (Figure 8) is a work in progress. The concept is good, but the current technology needs refinement. The LMOB's design allows it to breach antipersonnel mines only, and it will not cut wire. These facts alone limit the applications for the LMOB in its current configuration. The breach lane width, advertised as 0.6 meters, is inadequate for a combat breach. Additionally, the breaching system weighs 55 pounds, and the mock trainer does nothing to simulate the breach. Therefore, it doesn't lend itself to dynamic training in the combined-arms breach.

The LMOB is currently fielded with a case, and we recommended a pouch or bag to facilitate dismounted transportation over long distances. The Maneuver Support Center decided not to continue investing in this initiative and will focus on the Antipersonnel Obstacle-Breaching System (APOBS) that will clear an adequate lane for light forces.



Characteristics

- Creates an 80-meter-long by 0.6-meter-wide footpath.
- Detonates surface-laid and buried antipersonnel mines, pressure-plate mines, and trip wires.
- Is manpackable (weighs 55 pounds).

Figure 8. LMOB

The **Digital Topographic Support System-Light (DTSS-L)** (Figure 9) is an example of the recent ability to move technology closer to the soldier. Current automation technology is mobile and deployed closer to tactical planners and decision makers. The DTSS-L can be deployed with brigade combat teams to provide dedicated and real-time topographic support. Some benefits of the system are that it allows the creation of improved map products for brigades and allows teams to stay on-site and engaged in current operations and planning. Additionally, the improved hardware and software in the DTSS-L is similar to the current garrison equipment and does not require new training.



Characteristics

- Provides a division terrain detachment with garrison-level capability while deployed.
- Has a HMMWV-mounted shelter.

Figure 9. DTSS-L

Rapid hardcopy reproduction (RHR) and **rapid terrain data generation (RTDG)** (Figure 10) significantly improve the terrain team's ability to provide support in the field. These capabilities allow large numbers of high-quality products to be printed very rapidly. The brigade requested 100 copies of high-resolution overhead imagery of the town for future MOUT, and the terrain team was able to meet that requirement and send the maps out on the next logistical package. The recommendation for the RHR trailer was to reconfigure the printer layout to maximize the limited space available.



Characteristics

- Provides hardcopy, nonstandard map-production capability directly from digital cartographic, terrain, and operational information.
- Produces at least 5,000 full-color, water-resistant standard products per day.
- Makes tactical decision aids and high-resolution image maps.
- Makes large-scale image maps.

Figure 10. RHR and RTDG

MCS-Light

The MCS-Light, a software program that allows engineers to effectively increase C2, is the baseline maneuver tool in the digital architecture for the 10th Mountain Division JCF-AWE. The system's unique features include the ability to post overlays and orders electronically, display real-time situational awareness of blue and near real-time of red unit icons, "chat" with other elements through the use of Microsoft® NetMeeting, and share common desktop folders and white boards. Information is shared with other MCS-Light users and— to a more limited extent—FBCB2 computers typically mounted in vehicles.

The old adage "a picture is worth a thousand words" holds true and should be the future course for reporting and sharing information. The inefficient analog method of sending pages and lists of raw data and grids requires the receiver to replot the grids on his map. The method of maintaining overlays and maps can now be manipulated electronically via MCS-Light. The engineer obstacle overlay can now be created on a digital map and passed to a common database or sent to another computer for display. Enemy obstacles and the status of main supply routes can be displayed on a digital map and sent to all units. Electronically sending digital maps and overlays eliminates the need to physically transfer acetate products.

It is imperative that the engineer community adopt a system that incorporates both planning and operational tools into a complete software package. Essentially, we recommend incorporating planning tools into the MCS-Light platform. The planning program should be menu-oriented and assist the user through the military decision-making process. The menu orientation would prompt and assist the user in remembering many of the considerations for the planning mission. Recommendations include the following:

- Improve the digital link between the MCS-Light and the FBCB2. (Minefields displayed on the MCS-Light need to constantly update and reliably post on the FBCB2.) This is critical information with lifesaving implications. Soldiers died on the JRTC battlefield because they didn't have situational awareness of mines.
- Improve the fidelity of the engineer graphics and symbols in the MCS-Light software.
- Add engineer spreadsheet planning tools (for example, the user enters units and receives equipment numbers and unit capabilities in terms of mobility/countermobility/survivability/sustainment engineering planning factors).
- Add engineer-specific tools for developing mission analysis, courses of action, commander's critical information requirements, etc., to facilitate the military decision-making process.

Supplemental training on the system at the Engineer Officer Basic Course is also required. We must develop an engineer system now that can meet our current and projected requirements; only then will we have a base from which to build or shift to be compatible with the maneuver architecture.

Future Experimentation and Evaluation

The JCF-AWE engineer initiatives have the potential to significantly improve the engineer's ability to support decisive, full-spectrum operations. Product refinements and subsequent experimentation must be continued to ensure that we get the best equipment in the hands of our light engineer forces. With an established, powerful, and proven experimental process like the JCF-AWE, we—as a multiservice/multicomponent engineer community—must continue our cooperative efforts to shape our future modernization strategy. This will require a systems-analysis process with other battlefield functional areas. The field artillery, air defense, and intelligence communities broke ground with their digital C2 initiatives—the Advanced Field Artillery Tactical Data System, the Air and Missile Defense Workstations, and the All-Source Analysis System—and are continuously working on building compatibility with the maneuver architecture as they evolve. Only through this type of cooperative modernization strategy can we sustain our relevance as a lethal, versatile, survivable, and sustainable combat multiplier on the modern battlefield.

Lieutenant Colonel Donahue commands the 41st Engineer Battalion, 10th Mountain Division, Fort Drum, New York. Previously, he served as chief of the Studies and Analysis Branch, Combined Forces Command, Seoul, Korea; and Engineer Brigade S3 and 11th Engineer Battalion S3, 3d Infantry Division (Mechanized), Fort Stewart, Georgia. A distinguished graduate of the Virginia Military Institute, LTC Donahue holds a master's in operations research from the Naval Postgraduate School and is a registered professional engineer in Virginia.

Major Griffith is the assistant division engineer, 41st Engineer Battalion, 10th Mountain Division, Fort Drum, New York. Previous assignments include engineer advisor for the U.S. Military Training Mission in Saudi Arabia; operations officer with the Corps of Engineers, assistant division engineer, 6th Infantry Division (Light), Fort Wainwright, Alaska; and commander of the 47th Engineer Company, 6th Engineer Battalion, Fort Wainwright, Alaska. He is a distinguished graduate of the Washington State University Reserve Officer Training Corps program and holds a master's in administration from the University of South Dakota.



BCTP Terrain Analysis: Unlocking the Mystery



By Chief Warrant Officer 2 Theodore W. Mohn

"Know the enemy, know yourself, your victory will never be endangered;
Know the ground, know the weather, your victory will then be total."
— Sun Tzu, 500 B.C., The Art of War

As the Army's terrain experts, engineers understand the impacts and effects that terrain has on units conducting and supporting military operations. Within the engineer community, topographic engineers (military occupational specialty [MOS] 215D terrain analysis technicians and MOS 81T topographic analysts) are the subject-matter experts that maneuver commanders and their staffs rely on to provide timely and accurate terrain-analysis and terrain-visualization products. Topographic engineers routinely conduct terrain-analysis for contingency operations and support to engineer battlefield assessment (EBA) and intelligence preparation of the battlefield (IPB).

Terrain analysis is also conducted to support a unit's Battle Command Training Program (BCTP) evaluation. However, this analysis is unique because of the simulations aspect of the exercise. The BCTP's automation system uses Corps Battle Simulation (CBS) terrain data. This terrain has specific categories and specific terrain layers within those categories. To properly conduct an EBA and IPB during the military decision-making process, units must acquire CBS terrain. Topographic engineers have the ability and equipment to manipulate CBS digital terrain data and display the data for use in the unit's planning process.

This article explains CBS terrain data, how it works, and why planners and commanders involved in a Warfighter exercise need to understand the differences in CBS terrain data as it relates to existing terrain shown on hard-copy maps. When CBS is analyzed properly, it greatly increases the possibility for corps, division, and brigade commanders to decisively employ forces that are fully capable of defeating the World Class Opposing Force (WCOPFOR). Topographic engineers are vital in analyzing the CBS database, displaying CBS data in a usable format, and providing a thorough explanation of its effects on operations.

The BCTP

The BCTP, located at Fort Leavenworth, Kansas, is the Army's capstone combat-training center that demonstrates a unit's abilities to perform and execute combat operations and then identify their shortcomings. The BCTP provides command and battle-staff training to commanders of corps, divisions, brigades, and their staffs; major subordinate commanders; and supporting special operations forces. Worldwide battle-simulation centers (BSCs) provide the framework to conduct command-and-control training from joint-task-force to brigade-level operations. The BCTP provides a "free-thinking" WCOPFOR, certified observer-controllers/trainers, and senior observers as mentors and coaches. The combat-training center provides highly realistic and stressful joint, interservice, and combined-arms training according to Army doctrine.

CBS Terrain Data

CBS terrain is the "real terrain" during a BCTP exercise. Commanders and decision makers need to look beyond the thought that a map covering a BCTP exercise area is the most current depiction of the terrain. One should think of CBS terrain as information gathered, and then verified and published, by an engineer reconnaissance team, scout team, or intelligence collector. The result of their reconnaissance is CBS terrain, which is the only common operational picture of the battlefield. Units that take advantage of CBS terrain historically have greater success against the WCOPFOR.

Units participating in a BCTP Warfighter exercise need their supporting terrain teams to acquire CBS terrain data, which ensures that all participants are aware of the battle area. Terrain-analysis units can access this data from the National Simulation Center's CBS support teams. After downloading CBS terrain

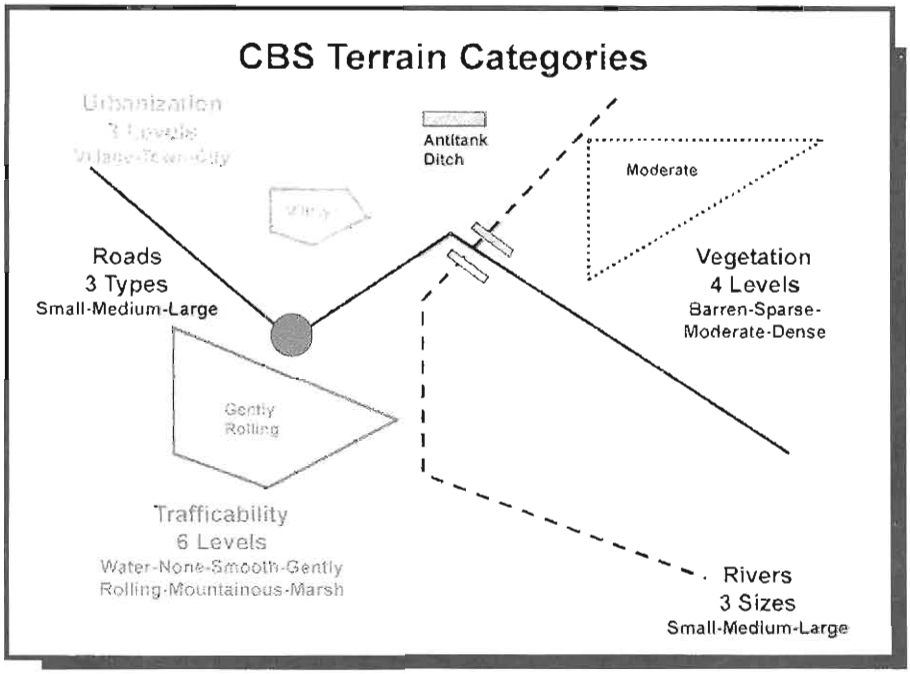


Figure 1

files, topographic engineers run each file through a series of conversions. Once converted, these files can be used in the automation systems that topographic-engineer units possess. Additionally, these files can be displayed using the latest version of Microdem/TerraBase II software. Engineers and other unit personnel (that are well versed in Microdem/TerraBase II) can perform their own limited analysis and visualization within the constraints of the software. This enables engineer commanders and staffs expanded access to the CBS terrain they must negotiate during a BCTP Warfighter exercise.

CBS terrain attempts to replicate a military map. However, computer capabilities and technologies limit CBS terrain categories and their layers to finite numbers. These categories consist only of roads, rivers, urbanization, vegetation, trafficability, bridges, and elevation/slope triangulated irregular networks (TINs). The first five terrain categories and their layers are shown in Figure 1. Bridges and TINs are discussed separately. Some common terrain features that do not appear in CBS are railroads, power lines, embankments, escarpments, levees, dams, pits, quarries, and tunnels.

Roads. Three types of roads are depicted in the CBS terrain data—large, medium, and small. Large roads are considered to be four lanes wide, and vehicles are permitted to achieve 100 percent of their maximum on-road speed. Maximum vehicle speeds are based on doctrinal vehicle characteristics. A medium road is considered to be two lanes wide, and vehicles are permitted to achieve 75 percent of their maximum on-road speed. Small roads are considered to be one lane wide, and vehicles are permitted to achieve 50 percent of their maximum on-road speed.

Rivers. Deliberate river-crossing operations require bridging assets. When units attempt river crossings at locations where no bridge exits, the following rules must be understood. A large river (greater than 47 meters wide) is nonfordable and requires a company's worth of bridging assets to cross. Medium rivers (20 to 47 meters wide) are nonfordable and require a platoon's worth of bridging assets to cross. Small rivers are fordable anywhere along the river course. However, without a bridge, units that cross/ford small rivers incur a 20-minute movement delay for bank-to-bank crossings.

Urbanization. This category of data is broken into villages, towns, and cities. The major effect that urbanization has on mobility is congestion. Units traveling on roads through these population centers incur a 20 percent degradation in vehicle speeds. Units must stay on roads to travel through urban areas.

Vegetation. Vegetation layers include barren, sparse, moderate, and dense forests. These categories also reduce off-road mobility rates. Figure 2 identifies speed-reduction rates based on the combination of slope and vegetation categories. Additionally, moderate and dense forests afford some level of concealment for all units (including the WCOPFOR). Moving through a dense forest without roads almost halts vehicle progress.

Trafficability. Layers in this category are water; none (no negative effect); smooth, relatively flat areas; gently rolling hills; mountains; and marshes. The three layers that severely reduce off-road movement rates are water, mountains, and marshes. Water is impassable, mountains add an additional 25 percent speed reduction to include restrictions already applied by the combination of vegetation and slope, and marshes reduce speeds to roughly 1 kilometer per hour.

Bridges

CBS terrain software automatically places a bridge wherever a road crosses a river, and regardless of the river or road type, these bridges have a default military load classification of 100. This allows freedom of movement for both the WCOPFOR and exercising units.

CBS Movement Rates

Figure 2 terrain layers, combined with the TIN file, are used to compute on- and off-road movement rates or speeds. Movement impediments are applied equally and without bias to the WCOPFOR and the unit being evaluated. CBS terrain is neutral to all participating forces involved in the exercise. The slowest a vehicle can travel in CBS is 1 kilometer per hour even in the most restrictive and difficult terrain. Open water is the only "no-go" terrain.

CBS Movement Rates

Roads

Large - 100% of vehicle speed (4 lanes)
Medium - 75% of vehicle speed (2 lanes)
Small - 50% of vehicle speed (1 lane)

Rivers

Large - >47 meters wide, bridge company required
Medium - 20-47 meters wide, bridge platoon required
Small - <20 meters wide, fordable with a 20-minute d[illegible]ay

Slope	Barren	Sparse	Moderate
0-3%	.75	.70	.55
3-7%	.70	.65	.48
7-12%	.50	.45	.35
12-25%	.35	.30	.30
25-55%	.20	.18	.15

(Additional 25% degradation in mountainous areas)

Urban areas - Additional 20% degradation
Congested areas - Additional 30% on medium roads
- Additional 50% on small roads

Figure 2

There is no formula that can determine exact speeds for vehicles moving cross country. Calculating unit- and vehicle-movement rates over varying terrain is difficult using any existing Department of Defense-approved mobility model. The Army-accepted models are the National Imagery and Mapping Agency's (NIMA's) Cross-Country Mobility Model and the North Atlantic Treaty Organization Referenced Mobility Model. Both models require extensive terrain information and only calculate movement rates for one vehicle at a time, using different algorithms as determined by the programmers and contractors who built the models. Therefore, calculated speeds are slightly different between the programs for vehicles traversing the same terrain. Mobility programs only calculate approximate movement rates based on doctrinal vehicle characteristics and fidelity of terrain information used in the software package.

CBS uses its own set of terrain layers, algorithms, and doctrinal vehicle characteristics to calculate unit and vehicle movement rates. Figure 2 reflects an approximation of the rates calculated in CBS software. The numbers and percentages depicted come from CBS terrain editors at Fort Leavenworth. Unit movement rates (platoon, company, battalion, brigade) may only achieve the maximum doctrinal speed of the unit's slowest vehicle.

Only the CBS computer system can calculate the exact speed of a vehicle (unit) at a specific location (grid) at a specific time in the exercise. The system has an independent set of algorithms for combining terrain layers and calculating speeds. CBS also uses a different type of elevation data than that of the standard NIMA Digital Terrain Elevation Data (DTED).

BCTP Elevation Data

The National Simulations Center uses a TIN elevation model to replicate the earth's surface. TINs represent the earth's surface using contiguous, non-overlapping triangles (see Figure 3). This is different from the DTED (a grid-based elevation model) and the Digital Elevation Model (DEM) produced by the United States Geological Survey (USGS).

Unlike the DTED and DEM, the TIN only affects air-to-ground and ground-to-air line of sight. There is no effect on ground-to-ground line of site. Therefore, friendly and WCOPFOR maneuver units visually acquire each other as if the world were perfectly flat.

CBS Terrain Data Layers

The 25th Engineer Detachment (Terrain), Schofield Barracks, Hawaii, takes full advantage of CBS terrain during exercises run from the simulation centers. On day one of the mission analysis, the detachment displays CBS terrain data to the battle-staff members and explains how it works. Once the battle staff understands that only roads, rivers, urbanization, bridges, trafficability, vegetation, and TIN categories are used in CBS for exercise purposes, they accept these features as fact and continue with their doctrinal planning. By knowing where the CBS terrain features exist in the exercise, the battle staff can better formulate courses of action and predict possible enemy courses of action.

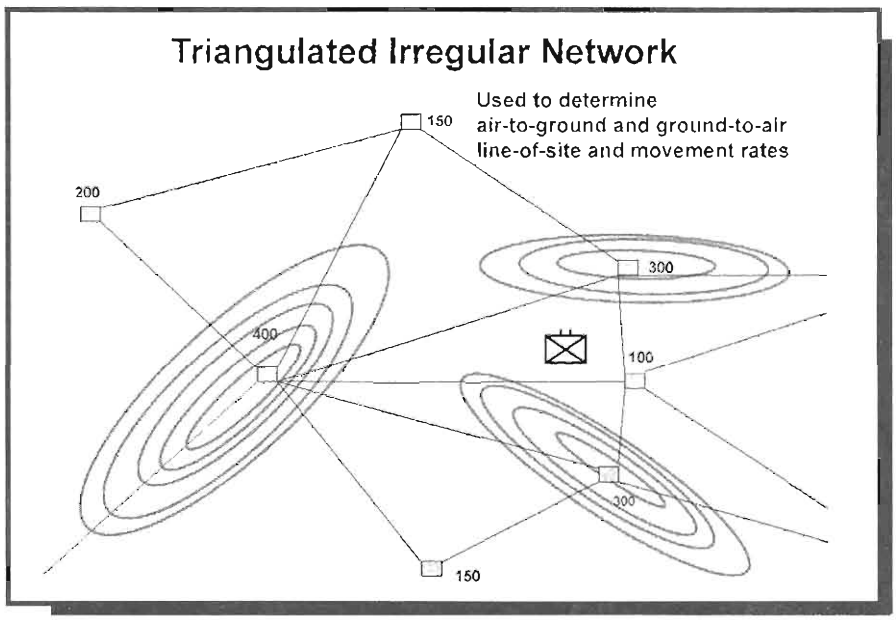


Figure 3

(Continued on page 57)



Integrating an RC Engineer Battalion Into an AC Maneuver Exercise

By Major Todd M. Jacobus

The 224th Engineer Battalion (Mechanized), an Army National Guard unit in Fairfield, Iowa, has line units in the southeast Iowa communities of Burlington, Ottumwa, Mount Pleasant, and Keokuk. The 834th Engineer Company, a divisional engineer company headquartered in Davenport, Iowa, is attached to the 224th for command and control purposes.

The mission statement of the 224th is threefold. On H-hour, M-day, the battalion moves to the mobilization station to conduct post mobilization operations and, on order, deploys to the theater of operations to provide corps-level mobility, countermobility, and survivability support. When called on, the 224th provides organized, trained, and equipped soldiers to protect life and property, preserve peace and order, and provide public safety under the orders of the governor. Finally, the battalion participates in local and state projects and programs that add value to the organization and the Iowa Army National Guard. The table on page 31 shows the variety of missions that the 224th Engineer Battalion has performed during the past 10 years.

Training Plan

During training year 1996, the commander of the 224th presented the battalion's training plan for the next 5 years. The unit needed to continue taking advantage of training opportunities with the separate infantry brigades, its war trace higher headquarters, the training support brigade, overseas deployments, and rotations at the combat training centers. But, above all, the commander wanted to see the 224th hone its war-fighting skills by linking up with Active Component (AC) maneuver units. Because of personnel turnover, every other year or every third year would be a "back-to-the-basics" year where the unit would consolidate its mobilization station to validate squads and platoons in critical tasks from its mission-essential task list (METL). By conducting validations during these off years, the 224th would have well-trained engineers available for linking up with maneuver units. This philosophy was implemented in training years 1996-1997, and follow-on battalion commanders embraced this philosophy and continued to implement it in training years 1998-2000.

In January 1999, the 224th contacted the 1st Infantry Division, Fort Riley, Kansas, and requested a linkup with a maneuver brigade sometime during training year 2000. The division sent the request to the brigades and received a reply from the 1st Engineer Battalion and 1st Brigade Combat Team (BCT) at Fort Riley that they could use the 224th for a National Training Center train-up scheduled for July-August 2000.

The battalion commander's objectives for training year 2000 were to—

- Conduct safe movement to and from the annual-training location.
- Conduct linkup with a maneuver element.
- Improve command and control, intelligence, and combat-service support to integrate the maneuver scenario into the 224th's annual-training plan.
- Improve proficiency on mobility and survivability at the platoon level.
- Improve the operations-order process.

- Qualify on crew-served weapons.
- Conduct training on the heavy-demolitions range and mine-clearing line charge (MICLIC).

Training Preparation

In preparation for the train-up, the units scheduled a reconnaissance of the training area, a planning conference, in-progress reviews, rock drills, and an officer-development program.

Reconnaissance

In March 1999, the 224th's S3 and operations sergeant visited Fort Riley to conduct reconnaissance and identify potential training areas, dig sites, ranges, the maneuver-area training-equipment site (MATES), and other support activities.

Planning Conference

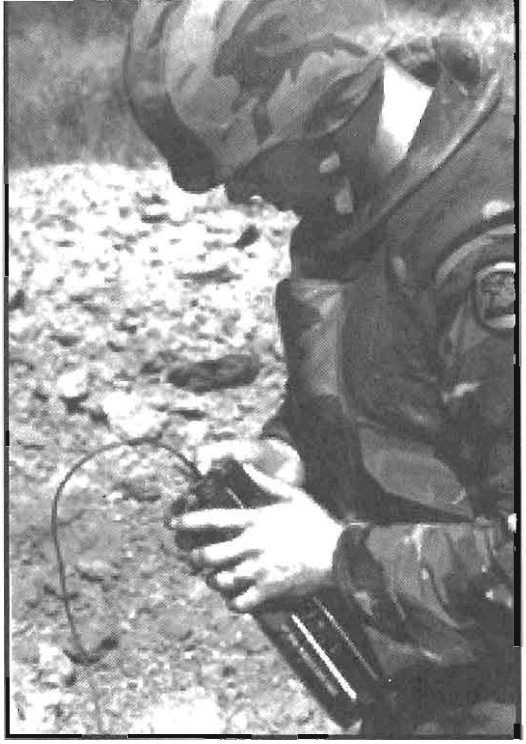
An initial planning conference in October 1999 enabled the units to confirm training objectives and coordinate future in-progress reviews. In addition, they could establish a synchronization matrix, the command/support relationships during each phase of breaching operations, the standard operating procedure (SOP) for breach marking, and the type of survivability positions desired by the brigade commander.

Battle Drills

The 224th's commander modified the unit's battle drills to facilitate a seamless appearance between the 224th and the 1st Engineer Battalion. After receiving a tactical SOP from the 1st Engineer Battalion and the1st BCT, the 224th's line units began training to the 1st Engineer Battalion's battle drills during inactive duty for training.

Officer-Development Program

In May 2000, the commander, S3, and assistant brigade engineer from the 1st Engineer Battalion participated in a 2-day officer-development program at Camp Dodge, Iowa, which was



A soldier from the 224th Engineer Battalion trains on an individual demolition task.

conducted concurrently with individual weapons qualification on a weekend of inactive duty for training. The program provided hands-on training to prepare for some of the requirements of the annual training. The training validated the commanders' and platoon leaders' ability to perform troop-leading procedures, issue oral operations orders, and perform critical mobility tasks such as conducting enemy-obstacle reconnaissance, reducing an obstacle mechanically, and marking and clearing lanes in a minefield.

The 1st Engineer Battalion commander's priority for the brigade reconnaissance element was to eliminate the combat security outpost to prevent a maneuver-on-maneuver fight. Next, the engineers would identify the main obstacle belt and the point of breach. This was no small task. If the main belt was not accurately portrayed, then large amounts of engineer

	224th Engineer Battalion Missions
Year	Mission
1991	Mobilized for Operation Desert Storm (as a corps wheel unit) and deployed to Grafenwohr Training Area, Germany, to support the 8th Infantry Division (transitioned to Corps Mechanized unit). Rotated through the Combat Maneuver Training Center in Hohenfels, Germany, where each of the line companies supported a maneuver task force.
1992	Conducted lanes training and combined-arms river-crossing operations with the 2d Brigade, 34th Infantry Division, at Camp Ripley, Minnesota.
1993	Provided relief to flooding communities throughout southeast Iowa after being ordered to state active duty.
1994	Performed engineer lanes training at Fort McCoy, Wisconsin.
1995	Participated in rotations at the Joint Readiness Training Center, Fort Polk, Louisiana, (three line companies) and supported a Blue Force rotation at the National Training Center, Fort Irwin, California (one line company).
1996	Executed squad-level lanes at Fort McCoy, Wisconsin.
1997	Supported the 45th Separate Infantry Brigade during company team assault lanes and a river-crossing exercise at Fort Chaffee, Arkansas.
1998	Provided mobility, countermobility, and survivability support to the 1st Cavalry Division at Fort Hood, Texas.
1999	Executed squad-level engineer qualification tables at Fort McCoy, Wisconsin.

resources would be expended on protective obstacles. The 1st Engineer Battalion commander did not have an engineer squad with the brigade reconnaissance team. Instead, there was only one engineer squad leader attached to the team. Lessons learned at the NTC show that the brigade reconnaissance team is quickly decimated and engineer assets lost if a great deal of equipment and personnel are put with this team.

The 1st Engineer Battalion commander discussed terms such as "zone of penetration" and "point of breach" and emphasized the importance of engineers thoroughly understanding and rehearsing the battle drill before movement. He outlined the battle sequence from an engineer perspective. The brigade reconnaissance team would take out the first target array, and the point of breach would be located. Engineers would have an assault, a support, and a reduction force. They would determine where the opposing force (OPFOR) had its battle positions and establish a point of breach based on that intelligence. The engineer company commander should take the lead on reducing obstacles, which would require that the engineers control maneuver assets at the point of breach. It would be imperative to get the assault force through the breach in less than 10 minutes. The unit should plan on 50 percent redundancy at the point of breach.

After the formal class, officers from the 1st Engineer Battalion and the 224th broke into three squads. The S3 appointed squad leaders, a platoon leader, and a platoon sergeant, and they were given a mission to mechanically breach a complex obstacle that had been built in the training area of Camp Dodge. During the troop-leading procedures, the commander of the 1st Engineer Battalion and his team helped officers of the 224th focus on what they needed to do during the final months of preparation for the annual training at Fort Riley.

Final Coordination

Following the officer-development program, there was a change of command at the 1st Engineer Battalion and the 1st BCT. Soon after, the 224th established a telelink between Camp Dodge and Fort Riley to discuss the upcoming training event with the new commanders. A continuous flow of information throughout the year was necessary for a seamless synchronization at the time of execution.

On 29-30 July 2000, the commander, executive officer, S3, S4, and company commanders of the 224th attended a final coordination meeting with the 1st Engineer Battalion. The commander of the 224th went through the operations order in detail with the company commanders, and they each briefed their plan for a final time to the battalion commander.

The Reserve Component Services Division at Fort Riley gave the 224th personnel a tour of the billets, mess hall, orderly rooms, hospital, post exchange, clothing-sales store, MATES, and range control and ammunition-holding areas. The 224th linked up with the 1st Engineer Battalion and made adjustments to the training areas, dig sites, and bivouac sites and then conducted a rock drill that included the battalion and company commanders, executive officers, and S3s from both battalions and platoon leaders from the 1st Engineer Battalion.

Training Execution

On 5 August, the 224th departed from home armories in five communities and convoyed to Fort Riley. After arriving at its destination, the battalion staged all vehicles in the motor pool and began mounting the Multiple Integrated Laser Engagement System and performing pre-field-training-exercise inspections. The tactical operations center (TOC) moved to the field the next day and located independently from the 1st BCT. Each line company followed, establishing company perimeters on the eastern border of the maneuver box and preparing to link up with their respective task forces.

Initial linkup between the engineer battalions and the 1st BCT took place on day two, when the 224th TOC tied in with the 1st BCT TOC and the 1st Engineer Battalion. The 224th administrative logistics control center moved into the brigade support area.

Initially, the 224th was involved with three training lanes. After linking up on the ground, the battalion supported three task-force maneuver lanes with one platoon from each company. The intent was to provide engineer platoon leaders from the 224th with an opportunity to plan, coordinate, and synchronize with maneuver commanders. During these combined-arms operations, the 224th conducted movements to contact, deliberate attacks, and deliberate defenses.

While the 224th line platoons provided mobility support, the heavy-equipment operators conducted survivability operations in conjunction with the 1st Engineer Battalion. The 224th's primary digging asset is the D7 dozer while the 1st Engineer Battalion has armored combat earthmovers (ACEs). For the first time, the 224th's operators were able to work with an ACE-dozer team during the construction of two-tier fighting positions, and Y-shaped fighting positions for the 1st BCT.

Internal Training

To maximize training time, the 224th established a training program independent from that of the 1st BCT and the 1st Engineer Battalion. The battalion TOC issued operations orders directing assault-and-obstacle platoons to construct turret and hull-defilade fighting positions for both M1 Abrams tanks and M2 Bradley infantry fighting vehicles. Small emplacement excavators were used to construct crew-served fighting positions at both the brigade TOC and the brigade support area.

The line platoons conducted internal mobility lanes, maximizing training time to conduct category-one tasks from the METL. This was a very resource-intensive training event. Evaluators from the peacetime higher headquarters evaluated the entire orders process. According to the battalion commander's guidance, evaluators focused their attention on troop-leading procedures, rehearsals, and the platoon leader's operations order.

The 224th benefited tremendously from the subject-matter experts provided by the 1st Engineer Battalion in training with the modernized demolition initiator (MDI) and the Volcano. While the 224th had been working with the MDI for the past 12 months, the 1st Engineer Battalion not only provided general instruction but also conducted training on different priming methods. The 224th was able to provide expertise in the siting process, because it had received the Volcano system in March 2000 and had conducted new-equipment training, demonstrated functions tests, and rehearsed system emplacement.

Lessons Learned

During its linkup with the 1st Engineer Battalion and the 1st BCT, the 224th learned some important lessons that should be helpful to other Reserve Component (RC) units when planning training with an AC maneuver unit.

Plan early and synchronize often. The first communication between the 224th and the 1st BCT/1st Engineer Battalion took place 19 months before the training event. Continuous communication on all aspects of the exercise tremendously increased the 224th's preparedness.

Be proactive during preparation for maneuver-force training. The AC maneuver/engineer units dedicate a great deal of time, energy, and resources during their field-training preparation. RC engineers can be either a training enhancement or a detractor, depending on their ability to be proactive during the process. Communicate your expectations and objectives so that the AC understands what you are trying to gain during the training. The 224th's experience was that the AC units were very supportive in helping to reach these goals.

Distribute SOPs down to the squad-leader level. When the 1st Engineer Battalion and 1st BCT forwarded their SOPs, the 224th gave a copy to each squad leader so they would know exactly what was expected when the linkup occurred.

Ensure that the organic training plan is prepared and ready. RC engineers cannot completely depend on AC engineers and maneuver forces to be the exclusive source of training when they link up. The 224th's S3 communicated early with company commanders to ensure that they had training plans and objectives outside the specific missions it was supporting. Commanders with solid plans used their soldiers' time efficiently; those who relied completely on their maneuver force for training were challenged to do likewise.

Do not plan weapons qualification during an integrated annual training. Because of the geographic location of the 224th, training areas that will support crew-served weapons qualification and demolition ranges are limited to the mobilization station at Fort McCoy, Wisconsin. Therefore, the unit normally qualifies on crew-served weapons during its annual training. However, when integrating annual training with an AC maneuver force, it is best to focus completely on the training opportunity at hand and save the crew-served weapons qualification for a weekend of inactive duty for training.



A soldier resupplies Class V for the next mission.

Incorporate the AC leadership into professional-development plans, if possible. The 1st Engineer Battalion commander's presence at and input into the 224th's officer professional-development program really focused the 224th's officer leadership team and validated what it had been discussing for the previous year. If the unit had to do it over, it would request that NCO leaders from the 1st Engineer Battalion participate in an NCO-development program with the 224th NCO leaders during the same month.

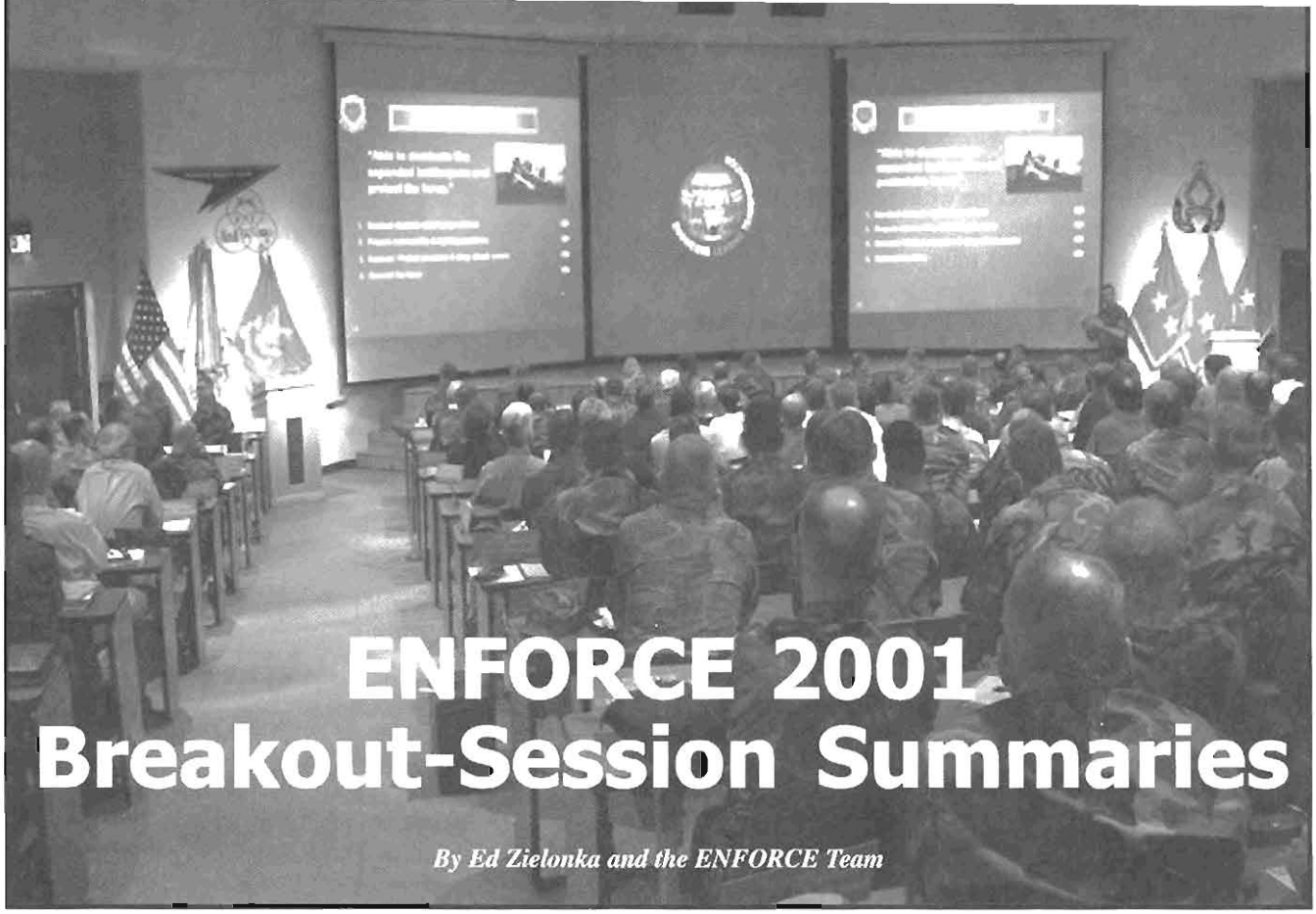
Summary

Integrating RC training with AC units is a mutually beneficial opportunity that should be pursued by RC engineers periodically. Each time we train with the AC, we increase the skills and understanding of all those involved.

There is no question that the officers, NCOs, and soldiers of the 224th benefited from this type of training. Our soldiers now can say that they trained for 2 weeks side-by-side with the 1st Engineer Battalion and the 1st BCT. They understand that even on active duty, training events are not perfect. The AC has many of the same challenges as the RC, such as resource availability and funding constraints. Our leaders were able to integrate with the AC, participate in the orders process at the task-force level, and communicate engineer capabilities with AC maneuver commanders. These communications challenges are issues that we will have to address if we are mobilized, but it is beneficial to first understand the challenges in a training environment.

MAJ Jacobus is the executive officer, 224th Engineer Battalion, Iowa Army National Guard, Fairfield, Iowa.

Photographs are courtesy of Nels Page, a U.S. Marine Corps Vietnam veteran and a volunteer photographer for the 224th Engineer Battalion. Mr. Page is an employee of the Medical Media Services Division, Veterans Administration Medical Center, Iowa City, Iowa.



ENFORCE 2001 Breakout-Session Summaries

By Ed Zielonka and the ENFORCE Team

The ENFORCE 2001 conference in May included a morning devoted to breakout sessions that allowed attendees to contibute to the DTLOMS process in some of the Regiment's most important issues, concerns, and programs that will have an immense impact on the Engineer Regiment during the Transformation. The six sessions from this year's conference are sununarized below.

Combat Bridging Requirements

By Lieutenant Colonel Harry Greene

The session provided an opportunity to review the current systems under development in the bridging community and the capabilities these systems will provide on the battlefield. Topics included the current status of the Wolverine, the armored vehicle-launched bridge (AVLB), the heavy dry support bridge (HDSB), and the improved ribbon bridge (IRB) programs and the activation of the multirole bridge companies. Key points of the initial briefing were as follows:

- Of the 132 Wolverines projected, 44 are currently funded.
- A Service Life Extension Program (SLEP) is being proposed for 220 AVLBs under the Army's RECAP program to offset the assault bridging shortage caused by limited funding for the Wolverine.
- Current Department of the Army plans call for a combined total of 352 Wolverines and AVLB-SLEP. Beyond these systems, the Engineer School is reviewing doctrinal and organizational solutions for the remaining requirement.
- The HDSB will be fielded during FY03 to multirole bridge companies at a per-unit ratio of four 40-meter bridges and four launchers. The HDSB has a military load class (MLC) 70/96 capability.
- The IRB will be fielded during FY03 to multirole bridge companies. This is a one-for-one replacement of the currently fielded standard ribbon bridge. The IRB has an MLC 80/96 capability.
- The multirole bridge company conversion is on schedule, with three Active Component and five U.S. Army Reserve units completed. A National Guard company activation is scheduled for this summer.

The following questions were presented for discussion:

Question 1: Given the decrease in the number of Wolverines to be fielded, and the proposal of an AVLB-SLEP, how do we adequately meet the requirements for assault bridging? Currently the AVLB/Wolverine are issued as one launcher, one bridge. Is this the proper ratio to support the force?

Question 2: What is the right mix of assault, support, and line-of-communication (LOC) bridging to fully support the force? Where in the force structure should it be assigned/controlled?

Question 3: How do we transition from assault to support to LOC bridging?

The Engineer School is exploring several courses of action (COAs) to make up for the bridging shortage caused by the loss of funds for the Wolverine program. The breakout session attendees concluded that the Engineer School, in conjunction with the Product Manager-Wolverine, should identify one chassis for the AVLB and develop an AVLB-SLEP to meet the requirements for assault bridging. It was recommended that the assault bridging capability be retained at the division-and-below levels.

Other areas explored and discussed were doctrinal issues associated with the employment of multirole bridge companies and how long an assault or support bridge should stay in place before being replaced with a LOC bridge. Command and control (C2) in the multirole bridge companies must be addressed, as well as the types and number of bridges assigned at the brigade, division, and corps levels. A recommended solution was to issue one additional bridge for each Wolverine and AVLB launcher at the brigade and division levels. Another alternative suggested was to add a third platoon to the multirole bridge company, thus having a full complement of assault, support, and LOC bridging capabilities at the corps level.

Attendees agreed that a study should be conducted to address the assault, support, and LOC bridging requirements and distribution and the level of command for all bridging assets within the force structure to support Transformation of the Legacy Force to the Objective Force. The Engineer School is pursuing funding to conduct this study.

Construction Engineering

By Captain William R. Guevremont III

During this session, representatives from the Active and Reserve Components and agencies of the U.S. Army Corps of Engineers broke into four groups to discuss echelon-above-division (EAD) engineer missions, organization, and allocated equipment. Three of the groups evaluated several COAs to determine the best organizational mix of four current EAD companies, under a battalion headquarters, to perform the following missions:

- **Division:** Missions required in the division area of operations that the division's organic engineer resources cannot execute. These missions were assessed for shortfalls in mobility, countermobility, survivability, and general engineering capabilities that require augmentation with additional construction engineering resources.
- **EAD:** Missions required to support the LOCs and infrastructure in support of division operations and extending through to the corps operational area.
- **Echelon above corps (EAC):** Missions required to open and maintain sea and aerial ports of debarkation and the infrastructure feeding into the corps.

The fourth group discussed prioritization of construction-engineer equipment, using a wide range of criteria to determine what equipment is the "core" of the construction force, the pieces least used, and strategic deployability.

The results and recommendations of these four groups are as follows:

- The organizational mix for the divisional group was one mechanized engineer company, one combat heavy company, one combat wheel company, and one combat-support-equipment company. The Engineer Division, Directorate of Combat Developments (DCD), MANSCEN, is evaluating a concept that incorporates a multirole bridge company to provide bridging in support of division operations.
- The organizational mix for the EAD group was two combat heavy companies, one combat wheel company, and one combat-support-equipment company.
- The organizational mix for the EAC group was two combat heavy companies, one combat-support-equipment company, and one construction-support company. However the group also recognized certain advantages in retaining a "plug-and-play" capability for EAC battalions (for example, replace the construction-support company with a port-construction or pipeline company for specific missions).
- The discussion/review of equipment produced several ideas for increased efficiencies that include leveraged engineer-group consolidated assets and the potential for leasing low-density equipment.

The next stage of this ongoing effort for Engineer Transformation is to produce detailed concepts for worldwide staffing.

Geospatial Engineering

By Lieutenant Colonel Steve Tupper

This session was designed to gather and consolidate suggestions for the National Imagery and Mapping Agency (NIMA) terrain data and product requirements process. The session followed the address given by the NIMA Director to the Regiment's leadership concerning the support NIMA provides to the Department of Defense. U.S. Army engineers help drive the procedures that Army forces use to secure the terrain data that major tactical units and their terrain teams use to support the field. The requirements process includes ordering and delivery information.

Breakout session attendees agreed on several key points:

- The Army needs a simple, step-by-step, comprehensive, consolidated set of instructions—not a series of uncoordinated guidance.
- The Defense Logistics Agency (DLA) or NIMA must create an interface between the NIMA Gateways (secure Internet Web sites for ordering data) and the DLA Web site for ordering and shipping.

(Continued on page 38)

ENFORCE 2001 Highlights














ENGINEERS
"Engineers Leading Transformation"

(Geospatial Engineering, continued from page 35)

- Users need feedback from the NIMA system that reports exactly what has been ordered, how large the product is for electronic storage and shipping, and how long it will take for delivery.
- Some orders will be for existing products while others generate new production. The responsibility for filling requests for existing products remains with DLA. The responsibility for new production lies with NIMA. This split should not affect the user.
- The chief of the TRADOC Program Integration Office-Terrain Data showed a draft geospatial product-request form that was created using Microsoft® Access®. Attendees recommended several modifications to the form.
- Army units desiring NIMA data should consider their orders for Mission-Specific Data Sets (MSDS) as a starting point for negotiations with the NIMA Customer Support Team (either the Army team or a CINC support team). The team will advise the customer on the data available that NIMA can gather or generate by the requested date.

The session ended with the positive feeling that NIMA is moving in a direction that is advantageous to the Army's long-term interests. Over the next few years, NIMA will—

- End production of 1:50,000-scale maps.
- Increase the holdings of foundation data.
- Drive services to request MSDS.
- Build the commercial joint mapping tool kit to view the data on the Army Battle Command System.

This transition may be difficult, so beginning the transition now is smart. The ongoing exercise schedules, automated C2 systems integration, and the Army Transformation give an opportunity to make these changes outside of actual operations. The Army has an early voice in defining future requirements, and engineers are leading the Army's Transformation in this aspect.

IBCT/IDIV Engineers

By Major Ronald Condon

This session focused on taking a firsthand look at the engineer units in the Interim Brigade Combat Team (IBCT) and Interim Division (IDIV) and recommending changes—across doctrine, training, leader development, organization, materiel, and soldiers (DTLOMS)—to help ensure optimal bang for the buck. This is an area we must "get right the first time." The personnel attending this breakout session discussed—

- The operational environment. Its characteristics include—
  - Distributed and simultaneous operations.
  - Limited or poorly developed infrastructure.
  - Noncontiguous battlefield.
  - Complex terrain, to include a wide range of operating conditions.
- The threat concepts and capabilities. The threat—
  - Will marginalize the U.S. high-tech advantage via asymmetric operations.
  - Can employ military forces where and when it chooses.
  - Can accept "not losing" as a strategic goal.
  - Can support a prolonged conflict in the contested area.
  - Will deny U.S. access and limit tactical mobility through extensive use of mines and chemical-biological agents.
  - Is modernizing in light of late twentieth-century lessons.
  - Can counter with sufficient mass and technology to inflict highly visible and embarrassing losses.
- The IBCT Operational and Organizational (O&O) Concept and the Engineer Battlefield Functional Area (BFA) Assessment. The organic IBCT engineer company—
  - Is optimized to provide mobility support to maneuver battalions.
  - Provides limited survivability and countermobility support.
- The IDIV O&O Concept. The IDIV—
  - Is full-spectrum capable.
  - Will have three IBCT-like combat formations.
  - Uses current "off-the-shelf" technology and platforms.
  - Is the bridge to the Objective Force.
  - Is an early-entry force (simultaneously deploys and shapes; is decisive earlier).
- The engineer IBCT and IDIV engineer BFA O&O requirements versus capabilities. Attendees—
  - Analyzed the DTLOMS impacts.
  - Identified risk/excess capability for IDIV O&O mission-essential tasks.

Although the session did not allow enough time to answer all of the outstanding issues, it did provide a venue for engineer commanders to understand the issues and provide recommendations for the design of the IDIV engineer organization. All participants agreed that the current engineer-force structure was too small to effectively support the IDIV mission sets. They further agreed that—because of the complex operations and the environment—an engineer colonel is needed to command the IDIV engineer organization. Three possible IDIV engineer organization courses of action (COA) were discussed:

COA 1: The working engineer group or regiment. This COA consists of a group or regimental headquarters (commanded by a colonel) and five companies:

- Three IBCT engineer line companies (typically directly supporting each IBCT).
- An "IBCT-like" general support sapper company (provides close combat support to weight the IDIV main effort).
- A construction engineer company (provides general support to the division—similar to a light equipment company).

COA 2: An engineer group or regimental headquarters with two subordinate engineer battalions:

- A battalion headquarters consisting of the three IBCT companies and an "IBCT-like" general support sapper engineer company.
- An engineer battalion consisting of an IBCT-like general support sapper engineer company, a "corps wheel-like" engineer company, and a corps light horizontal equipment construction company.

COA 3: An engineer group or regimental headquarters and one subordinate engineer battalion:

- A regimental headquarters commanding an IBCT-like general support sapper engineer company, a corps wheel-like engineer company, and a corps light horizontal construction engineer company.
- An engineer battalion consisting of three IBCT engineer companies and an IBCT-like general support sapper engineer company.

The breakout session attendees agreed to recommend COA 2 to the commanding general: Increase the engineer force structure and ensure that it supports the growth of future IDIV engineer group or regimental and battalion commanders. The Engineer School continues to analyze the best force-structure mix for the IDIV engineer organization and will validate the engineer requirements in upcoming IDIV rock drills before finalizing the IDIV O&O on 1 March 2002.

Mine/Countermine

By Colonel John Holler

This session consisted of brief presentations on the evolution of mine and countermine (M/CM) systems and highlighted Engineer School efforts for the future. Engineer leaders, materiel developers, combat developers, and contractors discussed doctrinal and materiel efforts affecting future M/CM systems. The following topics were discussed:

- For political reasons, it may be advantageous to stop referring to systems as "mines" (particularly the "smart" ones) and change the terminology to "munitions."
- C2 systems must do a better job of tracking and portraying mine/munition locations. These systems must display exact locations of individual mines or exact boundaries of fields to Force XXI Battle Command, Brigade and Below (FBCB2). A challenge exists in passing information between differing digital systems or in integrating echelons above division or other units not possessing digital or compatible C2 systems. There are too many manual or "swivel-chair" work-arounds in use.
- Commanders in the field would be much better served if we could modify the Volcano system to allow self-destruct times to be reset and add a command-detonation feature. Currently, maneuver commanders are reluctant to use anything beyond a 4-hour self-destruct time. They view even 48 hours as too long a commitment. The 4-hour self-destruct time severely impacts the engineers' ability to shape the battlefield. They must closely assess decision and trigger points when executing a system that begins its self-destruct cycle in less than 4 hours. A reset feature would allow commanders to lengthen effects, and a command self-destruct—or better yet a render-safe—feature would allow friendly forces to pass without having to breach our own minefields. If these features cannot be incorporated into the Volcano, they must be features of any future mine systems.
- Future mines must all have a capability to identify friends and foes or have a remote on-off-on feature. We need these technologies to minimize fratricide. Also, future emplaced mine/munition fields should have a warning technology to alert errant friendly forces that they are approaching a danger area. Electronic or visual warnings on C2 systems and "in the clear" must be used. These warnings need to be effective for both digitized and nondigitized forces.
- We may need to look at using mines without an explosive fill—nonlethal and other technologies. Perhaps we can fulfill the role of mines with systems that attack the electronic components of a vehicle or its engine—or with a technology that attacks some other part of a vehicle that prevents it from moving or prevents the occupants from controlling or using the vehicle.
- It is time to reconsider our classification of minefield locations. Currently, the location of minefields and even individual mines is classified as "Secret." This leads to serious challenges with the new "smart" mines/munitions that self-report their locations and other information to remote-control stations.
- Senior leaders have questioned our continued need to use "brute-force" breaching systems. Currently, some form of brute-force breaching may be the only way to deal with certain mine threats. These systems, by necessity, will remain a viable part of our countermine capability. Additionally, searching for a single "silver-bullet" technology is too optimistic. Our countermine success will continue to be tied to several systems, each of which provides a specific but limited capability.
- We currently are developing precision standoff detection and neutralization approaches to the countermine problem. A more beneficial option may be to develop an area-neutralization capability. If we can neutralize mines over a wide area instead of focusing on precise neutralization, we can eliminate the need to conduct precise mine detection.

These comments are all well founded and must be considered by all that are developing the future M/CM systems and doctrine for our Regiment and Army.

Officer Development

By Lieutenant Colonel Susan Myers

This session provided the Regiment with information concerning the transformation of the Engineer Officer Basic Course (EOBC) to the Basic Officer Leader Course (BOLC) Phases I and II in fiscal year 03. The purpose of this change is to produce leaders with character and competence who are self-aware and adaptable and act to achieve excellence. This initiative is being directed by the Training and Doctrine Command and will repackage the current EOBC 17-week course to a 20-week course.

The first 7 weeks of the BOLC Phase I will take place at Fort Benning, Georgia. This course will be a mix of officers from all branches and will focus on leadership development. Course material includes tactics, leadership, doctrine, counseling, weapons qualification, land navigation, physical training, and situational tactical exercises. Common-core instruction includes maintenance, preventive medicine, air defense, and communication skills. Approximately 76 percent of the instruction will take place in the field and the remaining 24 percent in the classroom.

To graduate from BOLC Phase I, all lieutenants will meet height/weight standards, pass the Army Physical Fitness Test, perform satisfactorily in leadership requirements (counseling, peer evaluations, and cadre assessments), qualify with the M16A2 or M4 rifle, complete 4- and 6-mile foot marches, and run 3 miles in less than 27 minutes in formation. Other skills will include combat water survival, running 4 miles in less than 36 minutes, completing 8-mile foot marches, and passing basic land navigation (day and night) and a leadership exam from FM 22-100, *Army Leadership*.

The second phase of BOLC—or BOLC II (Engineer)—which is at Fort Leonard Wood, Missouri, will be similar to the EOBC program of instruction that is currently being taught. There will be some course reductions because of time constraints. Most of the common-core subjects will emphasize engineer systems, combat engineering, tactics, and construction skills. The combat-engineering instruction will focus on the task-force-engineer operations-order process, mine warfare, bridging, reconnaissance, demolitions, target folders, breaching operations, engineers in military operations in urban terrain (MOUT), obstacle tactics, and engagement-area development. The construction subjects will include project management, structures, utilities, concrete, survivability positions, drainage, airfield-damage repair, and road/airfield construction. Some of the subjects that will be deleted are Bailey-bridge design, the river-crossing practical exercise, and equipment training.

Some of the issues raised during ENFORCE were scheduling of the courses so the Reserve Component officers have some flexibility in working their schooling with their careers, minimizing duplication of subjects taught in other schools, and making course material available online. The Engineer School is continuing to train our future leaders to be a vital part of the combined-arms team. We appreciate your feedback and look forward to your support of the Engineer BOLC.

Officer Retention

By Lieutenant Colonel Mike Helmick

The purpose of this breakout session was to educate the engineer leadership on retention challenges and develop proposals on how the Engineer Regiment can improve engineer-officer retention.

During the session, information was presented on the Army's initiatives to retain company-grade officers and its efforts to man the force. These initiatives included expanding educational opportunities, increasing assignment choices to better accommodate officer preferences, and providing better communication to the field. During the session, senior leaders also discussed an initiative by the U.S. Army Corps of Engineers to provide junior officers opportunities to work in local engineer districts as part of a junior-officer intern program.

Breakout-session discussions included the following topics:

- The need to balance assignments to minimize the impact on the family.
- The changing Army demographics. A higher percentage of spouses work and have professional careers, which creates a need for more stability and a better support system for families.
- The fact that married couples in the service are leaving the Army together.
- That commanders should do all they can to help retention. Officers frequently say that the senior leadership is one of the reasons they are leaving the Army.
- The Army met its goal for the Active Duty Recall Program for captains.
- Encouraging officers to switch from Active Component to Reserve Component, or vice versa, to retain quality officers in the total Army.

There is no single reason why officers leave the Army, and there is no one solution for improving retention. However, each leader can positively impact retention by actively participating in senior-level discussions and providing direct leadership to junior officers.

Conclusion

This year's breakout sessions provided a valuable platform for senior leaders to discuss some of the most important subjects facing the Engineer Regiment. Some very critical issues were raised and addressed. Session notes are being finalized and will be forwarded to the ENFORCE coordinator for further action as necessary.

Where Is the MTOE Guy?

Recommendations for the Combat-Engineer Company (Heavy Division) MTOE

By Captain Edward P. Chamberlayne

On 17 October 2000, a new edition of the modified table of equipment (MTOE) went into effect for the mechanized combat-engineer battalions. Over the years, the MTOE has been pared down at a considerable savings. As an officer in combat-engineer battalions, I have been frustrated with the inadequacies of the MTOE. In this article, I list the items, by priority, that I believe could improve the readiness and combat ability of the combat-engineer company. I list dollar amounts, when possible, to justify the additions and deletions to the MTOE. Where appropriate, I include a table that summarizes the current MTOE and my recommendations. The prices, which are based on the March 2000 FEDLOG CD-ROM set distributed by the Defense Logistics Agency, are an attempt at quantifying the changes and are not intended to be a complete statistical analysis of the MTOE. My intention is to generate discussion between the combat-engineer battalions and then provide feedback to the Engineer School to the desk of the MTOE guy.

Armored Combat Earthmover (ACE)

Recommendation: Change the MTOE to five ACEs and two D7G bulldozers with M916 prime movers and M870 trailers.

Engineers know or have heard about the problems with the ACE. It is a great concept—combine the digging capability of the D7 bulldozer with the speed, mobility, and armored protection of an M113. This concept is not a reality yet, but the systematic improvement plan for the ACE is continually improving the vehicle. It is good for breaching, digging protective berms, and pushing soil. But for constructing hull or turret defilade vehicle fighting positions in rocky or clay-rich soil, you need something more durable—the D7G with rippers. We had D7Gs until the ACE arrived. What I recommend now is a mix—five ACEs and two bulldozers. This would allow the commander to task-organize for the defense, offense, or stability and support operations. This will also give the combat-engineer commander the ability to improve roads and construct hasty trails for the maneuver commander.

Incorporating the D7G bulldozer will mean a savings for the combat-engineer company (see Table 1). This recommendation assumes that the person will operate the M916 prime mover and the D7G. A cost that is not included in this proposal is the maintenance of the ACE versus the D7G. However, eliminating two ACEs will save a significant amount of money on Class IX repair parts.

High-Mobility, Multipurpose Wheeled Vehicle (HMMWV)

Recommendation: Add one M998 HMMWV to the MTOE for the first sergeant.

It seems that every first sergeant in every combat unit on the battlefield has a vehicle except the combat-engineer first sergeant. I believe that he needs a cargo HMMWV so he can inspect training, deliver Class I supplies to soldiers, deliver Class IX repair parts, deliver/pick up mail, conduct casualty evacuation, and so on. Some would argue that the 5-ton or the 2 1/2-ton truck in the headquarters platoon is available. However, the supply sergeant and supply clerk use the 5-ton truck , and the prescribed-load-list (PLL) clerk uses the 2 1/2-ton truck. A vehicle for the battalion command sergeant major and battalion executive officer was just added to the MTOE, so I recommend one for the first sergeant. The cost would be about $34,735.00.

Combat Engineer Vehicle (CEV) and Personnel

Recommendation: Reinstate the two staff-sergeant positions and a cargo HMMWV.

In 1996, the combat-engineer company lost two CEVs and eight personnel, according to the revised MTOE. I think this was done to save money on repair parts, prepare for the fielding of the Grizzly, and improve unit manning (about 504 engineers [12B]). This created a significant void in our mobility-support capability. The other impact was the loss of two of the three

Current MTOE			
Vehicle	Quantity	Cost per Unit	Total
M9 ACE	7	$887,050.00	$6,209,350.00
Changed MTOE			
Recommended Vehicles	Quantity	Cost per Unit	Total
M9 ACE	5	$887,050.00	$4,435,250.00
D7G Bulldozer	2	$241,642.00	$483,248.00
M916 Tractor	2	$69,310.00	$138,620.00
M870 Trailer	2	$20,007.00	$40,014.00
		Total	$5,097,168.00
		Total Savings	$1,112,182.00

Table 1. Recommended Vehicle Changes

squad leaders in the assault-and-obstacle (A&O) platoon. The platoon was broken into two assault sections—each led by a staff sergeant who was also the tank commander for the CEV—and an obstacle section. The most senior armored vehicle-launched bridge (AVLB) tank commander—usually a junior sergeant who must lead his soldiers and peers—is now the squad leader. This creates a void of leadership in the A&O platoon. It is the most maintenance-intensive platoon in the company, yet it has the most junior noncommissioned officer (NCO) leadership. This does not set the platoon up for success. Consequently, if we add the squad leaders, then we should add a vehicle for them (see Table 2).

FY96 MTOE			
Vehicle/Personnel	**Quantity**	**Cost per Unit**	**Total**
CEV	2	$676,796.00	$1,353,592.00
12B30	2		
12B20	2		
12B10	4		
Changed MTOE			
Recommended Vehicle/Personnel	**Quantity**	**Cost per Unit**	**Total**
M998 (cargo)	2	$34,735.00	$69,470.00
12B30	2		
		Total Savings	$1,284,122.00

Table 2. Recommended Vehicle Additions

Communications Equipment

Recommendation: Upgrade the radio configurations.

Communication with the soldier in the field has always been a challenge. The recent MTOE change was a positive one—every vehicle in the engineer company is now authorized a radio system. However, most of the vehicles need long-range capabilities since an engineer company can be spread across a task force or even a brigade during combat operations. Thus, I recommend that every radio in the vehicles be able to talk long range and that leaders be able to talk on at least two radios at long range. Adding a power amplifier to the existing radio system—a cost of about $921.00—could solve this problem. Table 3 lists the recommended changes by vehicle type in a combat-engineer company.

AN/PVS-4 Night Sights and M203 40-mm Grenade Launchers

Recommendation: Add 2 more AN/PVS-4 night sights and authorize the company to carry 12. Add 2 more M203s to the MTOE and authorize the company to carry 6.

Current MTOE			
Vehicle	**Radio System**	**Description**	**Quantity**
M60 Tank	AN/VRC-87D	SR	4
M9 ACE	AN/VRC-87D	SR	7
HEMTT	AN/VRC-87D	SR	2
Squad M113	AN/VRC-88D	SR w/dismount kit	6
Platoon sergeant HMMWV	AN/VRC-88D	SR w/dismount kit	2
A&O platoon sergeant M1038	AN/VRC-90D	LR	1
Platoon leader M113/M1038	AN/VRC-91D	SR/LR w/dismount kit	3
Commander's vehicle/M577	AN/VRC-92D	LR/LR	3
M548 Volcano	AN/VRC-87C	SR	2
First sergeant HMMWV	None	N/A	1
Assault section HMMWV	None	N/A	2
Supply 5-ton	AN/VRC-89D	SR/LR	1
PLL 2 1/2-ton	AN/VRC-89D	SR/LR	1
SEE truck	AN/VRC-89D	SR/LR	2

Changed MTOE				
Vehicle	**Recommended Radio System**	**Description**	**Upgrade Cost per Unit**	**Total**
M60 Tank	AN/VRC-90D	LR	$1,069.00	$4,276.00
M9 ACE	AN/VRC-90D	LR	$1,069.00	$7,483.00
HEMTT	AN/VRC-90D	LR	$1,069.00	$2,138.00
Squad M113	AN/VRC-91D	SR/LR w/dismount kit	$10,730.00	$64,380.00
Platoon sergeant HMMWV	AN/VRC-91D	SR/LR w/dismount kit	$10,730.00	$21,460.00
A&O platoon sergeant M1038	AN/VRC-91D	SR/LR w/dismount kit	$10,071.00	$10,071.00
Platoon leader M113/M1038	AN/VRC-92D	LR/LR	$2,011.00	$6,033.00
Commander's vehicle/M577	No change			$0.00
M548 Volcano	AN/VRC-90C	LR	$1,069.00	$2,138.00
First sergeant HMMWV	AN/VRC-92D	LR/LR	$21,238.00	$21,238.00
Assault section HMMWV	AN/VRC-90D	LR	$13,178.00	$26,356.00
Supply 5-ton	No change			
PLL 2 1/2-ton	No change			
SEE truck	No change			

Table 3. Recommended Radio-System Changes

LIN	Nomenclature	Cost per Unit	Quantity	Subtotal	Remarks
B49004	Bayonet	$79.04	24	$1,896.96	71 M4s and M16s means 24 excess bayonets
B84404	RB3 recon boat	$1,207.00	2	$2,414.00	Not used
G66776	Driver proj powder actuated	$395.85	2	$791.70	Not used
M60449	Multimeter	$130.00	1	$130.00	Used and needed but not authorized
L44595	M203 grenade launcher	$593.00	8	$4,744.00	Reduced from 12 to 4
P06148	PLT early-warning system	$8,312.00	2	$16,624.00	Not used and obsolete
R93169	AN/PRM-34 radio test set	$932.00	1	$932.00	Used and needed but not authorized
T63238	Sketch set	$690.04	2	$1,380.08	Not used
W48074	Platoon pioneer tool kit	$3,891.49	1	$3,891.49	Not used—already removed from MTOE
W34511	Platoon carpenter tool kit	$1,404.03	1	$1,404.03	Not used—already removed from MTOE
X11320	Transit pocket clinometer	$164.55	2	$329.10	Not used
W37483	TK-101 commo SPC tool kit	$976.00	1	$976.00	Used and needed but not authorized
	M9 ACE and dozer-mix idea			$1,112,182.00	Changed to 5 ACEs and 2 D7G dozers
	First sergeant's HMMVW idea			-$34,735.00	Give first sergeant a HMMWV!
	Assault-section squad-leader idea			$1,284,122.00	Give squad leaders HMMWVs
	Radio-upgrade idea			-$165,573.00	More radios means better communication
	M203 and AN/PVS-4 idea			-$6,864.00	Allocate the weapons and night sights better
	Company commo-section idea			-$2,038.00	Bring back the 31U10 and tools
	PLL-section idea			-$8,524.00	Establish company PLL and give M105 trailer
		Total Savings		$2,214,083.36	

Table 4. Summary of Recommended Changes to the MTOE

The MTOE change reduced the number of AN/PVS-4 night sights to 10. These sights are used with the M249 squad assault weapon (SAW) and the newly fielded M240B machine gun. Currently, the MTOE has eight M249 SAWs and four M240B machine guns. Therefore, we need two more AN/PVS-4 night sights to be effective. Before the latest update to the MTOE, we had two M203s per squad (12 total in the company), which the team leaders normally carried. The current authorization is four per company. I believe the absolute minimum should be one per squad, assigned to the squad leader. The cost would be about $6,864.00

Communication Personnel

Recommendation: Reassign one military occupational specialty (MOS) 31U10 and reinstate the TK-101 communication specialist tool kit, multimeter, and AN/PRM-34 radio test set.

As of 17 October 2000, the 31U10 MOS and the TK-101 were no longer authorized. Engineer companies are designed to support mechanized and armored task forces, but they also operate independently. The Single-Channel Ground-to-Air Radio System (SINCGARS) equipment is more complicated when troubleshooting defective radios and installation kits in the tracked vehicles. The company needs a 31U10 to troubleshoot the internal intercom systems, power-junction boxes, and combat-vehicle-crewman helmets. We also need the diagnostic tools such as the multimeter and AN/PRM-34. The cost would be about $2,038.00.

Company Prescribed Load List (PLL)

Recommendation: Reassign one MOS 92A10 (PLL clerk) to the MTOE of each company and add an additional M105A2 trailer.

The engineer battalions are not authorized enough 92A10s to operate a Unit-Level Logistics System-Ground (ULLS-G) computer (or box) for each company. If we are to maintain our equipment properly, keep the equipment at -10/-20 standards, then we must be authorized the 92A10. Forcing the engineer company to train 12B10s to do the job takes away from our total engineer capability and prevents a soldier from continued engineer training.

Engineer squads use the M105 trailer to move the equipment that does not fit in the squad M113s. A seventh trailer, which is used to move equipment for the company headquarters M577, is authorized. The company needs an additional trailer to move equipment behind the 2 1/2-ton for the company PLL. The cost would be about $8,524.00.

Conclusion

We are constantly challenged to face various missions on a daily basis. Let's design an MTOE that helps the soldiers face these missions more effectively and efficiently. Table 4 is a summary of the changes I recommend to the MTOE. We must remain flexible to adapt to new missions; having the proper equipment and personnel will allow us to do this better. I would like to encourage more discussions about our MTOE, suggest ideas on how to improve it, and make an impact on our future readiness.

Please send feedback regarding this article to *edchambe@vt.edu*.

Captain Chamberlayne just left company command of C Company, 70th Engineer Battalion at Fort Riley, Kansas. He has served as platoon leader, company executive officer, S3 operations officer, and assistant brigade engineer in mechanized engineer battalions. He is currently assigned to the U.S. Army Student Detachment while in graduate school at Virginia Tech.

Cave Demolition

By First Lieutenant Scott Swilley

From 2 June to 10 December 2000, Alpha Company, 16th Engineer Battalion, Giessen Army Depot, Germany, was deployed to Camp Monteith, in Kosovo, to help maintain a safe, stable, and secure environment for the people of Kosovo. The company supported the Task Force 1-36 Infantry sector by managing eight towns and monitoring the provisional boundary. In addition, the company conducted on-order missions out of the sector to apply its engineer-specific skills. In early November, the task force called on those skills.

As winter approached, caves were being discovered in the mountainous southeastern part of Kosovo—one of them in the Task Force 1-36 Infantry sector. The task force had learned that a cave also had been discovered in the Polish sector and, after the entrance was cleared, multiple antipersonnel mines with trip wires were found. Additionally, the cave contained a weapons cache, a much-earlier victim of a booby trap, chemical fuses, and a gas mask for a horse. This indicated the age and diversity of the cache and suggested the possibility of a chemical threat associated with caches in remote areas. Alpha Company's 1st Platoon was tasked to clear and seal the cave in the Task Force 1-36 Infantry sector and provide command and control of additional assets, as necessary. This article relates the events surrounding the demolition reconnaissance, hypothesis, and execution and the lessons learned.

Reconnaissance

Key leaders from the platoon, an explosive ordnance disposal (EOD) team, and a security detail from Alpha Company, 3/327 Infantry, which owned the sector in which the caves were found, went into the hills to conduct a reconnaissance of the cave. The route leading to the cave—about 15 kilometers of dirt road containing potholes and extremely sharp curves—was untrafficable to vehicles with long wheel bases (such as heavy expanded-mobility tactical trucks [HEMTTs], dump trucks, and mix trucks). After arriving on-site, the infantry secured the area, and sappers in mission-oriented protective posture (MOPP) Level 1 gear used AN/PSS-12 mine detectors to sweep a path to the entrance of the cave, while scanning for signs of booby traps. Once a path had been cleared, a left and right handrail was emplaced using high-visibility tape.

Sappers from 1st Platoon were then ready to begin gathering critical dimensions of the cave for a potential demolition mission. Before they could determine the inside diameter, they had to clear several feet into the cave. First, they visually inspected with a flashlight from a cleared position and then grappled into the cave as far as possible from behind a berm a few meters from the entrance. Once this was completed, the dimensions could be collected.

1st Platoon sappers discovered that the average interior diameter of the cave, which extended into the hill approximately 75 meters, was 5 feet. There were no abrupt changes in direction in the cave, and it was level with the horizon. Although the cave appeared to be constructed by man, there was no evidence of spoil or means for spoil removal. The hill that the cave extended into resembled granite in appearance, strength, and hardness.

Hypothesis

After collecting the critical dimensions and the necessary information for the demolitions reconnaissance report, the recon team members returned to Camp Monteith to formulate their plan of attack. They established design criteria based on two demolition techniques.

The first technique was based on a combination of the Methods I and II attack on an arched, closed-spandrel, masonry bridge. Essentially, the structural integrity of the cave would be destroyed by placing a charge on each wall and one on the ceiling to create the necessary spoil to seal the cave. These three charges formed one firing system.

The second demolition technique used the premise of counterforce-charge demolitions. The challenge would be to create the required amount of spoil to seal the cave, while taking into account the amount of rock that would be pulverized into inadequate sealing material. The solution was to create a counterforce shock wave by placing three equally spaced firing systems in the cave and detonating them simultaneously. The theory was that the shock wave from the two outer charges would collide with the shock wave from the inner charge and force the inner charge to penetrate to a much greater depth, causing a larger volume of material to be displaced. If too much force was generated, material could be blown from the cave, creating a large crater and subsequently a second entrance to the cave from above. These were the premises that were the foundation for the design of the charges.

The charge design was based on calculations in Field Manual 5-250, *Explosives and Demolitions*, for breach charges attacking rock. Taking into consideration the dimensions of the cave and the volume of material necessary to be produced plus the void created by rock pulverization, a 7-foot breach charge was selected. This amounted to 118 packages of C4 explosives per breach charge, 354 packages per counterforce charge, and 1,062 packages for the firing system—or 1,327.5 pounds of C4 to be detonated simultaneously (see Figure 1).

When Alpha Company personnel contacted the Engineer School to verify the method and amount of demolitions, they learned that there was no doctrine for this type of operation. Basing their answer on demolitions for quarrying operations, school personnel suggested boreholes as the preferred technique. However, it was not possible to drill boreholes, and explosive boreholes were not an option because of the possibility of a cave-in when reentering the cave after demolitions had been executed inside. The school personnel concurred with the platoon's assessment of the situation.

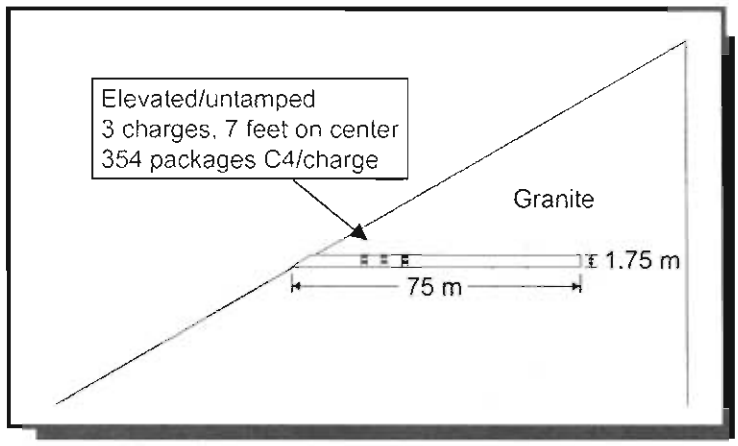


Figure 1. Cross-Sectional View of Cave and Charge Placement

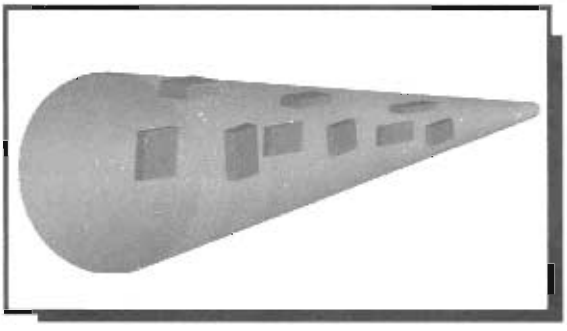
Executing the Mission

After coordinating with EOD, security, and medical-evacuation personnel, the platoon was ready to execute the mission. Because of the route conditions, Class V materials had to be shuttled to the site via a cargo HMMWV. Once the platoon reached the cave, it reestablished security, cleared and marked a lane to the entrance of the cave, and cleared a space for preparing the demolitions.

One platoon member and a soldier from the EOD team entered the cave to look for booby traps and caches. Since the cave surfaces were solid rock, there was no place to bury or camouflage booby traps, so the soldiers could visually clear the cave by using a flashlight. Moving deliberately through the cave, the two soldiers scanned all sides for anything unusual before proceeding. The clearing operation took approximately 30 minutes, and no booby traps or caches were found.

Thirty-seven cases of C4 explosives were shuttled up to the site along with the Class IV materials. To enable the charges to be placed against the sides and ceiling of the cave, platforms were constructed which would allow proper contact between the explosives and the cave surface. Figure 2 shows the placement of the charges. In addition, a crawl space was created where sappers could prime the charges once they had all been placed.

To obtain a counterforce effect, all charges had to be simultaneously detonated, so an interesting problem was posed. Due to the confinement of the cave and the amount of charges, a dual-fired system consisting of British junctions was not a feasible solution. A modernized demolition initiator (MDI) would have to be used to ensure a simultaneous detonation. However, it had to be verified that all the M11 shock tubes used to prime the explosives were the same length from the charges to the shock-tube consolidation point, care had to be taken to not rupture the shock tubes in the confined and rocky environment, and accountability of M11 shock tubes had to be maintained to ensure the integrity of the two firing systems.


Figure 2. Perspective View of Charge Placement

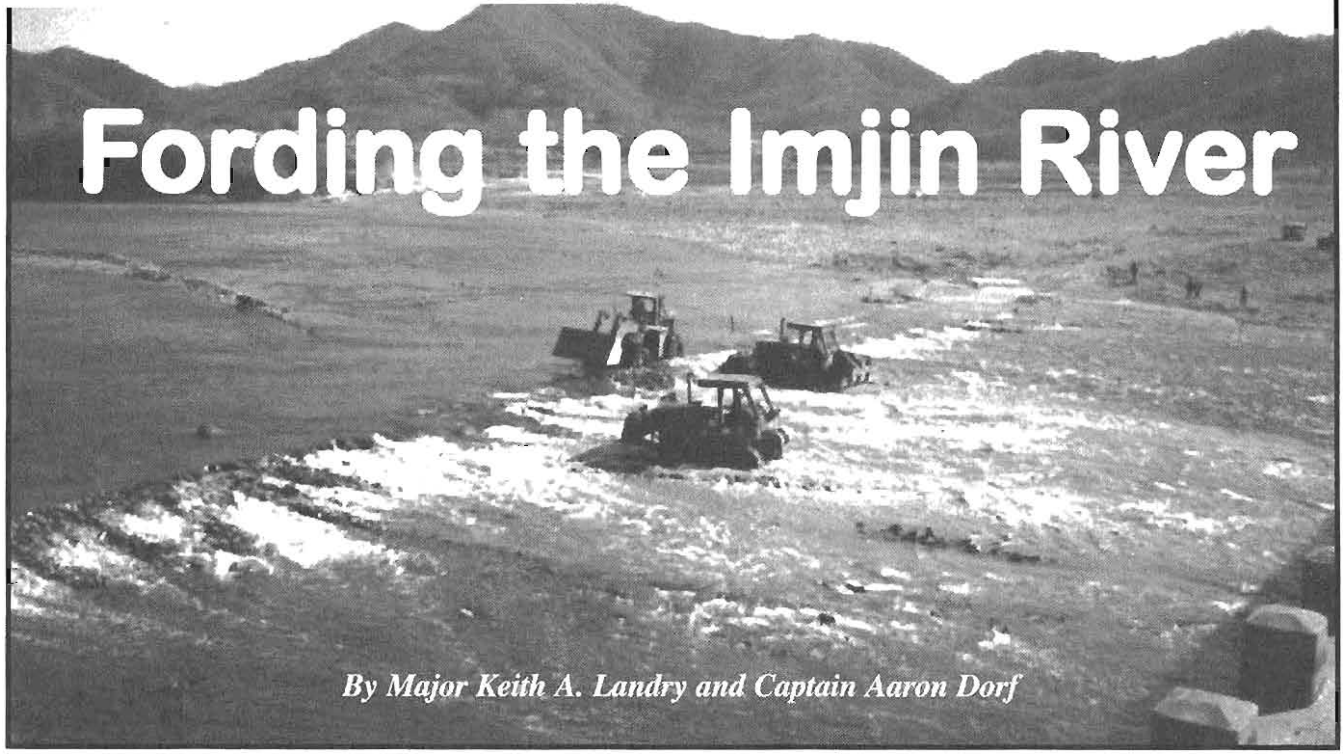
The MDI system worked very well. Two M11 high-strength blasting caps and shock tubes were used to prime each charge. An M11 from each charge was run to a central location, which ensured that all shock-tube lengths were equal. At that point, two M9 bunch blocks per firing system were used to consolidate the M11s, and two additional M11s were run out of the cave and tied into two series of M13 low-strength blasting caps with 1,000 feet of shock tube. This firing system would provide the necessary redundancy and ensure simultaneous detonation.

The demolition was executed and the desired effect achieved—the entrance to the cave was sealed by a massive amount of material, and the cave collapsed. This was evident by a depression in the hillside that extended along the route of the cave.

Lessons Learned

During this operation, the platoon learned demolition calculations and theory for cave and tunnel demolitions. It also learned the importance of continuing to maintain proficiency in wartime, individual engineer-specific tasks. Although the calculations worked in this case, a more detailed study would be required for developing doctrine on this subject. In addition, entering and clearing the cave was an engineer job that had not been performed recently. However, with continued battle-focused training, these skills will not be forgotten.

First Lieutenant Swilley, who led 1st Platoon, Alpha Company, 16th Engineer Battalion, during this operation, is the training officer for the battalion. He holds a bachelor's in civil engineering from Louisiana State University and is a graduate of the Engineer Officer Basic Course.



Fording the Imjin River

By Major Keith A. Landry and Captain Aaron Dorf

During the 2d Infantry Division's preparation for the U.S. Forces Korea's maneuver exercise Foal Eagle '99, the 44th Engineer Battalion (Combat) and the 82d Engineer Company (Combat Support Equipment) received the mission to emplace a tactical ford across the Imjin River. The ford site had to pass an armored task force containing M1 Abrams tanks and M2 Bradley infantry fighting vehicles through an 85-meter-wide water obstacle and support subsequent crossings by smaller groups of mechanized vehicles without significant degradation. For the engineer units involved, this task (from their mission-essential task list) provided an excellent opportunity for the chain of command to exercise engineer reconnaissance skills, integrate earthmoving NCO expertise with combat-engineer judgment, and safely emplace a viable ford on a fast-moving river.

Reconnaissance

As part of the troop-leading procedures, the battalion S3, the company commander, and the commander's key leaders conducted a thorough reconnaissance of the proposed ford site. As shown in the site sketch in Figure 1, the Imjin River at this location runs predominately east-west. At the desired crossing site, a rough access ramp led down to the south bank from the existing unimproved road. The exit ramp on the egress bank was nonexistent. There was a one-lane vehicle bridge (concrete deck and steel girders on concrete piers) just 15 meters west of the proposed ford site, but due to severe weathering of the deck and scouring at the base of the piers, the bridge was rated military load class (MLC) 05 and limited to wheeled traffic.

Using both hasty and deliberate reconnaissance techniques described in FM 5-34, *Engineer Field Data*, a team of combat engineers and engineer-equipment operators obtained critical information about the proposed ford site. The river reconnaissance was conducted in two parts: First, the engineers determined the key characteristics of the river, to include the water's depth and speed, river-bottom substrate, and composition of the egress and exit banks. The river-bottom composition was determined by wading into pools of still or slow-moving water at different locations, probing, and gathering soil samples. The hasty analysis revealed a 50/50 mix of cobbles and unsorted stones—mostly rounded float from the surrounding hills—and poorly graded sand without any significant deposits of silt or clay. Using available on-site litter (Styrofoam® and plastic soda bottles), the reconnaissance team calculated the river velocity at the planned crossing site and various locations upstream. The velocity of the water ranged from 0.5 to 3.0 meters per second across the river's width, with the highest flow in a deep, scoured channel adjacent to the exit bank.

Secondly, the reconnaissance team identified the high-velocity flow pattern across the river channel before placing heavy equipment in the water to construct the ford. The riverbed contained localized regions of above-average depth and increased velocity that shifted after each significant rainfall. Fortunately, the river water was relatively clear, which allowed the reconnaissance team to conduct a hasty field dye test to find those high-velocity flow regions. A map reconnaissance revealed an existing ford approximately 400 meters east of the proposed site (point C on the sketch in Figure 1), which would allow the D7 dozers to enter the water and cross the width of the river. Three dozers entered the water in column and traversed the river from south to north and back in high gear. The height of the water ranged from 1.1 to 1.3 meters (just enough to completely submerge the tracks on the dozers at times).

As the dozers crossed the gap, their tracks stirred up enough silt (our field dye) from the river bottom to reveal the high-velocity flow patterns. Five clearly visible flow channels,

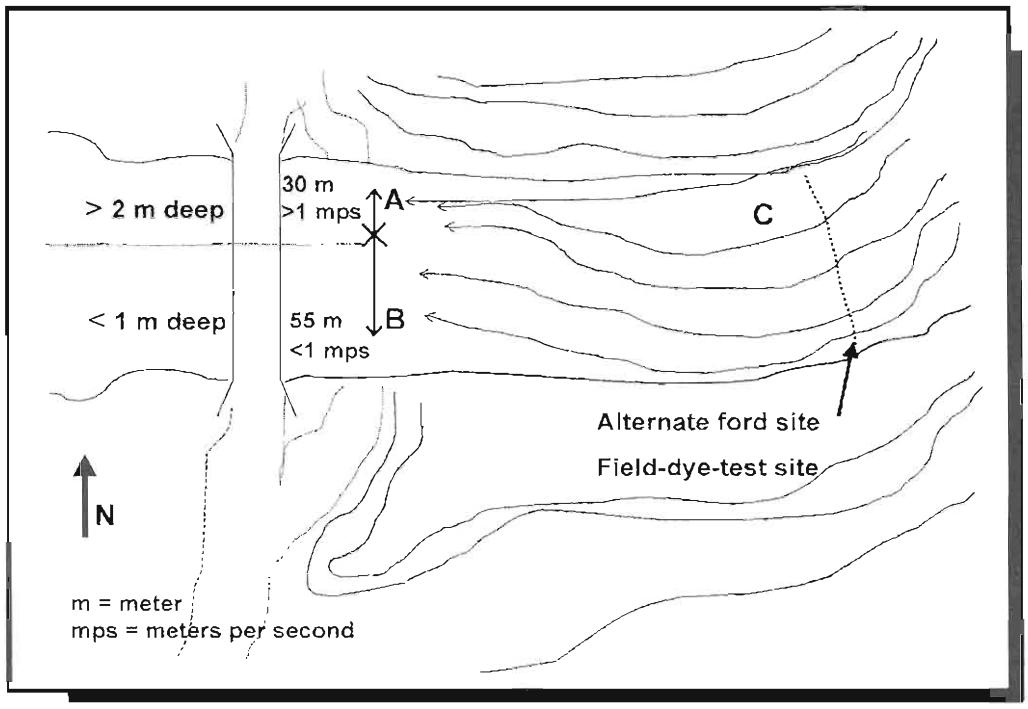


Figure 1. Site Sketch I (Problem)

depicted in Figure 1, were observed from the existing bridge just west of the proposed work site. As a side note, since the dozers were moving in water that exceeded 1.5 meters per second at certain locations, and the actual depth of the water was unknown across the entire river width, specific safety precautions were prescribed. All equipment operators wore Type III life vests when maneuvering in the water, and a safety dozer with recovery chains and life buoys was positioned downstream to assist if needed.

Course of Action

Since the mission was to emplace the ford site close to the existing bridge, it would be necessary to reduce the flow and depth of the high flow channel along the north bank of the river and distribute the water more evenly across the channel to satisfy the safety limits on water depth and velocity defined in FM 90-13, *River-Crossing Operations*:

"Combat vehicles can ford shallow rivers that have a limited current velocity and stable beds. Some vehicles have kits to increase fording depth. Fording is possible for current velocities that are less than 1.5 meters per second. Riverbeds at fording sites must be firm and free of large rocks and other obstructions. Vehicle-operator manuals contain specific depth capabilities and required adaptations."

Based on the results of the field dye test and our hasty calculations, the water depth and velocity were too high to place equipment in the river at the proposed ford site. We had to find a way to drop the volume of water entering the northern part of the river channel, reduce the water depth by 1-2 meters and reduce the water's velocity by more than 1 meter per second at the proposed ford site.

In an open-channel flow problem, the quantity or volume of water (Q) flowing through any given cross section is a function of the fluid velocity (V) and the cross-sectional area (A):

$$Q = VA$$

Assuming the quantity or volume of water moving through a cross section of the channel at the ford site was constant, the 82d Engineer Company would have to adjust the water depth across the channel and thus reduce the corresponding velocity. If the engineers could get Q to balance between sections A and B as shown in Figure 1, it would be possible to drop the water depth by 1.8 meters on the north side of the river in the vicinity of the ford site. Short of excavating or dredging a new channel, the only option appeared to be a

Engineer Reconnaissance Data

Facts:

- **Imjin River is 85 m wide**
  Part A: 30 m wide, 3 m deep, > 2 mps
  Part B: 55 m wide, 0.3 m deep, < 1 mps
- **MLC 05 bridge**
- **4 D7 dozers**
- **2 20-ton dump trucks**
- **1 5-yard loader**
- **1 grader**
- **Extensive supply of large river rock available on south bank of river.**
- **Field dye test revealed water flows as shown by arrows on site sketch.**



Two dozers work from south to north, leveling out the river bottom to determine approximate depth and fill requirements across the channel. The water diversion berm is visible in the top left corner of the photo.

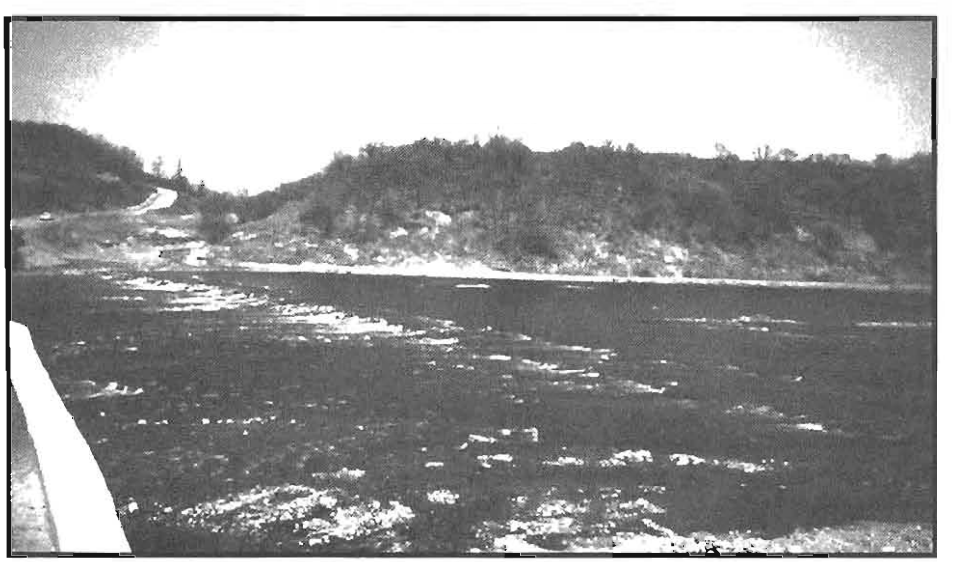
temporary water-diversion technique that required the construction of one or more sizable earthen berms in the middle of the river channel.

Getting to Work

Using the four D7 dozers available on-site, a test berm was constructed at a 45-degree angle across one of the five water-flow patterns to determine if this technique would produce a noticeable change in the water distribution across the channel. After 1 hour of earthmoving, the water depth began to drop on the north side and rise on the south side of the channel. Based on the test berm, we calculated that the primary diversion berm would run at approximately the same angle across the river's width for a total of 250 meters. We estimated that the berm, in its final form, would have to be 2.5 meters high and 6 meters wide to withstand small fluctuations in the river's flow for the duration of the exercise.

The dozers worked from southeast to northwest, building several smaller berms diagonally across the width of the river. To meet the desired flow speed in the deepest channel, three of the five major flow channels had to be successfully diverted. These smaller earthen berms were constructed of mostly river-bottom material, consisting of large angular gravel, cobbles, and small boulders that were concentrated along several sandbarlike deposits in the river channel. Eventually, these smaller berms were completed and connected to form the primary diversion berm.

Once the primary berm was in place, several hundred cubic meters of small boulders were dumped into the deepest flow channel at the point where the berm and channel intersected on the north side of the river, approximately 275 meters east of the ford site and 25 meters from the northern bank. This significantly slowed the flow of the water in that particular channel, resulting in a reduction of more than 1.3 meters in the water level and a reduced flow velocity of approximately 2.5 meters per second.



The finished ford before marking according to the 2d Infantry Division tactical SOP. The water flow across the entire length of the ford has been equalized, thus reducing the depth and speed of the water.

The dozers leveled the river bottom from south to north and removed large rocks or small boulders that could hamper tracked-vehicle movement. Working with two 20-ton dump trucks and a 5-yard loader, 400 cubic meters of material of unsorted rocky bank material—generally large gravel and small cobbles—were stockpiled at a borrow site on the south bank of the river. Material was pushed from the shore, then hauled by the 5-yard loader through the water and dumped into the deeper channel on the north side of the ford. As the water level continued to drop, two dozers—

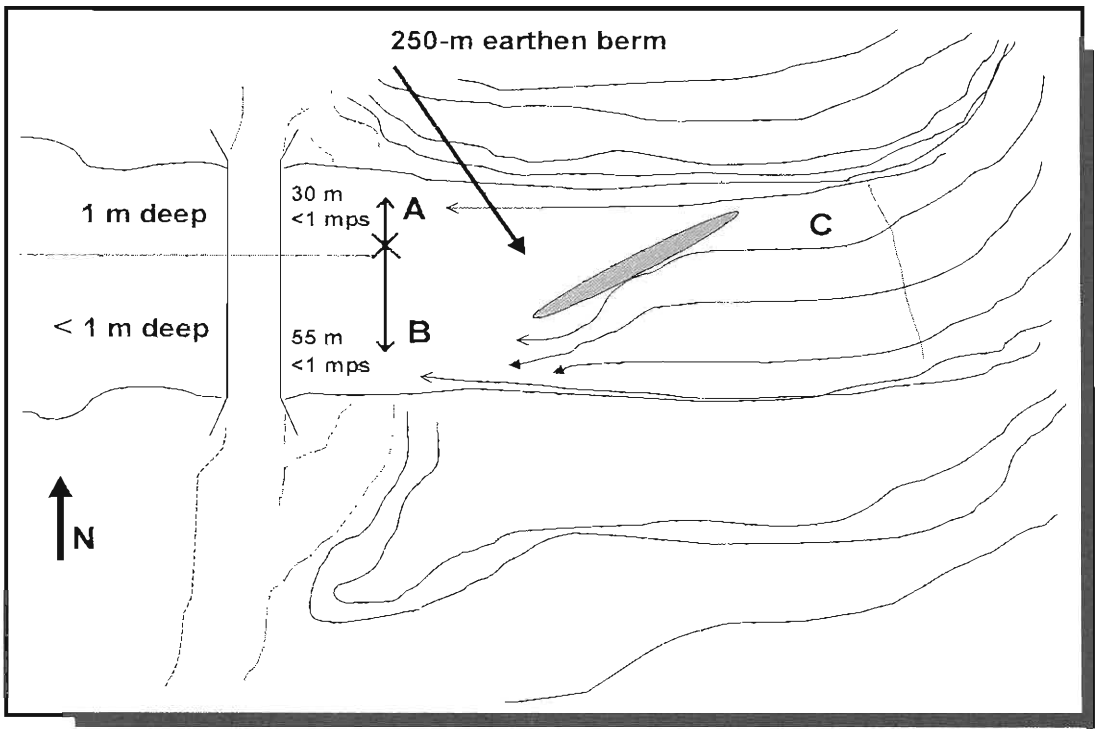


Figure 2. Site Sketch II (Solution)

pushing perpendicular to the ford—piled additional river-bottom material into the ford. This effort began to lift the ford (in essence, creating a weir) so that water would pool upstream and slow below 1.5 meters per second as it moved across the ford.

After two days, the work was completed. Actual work time in the water was 16 hours. The water on the southern half of the ford was 0.5 meters deep. On the northern portion, originally the deepest part of the river channel, the water was less than 1 meter deep. There was decreased flow velocity across the entire width of the river, with a maximum river velocity across the ford of under 1.5 meters per second. The ford site also required significant entrance- and exit-bank preparation in addition to the work in the river itself. This bank work was done in conjunction with the berm and weir preparation. The site sketch in Figure 2 shows the final results.

Lessons Learned

The units learned several important lessons, to include the following:

- Troop-leading procedures work! Whenever possible, conduct a personal recon along with key leaders. In this case, we included our highly skilled engineer-equipment operators and their NCO supervisors. These soldiers knew the equipment capabilities and offered valuable insights on how to safely tackle the problem. Fortunately, the existing bridge served as an excellent vantage point for discussing plans and observing movements on the ford.
- Regardless of the mission, always test the water before placing soldiers or equipment in the water.
- Comply with all local environmental laws and coordinate with all affected landowners or residents.
- Ensure that after conducting a comprehensive risk assessment, all unnecessary risks are eliminated and all required operations are properly resourced, planned, rehearsed, supervised, and executed.

This river-fording mission offered the soldiers and leaders of the 82d Engineer Company and the 44th Engineer Battalion an excellent training opportunity structured around a mission that they could be called on to execute during a hostile situation.

Major Landry is completing a doctorate in civil engineering at Rensselaer Polytechnic Institute in Troy, New York. He was previously the operations officer for the 44th Engineer Battalion, 2d Infantry Division, in the Republic of Korea and commander of C/12th Engineer Battalion, 1st Armored Division in Germany and taught in the Civil and Mechanical Engineering Department at West Point. MAJ Landry is a graduate of the United States Military Academy and the Command and General Staff College; Air Assault, Airborne, and Ranger qualified; and a professional engineer in the state of Virginia.

Captain Dorf is assigned with the Corps of Engineers in Bahrain. He previously served as the Assistant Brigade Engineer, 2d Brigade, 2d Infantry Division, Republic of Korea; and commander, 82d Engineer Company (Combat Support Equipment). CPT Dorf is a graduate of the University of Maine, Orono.

PERSCOM Notes

By Lieutenant Colonel John R. Luce

I want to reflect on my short year as chief of the Enlisted Engineer Branch and provide some perspectives on what I have learned and observed. It has been one of the most rewarding jobs of my 21 years of service in the Army, and I want to thank everyone who has assisted me in this effort.

Military Occupational Specialty (MOS) Health

The health of the enlisted force in the Engineer Regiment is the best it has been in more than a decade. Sixteen of our 21 MOSs are at or over 100 percent strength, and the projections for the future are very good. This is a great improvement in many of our MOSs, especially the 12 series—combat engineer and bridge crew member (mostly attributable to my predecessors). The good news is that we have recovered from the mid-80 to low-90 percent range to well over 100 percent in each of these skills. Because of this, we have had to place these MOSs in the Fast Track and the Excellence in Retention Program (ERP). Through Fast Track, we sent out memorandums to numerous soldiers in the 12 series inviting them to voluntarily reclassify into shortage MOSs in the Engineer Regiment or the Army in general. Currently, the ERP program restricts reenlistment for retraining only. This is why many of you found your reenlistment options reduced as of May. Once we meet our goal of 122 soldiers in 12B and 39 soldiers in 12C, we will reinstate normal reenlistment options. These programs will end when we reach our goals—by each MOS through volunteers—or in September, when we will select enough soldiers for reclassification to meet our goals.

Based on the above information, the strength of engineer MOSs in the units is close to or over 100 percent in the aggregate. Certain ranks are not up to strength. Generally, sergeants and staff sergeants are short in units across the Army because of the increased requirements for drill sergeants and recruiters.

There are some MOSs which continue to run short—00B divers, 52E prime-power-production specialists, and airborne soldiers in 62E and 62J engineer-equipment-operator specialties. Any soldier wishing to transition into one of these skills is encouraged to contact his retention noncommissioned officer (NCO) or Engineer Branch for more details—we need you!

Communication/Career Opportunities

Do you know who your assignment manager is or your professional development NCO (PDNCO)? You should! These people will work your next assignment and decide where you will go. If you want some input into this, you need to know who they are and open up lines of communication. Many of you do and find that although you do not always get your first choice (or even your second), you usually can find an acceptable location. Remember, filling out and submitting a Department of the Army Form 4187, *Personnel Action*, does work! We may not be able to grant all submitted requests, BUT if you don't send one, we won't know your request. If you have more than a year's time on station in the continental United States or are within a year of being eligible to return from overseas, you need to submit a form NOW! Keep on top of this action: call to make sure it arrived, and begin your dialogue with your assignment manager. You need to make the effort to find what is open and let your wishes be known. If you abdicate your vote in this process and do nothing, don't complain.

Your PDNCO is the second key player in this process. We choose three NCOs, one in each Career Management Field (12, 51, and 81), because of their excellent performance and experience. We charge them with the responsibility to review the assignment made by the assignment manager to ensure that it is beneficial for your professional development. These NCOs understand the key elements, positions, and career-enhancing (and terminating) assignments in their field and make sure that you are not given an assignment where you will not be able to progress. They try to avoid assigning you to back-to-back TDA assignments, even though requested, because such assignments are detrimental to career progression. Remember these NCOs are looking out for your best interests and the needs of the Army. If they have failed to meet your expectations or requests, feel free to contact either the branch SGM or this office directly. We are willing to review, with an open mind and a fresh look, any assignment made. If you have questions or concerns about the correct path for promotion and professional development, one of the best sources is the guidance for promotion boards and the review and analysis of the board after it has met. You can find this on the Engineer School's Web site under the Engineer Personnel Proponency Office.

Noncommissioned Officer Evaluation Reports (NCOERs)

Throughout my time in the Army, I constantly have been educated on the importance of our NCOER system—counseling sessions and writing NCOERs well so they "communicate effectively" to both the rated NCO and his professional evaluation board. I heard it so many times that I thought it overkill. However, once in this position, I reviewed a large number of these documents and clearly saw that the leaders in our

Regiment had not learned these lessons. In many cases, unfortunately, the one damaged by this lack of knowledge is the rated NCO! The biggest problem is lack of consistency between the rater and the senior rater—leaving the board the job of sorting out who was correct. If the senior rater disagrees with the rater, the senior rater can annotate his portion of the NCOER to clarify the discrepancy. If he does not and an inconsistency exists between his comments and the blocks that he marks, the reviewer should nonconcur and submit a memorandum of explanation along with the NCOER. This keeps the board from having to interpret and guess the intent of the rating chain. The following are examples of NCOER problems:

- One or two "Excellence" ratings, "Fully Capable" overall rating, and a "2/1" by the senior rater with a "Promote Now" bullet: In this situation, I would expect that the NCO would be among the best and not "Fully Capable."
- One or two "Excellence" ratings, "Among the Best," overall rating, and a "3/3" by the senior rater with a "Promote Ahead of Peers" bullet. In this situation, the senior rater's block ratings either are too low or the rest of the evaluation is too high.
- One to two percent of the NCOERs I have reviewed DID NOT have a comment on promotion potential. It is critical to let the board know what you think.

These examples clearly show an inconsistency, and if the rater and senior rater cannot agree on how to present a consistent picture to the board, the reviewer NEEDS to take the correct steps to give the board the correct impression. An unclear representation to the board puts good NCOs at risk when eligible for promotion and can fail to clearly indicate those NCOs who are not as deserving. A very good source for NCOER information (both the administrative process and content) is PERSCOM Online at The Adjutant General Directorate Web site for NCOER Newsletters.

My Replacement

I have been honored and privileged to serve in this position for the past year. Unfortunately, it is ending too soon. Lieutenant Colonel Pete Taylor will replace me in August. He is a superb officer who will serve the Regiment well in this important capacity. I encourage you to provide him the same support and advice that you did for me—it was all very helpful. Thanks to all.

Lieutenant Colonel Luce is the Branch Chief for Engineer Enlisted Assignments.

Activation of the Facility Engineer Group

By Master Sergeant David C. Cooper

The Secretary of the Army announced the activation of the U.S. Army Facility Engineer Group effective 16 October 2000. The purpose of the 400-soldier Army Reserve unit is to provide specialized engineering support to military commands throughout the United States and overseas.

The unit provides base-operating-system operational planning and technical engineer services for the U.S. Army Forces Command (FORSCOM), the U.S Army Reserve Command, the U.S. Army Training and Doctrine Command, the U.S. Army Materiel Command, power-projection platforms, power-support platforms, and FORSCOM-designated key installations. It offers full-spectrum, senior-level professional-engineer assets for real property maintenance, environmental protection and compliance, and minor construction management and repair to civil infrastructure.

The unit can deploy over 100 engineers, architects, and computer specialists—including numerous professional engineers representing disciplines such as civil, electrical, environmental, and mechanical engineering. It is the only unit of its kind in the U.S. Army system.

"The Facility Engineer Group's unique blend of experts provides the Army with an extremely cost-effective engineering resource," said Colonel Steven R. Abt, the new unit's first commander. "Where else can a commander pay $200/day for an $800/day architect?"

The unit helps the directorates of public works and the Army Reserve commands in inspecting and evaluating the nation's nearly 1,300 Army Reserve centers. Assisted by its regional headquarters in Wisconsin, Texas, Georgia, and Maryland, the unit provides complete coverage of all of the Army's regional support commands in the United States. In addition to the headquarters elements, the Facility Engineer Group fields thirty 7-member facility engineer teams and six 15-member facility engineer detachments.

Before being formally activated, the provisional Facility Engineer Group provided engineering support to peacekeeping efforts in such places as Bosnia and Kosovo and has supported humanitarian operations in Central America. Individual soldiers have deployed during Operations Desert Shield/Storm (Persian Gulf), Uphold Democracy (Haiti), Restore Hope (Somalia), and Joint Endeavor/Guard (Bosnia).

Headquartered with the 416th Engineer Command, the unit's address is: Commander, Facility Engineer Group, Parkhurst USAR Center, 10 South 100 South Frontage Road, Darien, Illinois 60561-1780. The telephone number is (800) 315-6327, the e-mail is *Al.Smith@usarc-emh2.army.mil*, and the Web site is *www.usarc.army.mil/416ENCOM/FEG*.

Master Sergeant Cooper can be contacted at (415) 744-2179 or e-mail *cooper.david@epa.gov*.

Army Engineers in the West

By Dr. James W. Dunn

In the first half of the nineteenth century, Army topographical engineers followed explorers and trappers West to survey and map the territory of an expanding nation. The U.S. expansion into lands claimed by Mexico and the Indians eventually led to wars with both parties. By midcentury, the engineers were surveying and mapping the new territory acquired from the war with Mexico. They surveyed the new border with Mexico, mapped routes through former Mexican lands to the Pacific Coast, and surveyed possible routes for a proposed transcontinental railroad. The Indians did not see these pre-Civil War surveys as an infringement on their land rights. There were no settlers with the surveying parties, and contact with the Indians was rare and usually friendly. When the Indians did resist settlers moving to Oregon or miners to the California gold fields, topographical engineers accompanied Army expeditions to protect the wagon trains and keep open the trails through the West. In the post-Civil War years, as the number of wagon trains westward increased, Indian resistance stiffened into periods of total war. For the engineers, it meant that surveying and mapping duties were at times affected by their duties as combat engineers.

Engineers gained experience in balancing these dual missions during the Mexican War. In 1845, in anticipation of hostilities with Mexico, the War Department ordered Colonel Stephen Watts Kearny to lead an expedition from Fort Leavenworth, Kansas, into Sioux lands in the Platte River Valley to ensure the safety of the Oregon Trail. After a successful conference with the Sioux at Fort Laramie, Wyoming, Kearny turned south and returned to Fort Leavenworth through Mexican territory. Lieutenant William Franklin, a topographical engineer on Kearny's staff, mapped parts of Nebraska, Colorado, and Wyoming, as well as Mexican lands.

During the Mexican War, Colonel Kearny used the Fort Leavenworth-based Army of the West to take New Mexico and then assist the Americans in California who had revolted against Mexican rule. Kearny had an engineer detachment of two lieutenants and two civilian assistants with his Army. Commanded by Lieutenant William Emory, the detachment produced good maps of the southwest, to include the Rio Grande Valley.

After the war, the engineers surveyed and mapped the land acquired from Mexico and a new border between the two countries. In Texas, Lieutenant Colonel Joseph Johnston had four Topographical Corps lieutenants and a Corps of Engineers lieutenant survey fort sites and connecting roads. An 1849 Army expedition into Navaho lands in New Mexico included a topographical engineer lieutenant and two civilian assistants to survey a route to California. In 1854, Captain John N. Macomb of the Topographical Corps began route surveys in New Mexico that ultimately formed the basis for that state's highway and railroad system.

The railroad system in the United States reached the Mississippi River by 1853, and Congress began to consider the possibility of a transcontinental line. With no agreement possible because of partisan politics, Congress told Jefferson Davis, then Secretary of War, to have topographical engineers survey four routes across the United States and recommend the most practical and economically feasible one for a railroad from the Mississippi River to the Pacific Coast. The routes considered were—

- North through St. Paul, Minnesota, to the Puget Sound.
- North central from St. Louis, Missouri, through the Great Salt Lake.
- South central through Albuquerque, New Mexico, to California.
- South along the border to California.

The surveys began in the spring of 1853. The north-central party had trouble in October when Paiute Indians killed Captain John W. Gunnison, a topographical engineer. Artillery Lieutenant Edward G. Beckwith, an 1842 West Point graduate and commander of the escort party, completed the survey along the route which eventually was used to build the Union Pacific and Central Pacific Railroads.

Topographical Engineer Lieutenant Gouvernour K. Warren's work on the railroad surveys aided his effort to map the Trans-Mississippi West territory that included the modern states of Nebraska and North and South Dakota and parts of Wyoming and Montana. In 1855, after the railroad surveys, Warren accompanied Colonel William S. Harney's successful expedition against the Sioux along the Platte River to keep them from raiding the Oregon Trail. In 1856, Warren was back surveying the upper Missouri and Yellowstone Rivers where he had no problem with the Sioux. However, in 1857, when he attempted

to survey the Black Hills, the Sioux stopped him. He reported that the Sioux would resist any attempted movement into the Black Hills.

During the Civil War, no surveying expeditions of note occurred in the West, but there were expeditions against the Indians that had repercussions after the war. In a series of campaigns from 1862 to 1864, Minnesota and Iowa militia units pushed the Sioux from Minnesota to the Dakota Territory. In November 1864, a Colorado volunteer unit attacked and destroyed a Cheyenne village at Sand Creek because the Cheyenne resisted the movement of miners and settlers into their lands. In retaliation, the Sioux and the Cheyenne attacked wagon trains along the Oregon-California Trail and the Bozeman Trail that branched off near Fort Laramie and led to the Montana gold fields.

After the Civil War, the Army built Fort Reno to protect the Bozeman Trail. But in the summer of 1866, Red Cloud, a Sioux chief, left a conference at Fort Laramie when he learned that the Army planned to build a chain of forts along the trail. In the ensuing 2-year Red Cloud War, the Sioux successfully resisted movement along the Bozeman Trail. They ambushed and annihilated a cavalry detachment in December 1866, and by 1867, they had closed the trail to all but heavily escorted wagon trains. In the 1868 Fort Laramie Treaty, the U.S. government agreed to abandon the forts and close the trail. The Sioux agreed to a great reservation in South Dakota and use of open land north of the Platte River from the Missouri River west to the Big Horn Mountains.

During the years immediately after the Civil War, the Corps of Engineers, which now included the topographical engineers, placed officers on the staffs of the division and department commanders in the West. Their mission was to prepare maps needed for field operations and to collect topographical information for the Engineer Department in Washington. In the summer of 1867, Lieutenant Rueben W. Pietriken, Chief Engineer, Department of the Platte, surveyed routes from Fort Russell westward to Fort Laramie and onto the Bozeman Trail forts. (Fort Russell was a depot fort used to support the forces involved in the Red Cloud War.)

The first major survey in the post-Civil War period began in 1867 when an expedition sponsored by the Corps of Engineers and led by civilian engineer Clarence King started to survey a 100-mile-wide strip along the 40th parallel line of the Union Pacific-Central Pacific Railroads from the California-Nevada border to eastern Wyoming. The survey, completed in 1872 without significant Indian interference, included a geological analysis report and topographical maps.

The Indians did not oppose King's survey because of a series of cavalry expeditions against the Cheyenne in the late 1860s. In the Medicine Lodge Treaty of 1867, the Comanche and Cheyenne agreed to move onto reservations in the Oklahoma Territory, but they raided into Kansas and Texas in 1868 when government subsistence did not meet their expectations. Major General Philip Sheridan, Commander, Department of Missouri, conducted a winter campaign designed



Lieutenant Colonel George A. Custer

to attack the villages and force the Indians to return to the reservation. Lieutenant Colonel George A. Custer's 7th Cavalry attack at the Washita River in November 1868 and the following winter pursuit did just that. By the fall of 1869, the area between the Platte and Arkansas Rivers was considered clear of hostile Indians. In that area in the early 1870s, Lieutenant Ernest Ruffner, Chief Engineer, Department of Missouri, accompanied the 5th and the 6th Cavalry reconnaissance to survey and map the terrain. As relative calm continued, Ruffner successfully requested a detachment from the Battalion of Engineers so he could expand his surveying and mapping operations.

In another major field survey in 1871, Lieutenant George M. Wheeler, Chief Engineer, Department of California, began the United States Geographical Surveys west of the one-hundredth meridian. The tasks included surveying and mapping the area, locating potential military sites and connecting roads, documenting the climate, and reporting on the geology and vegetation of the area. Brigadier General Andrew Humphreys, Chief of Engineers, wanted to support Lieutenant Colonel George Crook's operations against the Apaches while maintaining the Corps's position in western exploration. Accordingly, he lavished money and personnel, to include 16 engineer lieutenants, on Wheeler's efforts between 1871 and 1879. While Wheeler successfully mapped almost one-fourth of the region west of the one-hundredth meridian, Humphreys' effort failed when Congress appropriated money in 1879 for a new civilian agency—the United States Geological Survey—to study the geographical structure and economic resources of the public domain.

Although Wheeler's efforts were largely uncontested by the Indians, such cannot be said for a series of railroad surveys that began in 1871 in the Yellowstone River Valley. To continue the Northern Pacific Railroad from St. Paul, Minnesota, to

Seattle, Washington, surveying parties, escorted by Army units, entered the Yellowstone River Valley in the fall of 1871 without interference from the Sioux. However, when the surveying parties returned in 1872, Sioux resistance served notice that it opposed a railroad along the Yellowstone. Major John Barlow, Chief Engineer, Division of Missouri, accompanied both expeditions and accumulated enough topographical information to publish a map of the Yellowstone from its mouth on the Missouri to the mouth of the Powder River.

When the surveying parties returned to the Yellowstone in 1873, Custer's 7th Cavalry provided the escort, and Captain William Ludlow, Chief Engineer, Department of Dakota, accompanied the expedition. The Sioux attacked surveying parties on two separate occasions in August, but each time, the cavalry drove off the Sioux. The 7th Cavalry's success at protecting the railroad surveyors did not aid Ludlow as he found the cavalry officers too busy with escort duties to help him; thus, he was not able to collect much topographical information.

While Ludlow experienced mixed results along the Yellowstone, Captain William A. Jones, Chief Engineer, Department of the Platte, had some success in a reconnaissance of the headwaters of the Platte. Seeking to locate a route for a wagon road from the Union Pacific rail line in northwest Wyoming to Fort Ellis in Montana Territory, Jones left Fort Bridger, Wyoming, in June with a 2d Cavalry escort, four civilian topographers, and two civilian scientists. After completing his reconnaissance, Jones recommended a route for the road. The Department Commander and the Chief of Engineers endorsed it; however, Lieutenant General Philip Sheridan, Division Commander, could not fund it.

That lack of money—a result of the financial panic of 1873 which put the country into a recession through the 1870s—had an impact on the Corps of Engineers' effort to expand its mapping of the West. In 1873, the War Department supplied the military departments in the West with instruments to make an itinerary of every reconnaissance to post on a master map in Washington. By the end of 1875, however, little data was on the master map due to a lack of money. Captain William S. Stanton, Chief Engineer, Department of the Platte, reported that a shortage of funds restricted his efforts to conduct local surveys. He did not have enough money to hire civilian assistants and had to rely on the cavalry and infantry units for help. While he had the necessary surveying instruments, he lacked qualified assistants, which prevented him from successfully executing the June 1873 War Department order. Other engineers in the West, except for Wheeler, had similar financial problems.

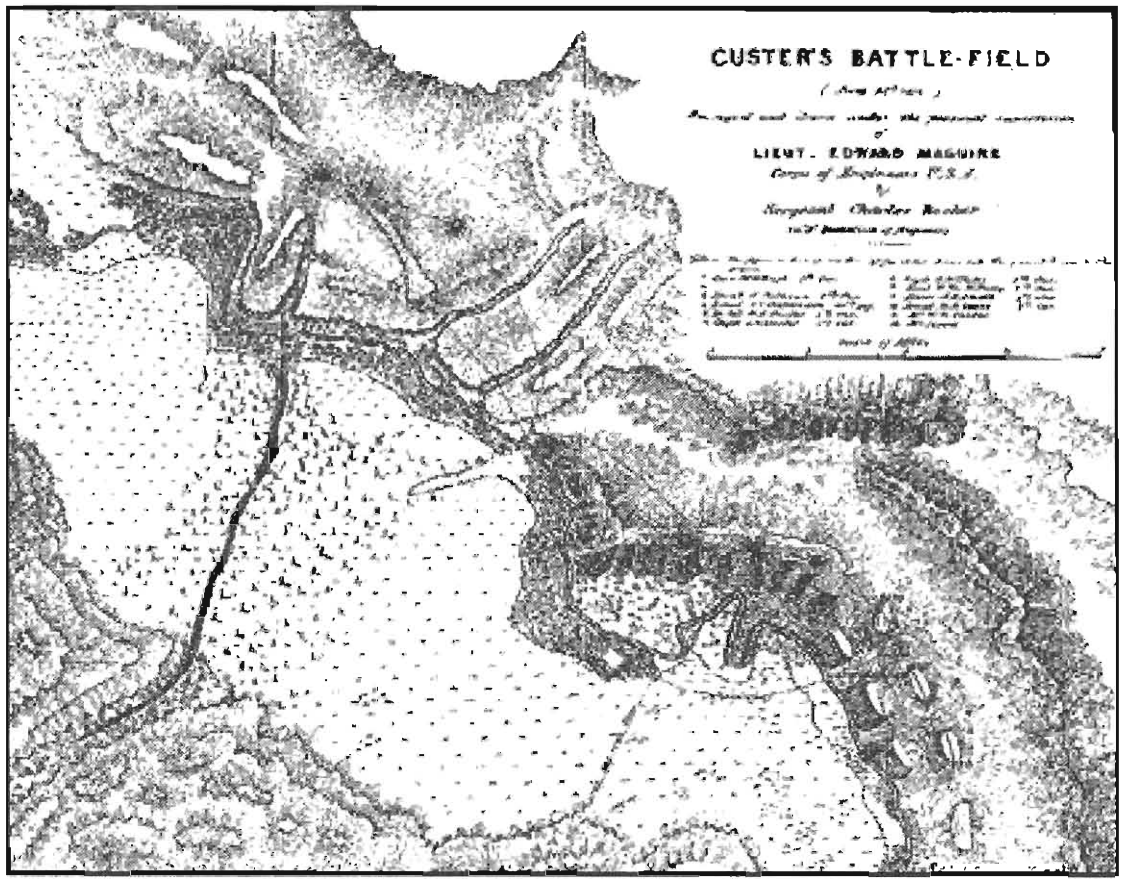
As the engineers struggled with mapping efforts, military operations against the Indians peaked in the last half of the 1870s. In the southern plains, Comanche and Cheyenne raided the Oklahoma Territory and Texas. In the 1874 Red River War, the Army successfully used a winter campaign to drive the Indians back to the reservation. Lieutenant Ruffner was able to produce surveying results during the campaign. While he did not have money to hire civilian assistants, he did send his detachment from the Battalion of Engineers to the 6th Cavalry's expeditions in New Mexico and Colorado. When the 6th Cavalry became heavily involved in the Red River War, Ruffner shifted his efforts to the 5th Infantry's expeditions in Texas. He also built a road from Santa Fe to Taos, New Mexico, with a congressional appropriation of $25,000. He surveyed the route in 1873, and civilians built it in 1874.

While Ruffner successfully used a detachment from the Battalion of Engineers, something similar occurred to the north in the Department of Dakota. In July 1874, Custer led a 7th Cavalry expedition into the Black Hills to locate sites for military posts, survey routes through the hills, and conduct geological surveys. Captain Ludlow again accompanied the expedition with a party that included two volunteer civilian assistants and a detachment from the Battalion of Engineers. Throughout the summer, the expedition operated in the Black Hills without interference from the Sioux, and Ludlow, well satisfied with the results, produced maps of the surveyed routes and topographical and geological maps. He reported that he thought the best use of the hills for the next 50 years was as a home for the Sioux. That did not happen because his report also noted small amounts of gold in the Black Hills. When the news of gold reached the East, which was in the middle of a recession caused by the financial panic of 1873, prospectors raced for the hills.

In 1875, while the Grant administration tried unsuccessfully to buy the Black Hills from the Sioux, Captain Ludlow led an expedition into western Montana to survey routes and examine Yellowstone Park. His party included volunteer civilian assistants and a detachment from the Battalion of Engineers. He noted the large number of hunters and souvenir gatherers in the park and recommended that it be put under the War Department for protection.

Meanwhile, the Grant administration, even though it failed to convince the Sioux to sell, decided to allow prospectors into the Black Hills. The Sioux had until February 1876 to vacate the area and go to the reservation. After that date, any Sioux not on the reservation would be considered hostile and an Army problem. Accordingly, General Sheridan planned a winter campaign similar to the one that proved so successful in the southern plains. However, the winters in the Dakotas and Montana were much more severe than in Oklahoma and Texas, so Sheridan delayed his campaign until the spring. His plan had three converging columns from the east, west, and south, trapping the Sioux south of the Yellowstone River near the Bighorn Mountains.

Colonel John Gibbon's Montana column left Fort Ellis on 1 April with six companies of his 7th Infantry, a battalion of the 2d Cavalry, and two Gatling guns. His acting engineer officer, Lieutenant Edward McClernand, 2d Cavalry, had a detachment from the Battalion of Engineers. As the column moved east along the Yellowstone, in late April, McClernand joined a cavalry scout south through the Bighorn and Little Bighorn Valleys. They made no contact with the Sioux, but later in May, Gibbon



did see signs of a village on the Tongue River. He was unable to force an encounter and, in late May, went into camp on the Yellowstone near the mouth of the Rosebud to await the arrival of the Dakota column.

Brigadier General Alfred Terry's Dakota column left Fort Lincoln on 17 May with Custer's 7th Cavalry, an infantry battalion, and two Gatling guns. His engineer officer, Lieutenant Edward Maguire, Department of Dakota, had a detachment from the Battalion of Engineers; several wagons of engineer equipment, to include a portable trestle bridge; and an odometer cart to measure mileage. As the column moved west across central North Dakota, it made only about 10 miles a day, as Maguire, with the help of a 7th Cavalry company of pioneers, used the bridging equipment to cross the numerous streams along the trail. The column reached the Powder River on 7 June without seeing any Sioux, so Terry sent Major Marcus Reno's 7th Cavalry battalion scouting to the south. Maguire assigned Lieutenant James Sturgis, acting engineer officer, to the scouting force.

Brigadier General George Crook's Wyoming column, the last to take the field, left Fort Fetterman on 29 May with two infantry and two cavalry battalions. His engineer officer, Captain William S. Stanton, Department of the Platte, did not have an engineer detachment and had to rely on the infantry and cavalry units to supply him with assistants. Crook reached the headwaters of the Rosebud on 14 June where he learned of the possibility of a large Indian village to the north. He moved toward the village and encountered a large force of Sioux and Cheyenne in the early morning hours of 17 June. He pushed the Indians toward the Little Bighorn River but was unable to pursue due to his losses and the difficulty of the terrain. When Crook withdrew to refit and await reinforcements, Stanton returned to Fort Fetterman. He felt that the expedition against the Indians was unproductive for engineering work and that he could accomplish more away from an active campaign. He spent the rest of the summer and fall surveying the military posts and connecting routes in the Platte River area.

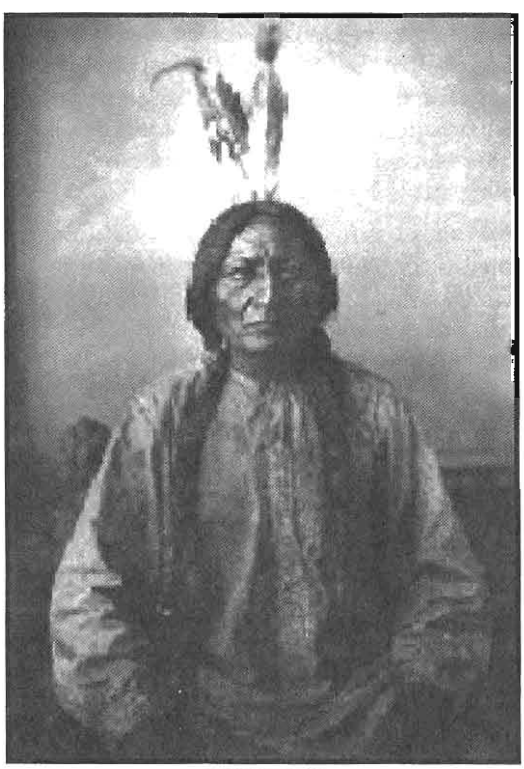
While Crook was fighting the Battle of the Rosebud, Reno's battalion was about 40 miles to the north following the trail of a large Indian village. Reno heard nothing about Crook's fight, so he told Terry about the signs of a large Indian village to the south. In a meeting with Custer and Gibbon on 21 June, Terry outlined a plan to take advantage of Reno's report. He ordered Custer to move south along the Rosebud while Gibbon moved southwest to the mouth of the Little Bighorn. Custer was to maneuver his regiment to push the Sioux toward Gibbon. Lieutenant George D. Wallace was the acting engineer officer for Custer's force; Maguire and the engineer detachment went with Terry's staff in Gibbon's column.

The 7th Cavalry moved south in the Rosebud Valley on 22 June as Gibbon started west along the Yellowstone. When Custer sighted a large village in the Little Bighorn Valley on 25 June, he planned to wait until the next morning to attack. However, he moved forward immediately when he saw Indian scouts nearby. He divided his force into three battalions and

"...as the number of rail lines increased, the Army reduced the number of small forts in the West. Troops now moved by rail from strategically located forts to trouble spots."

sent Captain Frederick W. Benteen's battalion to the left while he followed Reno's battalion toward the village. As Reno attacked across the Little Bighorn, Custer moved right to attack the village. The Sioux stopped Reno and forced him back across the river to a defensive position on the bluffs. They then turned their attention to Custer and annihilated his force before the end of the day. Benteen joined Reno and held out until the Indians began to withdraw on 26 June as Gibbon's column approached.

Terry kept the combined columns in the Little Bighorn area until 28 June to tend to Reno's wounded and bury Custer's dead. Maguire surveyed and mapped the battlefield and burial site during that time. Terry returned to the Yellowstone River Valley where he refitted and received reinforcements through July. He met Crook's column in the Rosebud Valley in early August, and the combined force pursued the Indians through the rest of the summer. The large Indian village broke up as it moved east, and the combined force made no significant contact. In early September, Terry's Dakota column returned to Fort Lincoln and Gibbon's Montana column headed for Fort Ellis. Crook took his column south toward the Black Hills where he attacked and destroyed a small Indian village on 8 September at Slim Buttes. Many of the Indian survivors returned to the reservation in the winter.



Sitting Bull

As the cavalry columns returned to their forts for the winter, Sheridan ordered Colonel Nelson Miles to organize several posts along the Yellowstone and use the 5th and 22d Infantry Regiments to harass and force the Indians onto the reservation. His acting engineer officer was Lieutenant Oscar F. Long, 5th Infantry Regiment. In December, Miles destroyed a Sioux village near Fort Peck, but Sitting Bull and many of his followers fled into Canada. In January 1877, Crazy Horse, leading a band of about 800 Sioux and Cheyenne, attacked Miles' position on the Tongue River. Miles repulsed the attack, pursued the Indians, and destroyed their village. By the spring, Crazy Horse and most of his followers were on the reservation. Finally, in early May, Miles used elements of the 5th and 22d Infantry and the 2d Cavalry to destroy a Sioux village on the Rosebud and force the Indians onto the reservation. Within one year of Custer's defeat, the Sioux and Cheyenne, except for Sitting Bull and his followers in Canada, were on the reservation.

The engineers experienced mixed results during the 1876-77 campaign. Major George Gillespie, Sheridan's Chief Engineer, Division of Missouri, wanted more Battalion of Engineer detachments in the West with at least one for each department. He thought the topographical information collected during active campaigns lacked quality, as the engineers had to go where the action dictated rather than where their surveying interests indicated. Maguire noted the difficulty of collecting topographical data while accompanying an operational expedition due to the inability to move far from the main force. He recommended a larger bridge train for a force the size of the Dakota column, which had more than one hundred wagons. He reported on the types of improvised bridges used, such as sod-covered wagon tongues, chain-and-rope suspension bridges, and wagon and water-keg floating bridges. Where trees were available, he recommended building trestle bridges.

Maguire's map of the Little Bighorn battlefield played an important role in events related to that fight. In July 1877, Lieutenant Colonel Michael Sheridan, brother and aide to General Sheridan, led a party to the battlefield to remove officers' bodies for reburial in the East and to rebury and mark the graves of the rest. He used Maguire's map to locate the original burial sites. In the January 1879 Court of Inquiry—held at the Chicago Headquarters, Division of Missouri—that examined Major Reno's conduct at the Little Bighorn, Maguire used his map to testify on the battle.

For the remainder of the 1870s, the engineers in the West kept as active as congressional appropriations allowed. In the summer of 1877, Ruffner used a 9th Cavalry expedition into New Mexico and Colorado to locate sites for military posts and survey connecting routes. Maguire named acting engineer

lieutenants from the 5th Cavalry and the 7th Cavalry for the fall 1877 campaign against Chief Joseph and the Nez Perce in western Montana. He also sent a detachment from the Battalion of Engineers to survey the site for Fort Keogh at the mouth of the Tongue River on the Yellowstone. He used Quartermaster Department money to examine the Yellowstone's use as a supply route for the military posts in the Montana Territory. In 1878, while Ruffner was building wagon roads connecting the military posts in Colorado, Maguire continued surveying Fort Keogh and the Yellowstone River. In 1879, he added Fort Custer (at the mouth of the Little Bighorn River) and the Little Bighorn battlefield as survey projects for his engineer detachment. He continued to work on the Yellowstone River, using money from the River and Harbor Act of 1878 to hire workers to open channels through three rapids. As he traveled throughout Montana by river steamer, stagecoach, and Army ambulance, Maguire reported to the Chief of Engineers on the quality of the schools in Bozeman and the number of settlers, type and quantity of livestock, and amount of land under cultivation in the Yellowstone Valley.

In the 1880s, a chapter closed on the history of Army engineers in the West. The United States Geological Survey, a civilian agency, now studied the geographical structure and economic resources of the public domain. In 1881, as the government erected a stone monument in the Little Bighorn cemetery, Sitting Bull and his followers surrendered at Fort Buford in the Montana Territory. The Northern Pacific Railroad reached Billings, Montana, in 1882, and the engineers reported a decrease in traffic on the Yellowstone River. By the end of the 1880s, three railroads crossed the continent, and as the number of rail lines increased, the Army reduced the number of small forts in the West. Troops now moved by rail from strategically located forts to trouble spots. As campaign and topographical duties decreased, the engineers turned their attention to border and coastal defense and river and harbor activity. In the twentieth century, these responsibilities, termed Military Programs and Civil Works, became increasingly important as the nation fought through a deep depression and several major wars.

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

Suggested Reading

Frank N. Schubert, *Vanguard of Expansion: Army Engineers in the Trans-Mississippi West, 1819-1879.* Washington, D.C. Historical Division, Office of Administrative Services, Office of the Chief of Engineers.

Robert M. Utley, *The Lance and the Shield; The Life and Times of Sitting Bull.* New York, Henry Holt, 1993.

(BCTP Terrain Analysis, continued from page 29)

The WCOPFOR is made up of experienced players who are extremely proficient at taking advantage of CBS terrain. Many of them are retired Army officers who clearly understand our doctrine and use CBS terrain during their military decision-making process. Because of their vast knowledge and experience, they have both a tactical and planning advantage over units being exercised and evaluated.

Payoffs of CBS Terrain

If properly displayed and explained, CBS terrain has many payoffs during the military decision-making process and throughout the course of the Warfighter exercise. Enemy avenues of approach become evident, which allows the intelligence community to focus its human, imagery, electronic, and signals intelligence-collection efforts. The deep-operations coordination cell can easily identify engagement areas, which allows it to concentrate deep fires, close air support, and air-interdiction assets, resulting in immense destruction of enemy units. By knowing the location of every bridge in the exercise area, engineers are better able to tie CBS restrictive terrain to their division-wide obstacle plan. They know exactly which rivers can be forded and what bridging assets are required when bridges are destroyed. Logistic planners are able to select main and alternate supply routes, forward-operating bases, refuel-on-the-move sites, and division support areas. Maneuver brigades can better plan their advance, select defensive positions, and seize the momentum by knowing exactly where they can and cannot maneuver.

Terrain-analysis units have the ability to display CBS terrain data in a variety of formats. The clear overlay is still a most sought-after format since nondigital divisions have map boards hung throughout the tactical-operations center. For engineers, Microdem/TerraBase II can display CBS terrain over maps, imagery, and elevation data. Once the product is displayed, Microdem/TerraBase II can easily export the graphic to a PowerPoint® presentation for use in briefings.

Summary

Terrain analysis is an engineer function, and topographic engineers are masters at producing mission-focused and -tailored terrain graphics in support of Warfighter exercise operations. Planning a BCTP Warfighter exercise must be approached the same way as planning for an actual deployment. The significant difference is that CBS terrain is the only terrain that counts during a BCTP evaluation.

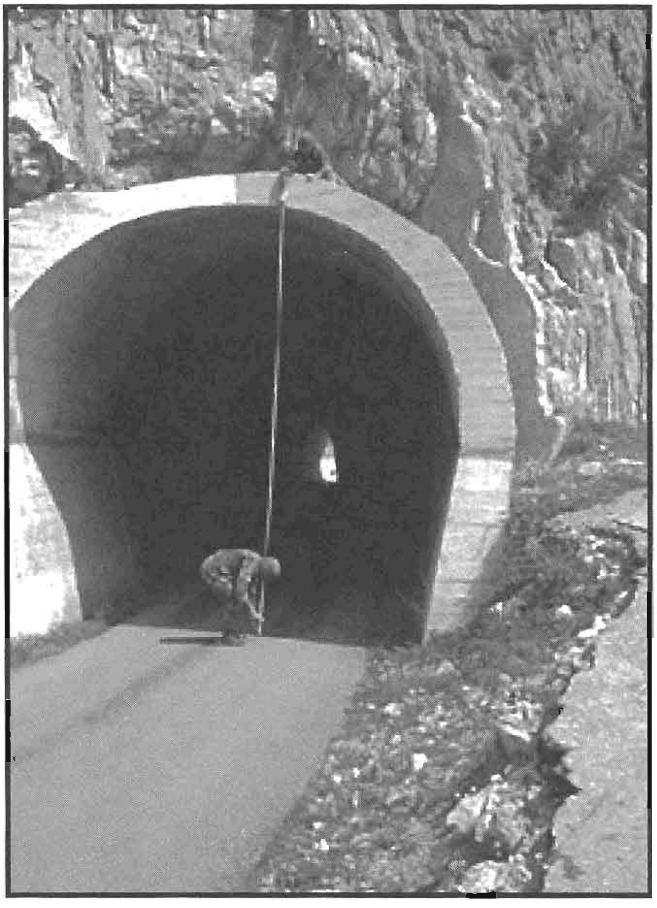
CW2 Mohn commands the 25th Engineer Detachment (Terrain), Schofield Barracks, Hawaii. Previous assignments include terrain-analysis technician, XVIII Airborne Corps, Fort Bragg, North Carolina; senior career management NCO (CMF 81), Engineer Personnel Proponency Office, Fort Leonard Wood, Missouri; and terrain analyst, USAREUR Combat Intelligence Readiness Facility, Augsburg, Germany.

Supporting the Title X Engineer Effort in the Balkans

By Major Garth M. Horne and Mr. Eldon "Scott" Lowdermilk

The U.S. Army Corps of Engineers (USACE) continues to provide continuous and diverse support to engineers and commanders in the Balkan area of responsibility. Currently, USACE has soldiers and civilians deployed in Germany, Hungary, Bosnia-Herzegovina, Kosovo, and the Former Yugoslavian Republic of Macedonia (FYROM) in support of various engineer requirements resulting from U.S. contingency operations.

The majority of the forward-deployed USACE support is provided by teams. The size and makeup of the teams are based on an analysis of the task-force engineer's requirements by the Office of the Deputy Chief of Staff, Engineer (ODCSENGR), United States Army, Europe (USAREUR). The main-body team, called a Base Camp Coordinating Agency (BCCA), coordinates the engineer construction being performed by military and civilian personnel and contractors in the task-force area of operations.



Soldiers classify a tunnel

The BCCA employs several technical capabilities. For instance, there are master planners, who design base-camp layout for the best use of facilities and land management. In addition, draftsmen—through the use of computer-aided design (CAD) software such as AutoCAD®—maintain detailed plans and drawings of the camps as well as other facilities being constructed or refurbished.

All but one of the USACE employees work in either the BCCA or on engineer staffs, and the remaining employee is assigned to USAREUR as the Operation Joint Forge cell chief. He serves as the primary liaison between the BCCA and base-camp staff engineers and ODCSENGR. The USACE civilian personnel are facility, mechanical, environmental, structural, and multidisciplined engineers (project mangers), as well as construction representatives, real estate specialists, and AutoCAD operators. Additionally, ODCSENGR uses Reserve USACE officers on 179- and 270-day orders to fill BCCA engineer positions in Bosnia, Kosovo, and USAREUR. The Reserve officer's role is expected to increase as the Balkans mission continues.

Title X

Contingency construction in support of USAREUR's mission in the Balkans is provided under the auspices of 10 U.S. Code 101 (a)(13) often referred to as "Title X." Appropriations for military construction are not used for contingency operations when construction is clearly intended to meet a temporary operational requirement to facilitate combat or contingency operations and the construction is not permanent. Congress provides the actual funding for contingency operations and supporting construction through supplemental appropriations.

The USACE Europe District—headquartered in Wiesbaden, Germany—serves as the "door to the Corps" for the European Command and USAREUR engineers in coordinating deployments to the Balkans and providing technical support as needed. Both military and civilian employees of the USACE provide technical expertise, design capability, project management, and quality-assurance assistance and support to the USAREUR in overseeing the Title X effort. This covers all areas of logistical and facility support to U.S. personnel deployed in the Balkans—construction, environmental, topographic, fire fighting, hazardous material (HAZMAT)/spill response, countermine/demining, base-camp standards, prime power, real estate, bridging, and snow and ice clearing (SNIC).



Wastewater treatment plant at Comanche Base in Bosnia

The ODCSENGR plays a major role in overseeing the Title X effort, which includes the support provided to other services, mainly the Air Force and to a lesser extent the Navy. Operationally, units within the Balkans report and operate under various commands that report to either NATO or subordinate USAREUR commands.

Construction. This is the area where USACE expertise and assistance has been used the most under Title X support. To provide such things as food, laundry, fuel, lodging, and morale and welfare support, either new facilities must be built or existing facilities renovated. All operations in the Balkans are considered contingency operations and thus require temporary construction. ODCSENGR defined temporary construction as that which "must be designed and constructed on an expedient basis, with finishes, materials, and systems selected with energy efficiency, maintenance, and life-cycle costs being secondary considerations with a life expectancy of 5 years or less."

Consistently using temporary construction standards is an ongoing challenge when units rotate in and out. Commanders constantly weigh the importance of trying to improve the soldier's quality of life (QOL) beyond that enjoyed by previous rotations versus creating a legacy from their tour that soldiers will remember and identify with and congressional visits will point to as a poor use of taxpayer dollars. This is often referred to as "QOL creep."

In Kosovo, U.S. Department of Defense engineers (Army and Navy) worked on initial construction requirements such as site preparation and critical facilities.[1] However, civilian contractors now execute most of the construction in Kosovo and Bosnia.

The Corps has several tools to ensure that construction can be performed, the main one being contract construction. One contracting tool is the indefinite delivery, indefinite-quantity (IDIQ) contracts that are maintained with reputable firms that can be turned on with little notice. These contractors are usually prepared to travel anywhere they are needed. However, the most widely used tool is the Logistics Civil Augmentation Program (LOGCAP) contract.[2] This is a cost-plus contract that can be used to provide any service or construct anything that is needed by a military commander. Because the U.S. military has downsized so dramatically, it maintains a reserve capability through contract support. The LOGCAP contractor is awarded a contract to provide services and construction on an as-needed, reimbursable basis.

A LOGCAP-type contract supports operations in Kosovo and Bosnia. In the early days of these operations, the Corps's emergency managers coordinated with several military units to develop a scope of work for anything and everything that the contractor might be asked to perform. Since the contract was relatively unknown to many maneuver commanders, this coordination proved to be invaluable. Today, the Balkans Sustainment Contract (BSC) still carries out the lion's share of Title X construction, providing transportation, dining and bed-down facilities, laundry services, waste management and disposal, and a host of other services to deployed forces.[3] The BCCA provides construction oversight for the BSC and other construction-related contracts in the Balkans.

Environmental. USACE deploys civilian environmental specialists to provide technical oversight on base-camp and forward-operating-base operations to ensure that U.S. personnel comply with environmental regulations, protect human health, and practice responsible environmental stewardship. Located within the BCCA at Task Force Eagle and Task Force Falcon and on the National Support Element

engineer staff at Taszar, Hungary, these specialists establish and document environmental baseline surveys at base-camp and forward-operating-base locations, conduct periodic sampling at base camps, and monitor wastewater-treatment operating parameters and performance, pest and vector control, and general environmental-program management and controls. They also assess current practices and activities to identify environmental concerns and develop action plans to address those concerns and to minimize or prevent waste and other forms of pollution.

Topographic. USACE provides limited topographic support to base camps through the BCCA AutoCAD operators and their specialized equipment. In addition, a USACE contractor developed a Bosnia master plan to assist in land management. Most topographic support is coordinated through ODCSENGR's Geospatial Information System (GIS) officer, using the 60th Topographic Detachment, which is attached to ODCSENGR.

Fire Fighting. The BCCA staff helps develop and maintain fire-inspection and -prevention measures. USACE has provided technical expertise on alarm systems and individual and structural fire-fighting equipment.

HAZMAT/Spill Response. The BCCA environmental specialists provide guidance on HAZMAT storage and management, to include spill response, although the BSC is primarily used for spill response. Initially, in Kosovo, Department of Defense fire-fighting teams were deployed to provide general fire-fighting services and HAZMAT/spill response. After initial-entry operations and the establishment of base camps, fire-fighting facilities and equipment were delivered through the BSC. Eventually, the general fire-fighting service, facilities, and equipment were all provided through the BSC. This freed up military firefighters, a low-density capability, for other deployments by March 2000.

Countermine/Demining.[4,5] The BCCA assists in ammunition-surveillance maintenance requirements. This has focused on developing plans to correct new deficiencies noted during each inspection of ammunition-storage and -holding areas where unexploded ordnance is stored as a result of weapons- and ammunition-collection efforts and demining operations.

Base-Camp Standards. ODCSENGR has established a Red Book on Base-Camp Standards to prescribe uniform facility standards within the limits of good fiscal stewardship for the Balkans. The ODCSENGR contracted a company through the USACE Europe District to develop a master plan for Bosnia for the next 3 to 5 years that would provide a prioritized road map on how to get from the existing conditions to the Red Book standard. The independent, coordinated effort of the master plan also provides supporting justification for the remaining construction effort in Bosnia. Construction managers and quality-assurance representatives from the BCCA ensure that proper construction practices and methods are being followed, that there are no safety hazards, and that contractors are meeting their requirements.

Prime Power. In both Bosnia and Kosovo, commercial power was not available when U.S. forces began their peacekeeping missions in support of NATO. The 249th Engineer Battalion (Prime Power), Fort Belvoir, Virginia, provided power generation initially and helped plan and coordinate for continued power generation beyond the initial-entry time frame.[6] Commercial power is now used in Bosnia; however, the 249th still leases some equipment to support Task Force Eagle. In Kosovo, commercial power will not be available for at least 2 more years. Technical experts have assisted ODCSENGR by gathering information to increase efficiencies with the current power-generation system and to develop a power-generation plan for the next few years until commercial power is available.

Real Estate. USACE provides personnel on both a temporary and a permanent-hire basis (1-year tours) to handle real estate issues. Real estate expertise is required to execute leases at every site that U.S. personnel camp at or use. This has been especially challenging in Kosovo, where the landowners may not be known or multiple parties may claim ownership. Real estate specialists in the BCCA ensure that real estate impacts are included in construction-cost estimates so that potential real estate problems can be avoided. When claims are made against the United States for property damage, these specialists assess the damage and compare it to preexisting conditions to help settle claims.

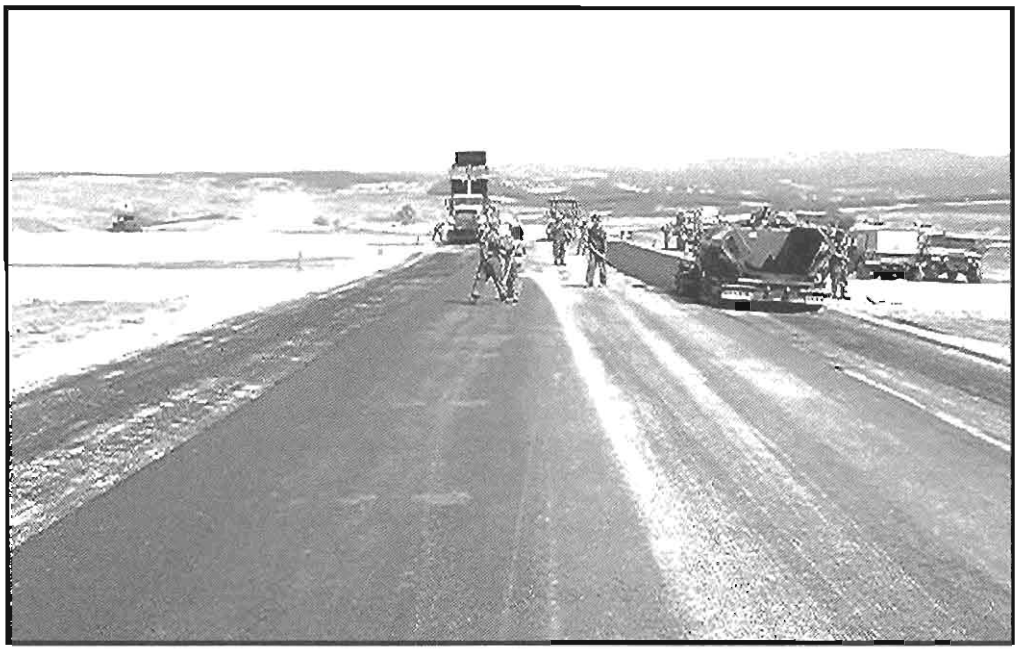
SNIC. A USACE expert develops SNIC plans for the base camps and the main supply routes and lines of communication to and from the base camps and surrounding areas—a critical effort during the winter months. ODCSENGR purchased 5-ton and high-mobility, multipurpose wheeled vehicle (HMMWV)-mounted snowplows and sand spreaders to give each task force the capability to operate when road conditions would otherwise be BLACK. The Cold Regions Research and Engineering Laboratory (CRREL) sent a training team to help install the equipment and train operators. This technical assistance and training is still provided annually before the snow season since units rotate out every 6 months, taking the experience and trained operators with them. Initially, in both Bosnia and Kosovo, the task-force engineers were responsible for SNIC. Although engineers from both Task Force Falcon and Task Force Eagle retain a SNIC capability, once the operational environment stabilized, they contracted out base-camp and task-force route clearance to host-nation contractors through the Defense Contract Management Command. SNIC along NATO routes is contracted out by the Stabilization and Kosovo Forces.

General Engineering and Technical Support

USACE provides additional engineering and technical support to ODCSENGR, divisional engineers, and commanders in the Balkans that is outside the basic Title X categories. For the most part, any support or expertise that USACE possesses has been used. Over the past year, this support has included the following areas:



Camp Bondsteel airstrip before paving



Paving the Camp Bondsteel airstrip

Tele-Engineering.[7] USACE, through the U.S. Army Research and Development Center's Waterways Experiment Station (WES), established Tele-Engineering capability between the Task Force Falcon BCCA and ODCSENGR at the beginning of the Kosovo mission, using a deployable video teleconferencing (VTC) system. This high-speed data link via satellite enabled ODCSENGR to conduct secure VTCs as well as other secure data transfer among ODCSENGR, WES, USACE Europe District, and the Task Force Falcon BCCA to coordinate various operational and construction issues. Personnel in the Balkans were able to consult with subject-matter experts thousands of miles away. This is tremendous value added to any operation since it keeps the number of deploying personnel down and gives access to a larger pool of experts.

The capability—used daily during the first months of the Kosovo mission—is still used at least weekly to continue coordination on construction progress and issues and to achieve efficiencies in construction methods and resource usage on a Balkans-wide basis. Over the past year, Tele-Engineering capabilities have been extended to divisional engineer brigades in Germany, the 130th Engineer Brigade, and the Task Force Eagle BCCA.

Laboratories/Centers of Expertise. In addition to the CRREL support for SNIC, USACE laboratories and centers of expertise have deployed personnel and teams on the following missions:

- **Bridge and Route Reconnaissance**. The USACE structural engineers perform surveys for both vehicular and train routes and assess the load classifications of bridges that may be crossed with heavy equipment on main supply routes.
- **Asphalt Capability Assessments**. Geotechnical experts perform soil stabilization and test batch samples of asphalt and concrete prepared by local batch plants. USACE sent asphalt experts into FYROM and Kosovo to assess bituminous-production capabilities and paving-materials availability.
- **Base-Camp Closure Environmental Assessments**. Numerous base camps and forward-operating bases have been closed in the Balkans. USACE has contracts in place for conducting environmental assessments, as required, which are coordinated through the permanent-party USACE environmental specialists/coordinators in each area. A comparison is made to the baseline survey to develop accurate scopes of work and timetables for returning land that is no longer used. Real estate specialists and supporting teams are also available to coordinate lease impacts.
- **Force Protection**. A force-protection expert ensures that camp design, layout, and function meet mission requirements while affording camp personnel with uniform force-protection measures based on the threat level. The USACE security-engineering and force-protection specialists were also used during camp planning and construction.
- **Well Drilling**. Hydrologists find the best places to drill for water, which has proved invaluable in areas where local water supplies are either not available or not potable. For larger base camps, wells have also resulted in a significant decrease in daily operations costs to the Army through greatly reduced water purchases.

USAREUR Engineer Repository.[8] The ODCSENGR used WES to purchase and install hardware and software, populate the database, and finalize system requirements for an engineer repository. WES also provides training for the system, database administrator, and users. A secure Engineer Information Repository Web site is under development, and a nonsecure site can be accessed at *http://engrep.-hqusareur.army.mil*. These sites contain archived copies of operations, after-action reviews, studies, and reports of various operations conducted in the Balkans and elsewhere within USAREUR's area of responsibility. In addition, both sites include country studies and other useful information.

A Combat Multiplier

There are a lot of new initiatives on the horizon as the Army prepares for a transition to the Objective Force. USACE has provided quality, responsive engineering services to the nation and the Department of Defense for a long time and is getting better with each operation. Military officers and civilian emergency managers in the Balkans face unique missions and often experience an uphill fight in getting support from counterparts in other USACE offices in the United States. By working through the technical and traditional problems with command support and emphasis, we are producing an engineering organization that has truly been a combat multiplier in the Balkans.

Major Horne, a deputy district engineer for the Sacramento Engineer District, served as the ODCSENGR Operation Joint Forge liaison officer for 6 months. He previously commanded Bravo Company, 91st Engineer Battalion, Fort Hood, Texas. MAJ Horne holds a bachelor's in civil engineering from West Point and a master's in environmental engineering from the University of Washington.

Mr. Lowdermilk is the chief of Operations, Plans, and Security for the Europe District in Wiesbaden, Germany. Past assignments include contingency plans officer, Transatlantic Programs Center, 1991-1996; operations officer, Europe District, 1996 - 1998; and contingency plans officer, Europe District, 1998 - 2000. Mr. Lowdermilk has an associate's in survival and rescue operations and a bachelor's in emergency management.

Endnotes:

[1]COL Robert L. McClure, "The Engineer Regiment in Kosovo," *Engineer*, April 2000, pp. 6-10.

[2] COL Donald T. Wynn, "Managing the Logistics-Support Contract in the Balkans," *Engineer*, July 2000, pp. 36-40.

[3]Ibid.

[4]1LT Eric Midden, "Demining in Bosnia-Herzegovina" *Engineer*, February 2001, pp. 20, 26.

[5] COL Andrzei Zarczynski, "Mine Threats in Mission Areas," *Engineer*, February 2001, pp. 4-7.

[6]CPT Jared Ware and SFC Ed Dawe, "The Next Generation of Power Generation," *Engineer*, July 2000, pp. 7-10.

[7] Dr. Paul F. Mlakar Sr., James C. Ray, and CPT Todd C. Liebig, "Bridge to the Future: Tele-Engineering and the Bubiyan Bridge Assessment," *Engineer*, April 1999, pp. 44-46.

[8]MAJ Barrett W. Larwin, "Enhanced Off-the-Shelf Technologies Help Engineers Prepare for Future Operations," *Engineer*, October 2000, pp. 38-39, 46.





CTC Notes

National Training Center

The Engineer Company TOC—A Critical Link in the Company's Success

By Lieutenant Colonel Thomas H. Magness and Captain David G. Ray

The Engineer Company Tactical Operations Center (ETOC) is often overlooked and receives minimal training or resourcing during a unit's preparation for a rotation at the National Training Center (NTC). However, many trends indicate that the effectiveness of an engineer company at the NTC is greatly influenced by the performance of the ETOC. This squad-sized element fills several roles: command post (CP) for the engineer company, mobility/survivability (M/S) Battlefield Operating System (BOS) representative for the supported maneuver task force (TF), and a direct liaison officer between the brigade combat team's direct-support engineer battalion and the maneuver TF.

ETOC Functions

An ETOC must perform the following six functions to effectively provide command and control for engineer elements operating in the TF sector and M/S BOS support to the TF:

Receive Information. An ETOC must receive information from the parent engineer battalion, the supported maneuver TF, and subordinate or attached engineer units operating within its area of operation (AO) to execute the remaining five TOC functions effectively. It is this function that dictates the need for the ETOC to possess the same command, control, communications, computers, and intelligence (C4I) capabilities as the engineer-company commander, supported TF, and parent engineer battalion.

- *Critical supporting tasks:*
  1. Receive messages, reports, orders, and overlays digitally or by frequency modulation (FM) or courier.
  2. Monitor and understand tactical situation.
  3. Maintain a log of significant activities and reports.
  4. Maintain status of critical classes of supply.
- *Noted trend–ETOCs are often unable to maintain effective communication with subordinate and higher-echelon engineer units.* This trend can be reversed by fully leveraging the C4I capabilities available within the engineer unit and supported TF. Digitized units must fully exercise the capabilities of the Force XXI Battle Command Brigade and Below System, and nondigitized units must fully leverage FM systems—including TF- and brigade-level retransmission capabilities, mobile subscriber radiotelephone coverage, and tactical facsimile, if available.

Distribute Information. An ETOC must be capable of rapidly distributing the information it has received to the elements requiring the information. This function must have adequate C4I capabilities and personnel trained to use the equipment.

- *Critical supporting tasks:*
  1. Submit reports to higher engineer and supported TF headquarters.
  2. Serve as a communication relay between units.
  3. Publish orders and instructions.
  4. Process and distribute information to appropriate units or staffs.
- *Noted trend–Units do not effectively track and disseminate obstacle information affecting TF mobility.* This includes friendly obstacles, planned or executed, and enemy obstacles confirmed within the TF, AO, or area of interest. The assistant task-force engineer (ATFE) should ensure that this information is posted on the engineer battle-tracking boards and the TF's current operations map and disseminated to the lowest level possible using obstacle overlays and FM updates. The use of a doctrinally correct obstacle-numbering system within the TF sector will improve the communication of obstacle status to the maneuver elements. It is also important that the ETOC monitors the communication of scatterable-mine warnings within the TF sector and to higher headquarters. The ETOC must be the critical node in collecting, verifying, and forward processing of hard copies of Department of the Army Form 1355, *Minefield Reporting*. Emplacing any land mines by U.S. forces must be thoroughly documented and then forwarded to the higher headquarters.

Analyze Information. The personnel manning an ETOC must continuously analyze the information from subordinate sources and higher echelons as to how it is affecting the M/S support of the current TF's scheme of maneuver. This function requires

that the members of the ETOC fully use their training and professional experience as combat engineers.

- *Critical supporting tasks:*
  1. Identify information related to the commanders' critical information requirements (CCIRs), essential elements of friendly information (EEFIs), priority information requirements (PIRs), and decision points.
  2. Prepare an engineer estimate.
  3. Conduct predictive analysis.
  4. Conduct terrain analysis.
- *Noted trend–Personnel in ETOCs are not trained to identify critical information, conduct predictive analysis, or use a decision-support matrix.* All members of the company CP must be familiar with the CCIRs, EEFIs, and PIRs designated for each operation. They must also understand the three components of the engineer battlefield assessment to analyze critical information in a timely manner.

Make Recommendations to the Commander. Filling the role of company operations officer and TF special staff officer, the ATFE and other members of an ETOC must be capable of rapidly and effectively communicating sound recommendations to the TF and engineer-company commanders.

- *Critical supporting tasks:*
  1. Develop and use decision-support template.
  2. Conduct tactical decision-making process (TDMP).
  3. Create/publish countermobility and survivability timelines.
  4. Recommend priority of employment of engineer assets.
- *Noted trend–ETOCs do not rapidly provide alternate courses of action (COAs) when fluctuations in time or assets available cause M/S effort to deviate from original plan.* All personnel in the ETOC must understand the engineer company and supported unit commander's intent. During the TDMP, the TF engineer must develop alternate engineer COAs based on likely changes in time and assets available. These COAs should be tied to specific actions that occur on the battlefield. They must be developed enough to be presented to the TF commander and implemented upon his approval.

Integrate Resources. An ETOC is responsible for coordinating actions internal to the engineer company and the M/S actions of the supported TF. Also, the ETOC must integrate vertically with higher engineer headquarters and horizontally with adjacent engineer units. It is essential that all members of the ETOC understand how to integrate with the remaining six BOSs during planning and execution of combat operations. The ETOC participates in all steps of the TF planning process and all TF-level rehearsals. During the military decision-making process, the ATFE conducts direct coordination with BOS representatives to ensure that all elements operating in the TF sector understand the scheme of engineer operations (SOEO).

- *Critical supporting tasks:*
  1. Conduct report procedures.
  2. Develop the SOEO.
  3. Conduct obstacle integration.
  4. Plan combined-arms breaching operations.
- *Noted trend–ETOCs do not address the essential elements of integration with the other BOSs during the planning, preparation, and execution phases of each operation.* All members of the ETOC must understand the role of the seven BOSs. It is essential that they understand how the M/S BOS supports and/or is supported by the other six. This is accomplished by maximizing opportunities to cross-train all members of the ETOC with members of the TF TOC.

Synchronize Resources. An ETOC must coordinate and synchronize the activities of all M/S assets within the TF AO. This process begins during the TDMP, as the ATFE ensures that the M/S BOS is represented during the war-gaming process and the development of the TF synchronization matrix. All members of the ETOC must understand how planned engineer actions relate to the actions of the other BOSs in the TF. The ATFE conducts the coordination before and during the war-gaming process. Thorough coordination before the COA analysis ensures that the SOEO is feasible and supports the TF commander's intent.

- *Critical supporting tasks:*
  1. Prepare an engineer annex.
  2. Participate in a TF war-gaming session.
  3. Conduct battle tracking of engineer assets.
- *Noted trend–ETOCs do not fully leverage the war-gaming process and TF-level rehearsals to adequately synchronize the M/S effort within the supported TF sector.* The ETOC must fully participate in all synchronization activities of the supported TF. During the war-gaming process and development of the synchronization matrix, all actions and effects of M/S assets must be included. During TF-level rehearsals, the presence of M/S factors must be addressed along with the actions of key engineer elements. Full participation in these activities will ensure synchronization with the other BOSs in the TF.

NTC Tactics, Techniques, and Procedures

Battle Rhythm. The ETOC must be effective during all phases of each mission (planning, preparation, and execution) for 14+ days of continuous operations. Each phase requires input from the M/S BOS; therefore, it is critical that trained and combat-effective personnel are on duty and contributing to each phase of the mission. The ETOC leadership must ensure that an effective battle-handover/shift-change plan is in place to ensure no loss of situational awareness (see Figure 1). To ensure that roles are filled and executed effectively, specific duties and responsibilities for each position should be

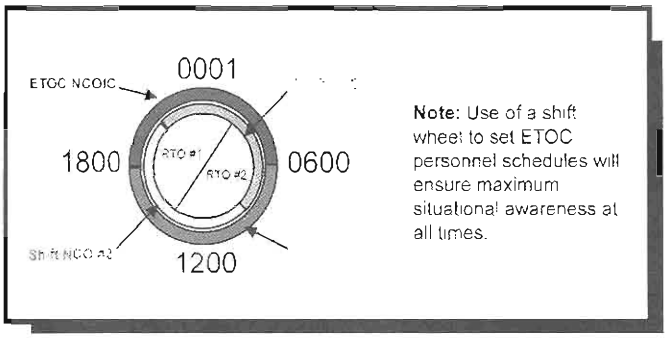


Figure 1. Example ETOC Shift Wheel

documented and placed in a TOC standing operating procedure (TOCSOP). This document will allow new personnel to quickly understand their roles and responsibilities as part of the ETOC. Smooth integration of new personnel will minimize the effects of personnel changes.

Individual Roles. The ATFE must not try to accomplish all missions and handle issues during all phases. He must be heavily involved in planning for future operations with the supported TF. This forces the operations noncommissioned officer (NCO) and remainder of personnel assigned to the ETOC to support the executive officer (XO) and handle current operations. This means the TF current operations section must rely heavily on the ETOC noncommissioned officer in charge and shift NCOs. Most often these individuals have not been battle-staff trained, but they must execute home-station training that educates them to that level. It is essential that the ETOC function without the presence of the engineer-company XO.

Providing Engineer Expertise to the TF XO/S3/Battle Captain. All personnel within the ETOC should be trained to provide timely and accurate engineer advice to the supported TF. Each member of the section should be current on engineer doctrine, engineer munitions, engineer planning factors, and engineer equipment/logistical requirements. Therefore, a functional field manual/technical manual (FM/TM) library should be accessible along with a battle book that is tailored to the needs of the supported TF. The ATFE must be the M/S BOS expert with the capability to analyze any friendly or enemy engineer actions and provide effective recommendations to the TF commander. The following items are essential to provide doctrinally sound M/S advice to a maneuver TF:

- FM 5-34, *Engineer Field Data,* August 1999.
- FM 20-32, *Mine/Countermine Operations*, May 1998.
- FM 90-7, *Combined Arms Obstacle Integration*, September 1994.
- FM 3-34.2, *Combined-Arms Breaching Operations*, date pending.
- FM 5-71-2, *Armored Task-Force Engineer Combat Operations*, June 1996.
- Supported unit's tactical SOP.

All personnel in the ETOC should be trained to conduct basic terrain analysis effectively. This means they must have access and be trained to fully leverage any terrain-analysis product or system available. Also, every member of the ETOC should be trained to operate the available terrain-analysis software.

Synchronizing the Mobility/Countermobility/Survivability (M/CM/S) Effort Among Maneuver Companies/Teams. The ATFE and ETOC are responsible for synchronizing M/CM/S effort across the TF. Clearly communicating the tasks that must be completed and their respective sequence can accomplish this synchronization. The first step toward this goal is publishing an effective engineer annex in the TF operations order (OPORD). This annex should include easily understandable execution matrixes for the TF M/CM/S efforts. The engineer cell should also provide accurate and up-to-date overlays to support each of these plans. The ATFE must ensure that M/S tasks for maneuver elements, essential to TF mission completion, are published in the TF OPORD in paragraph 3—Tasks to Maneuver Units. To help support the engineer annex, there are several graphical tools that can improve the planner's ability to communicate the key tasks and their relation to the time available:

- **Gantt Chart** (See Figure 2, page 66). This tool, often referred to as a timeline, can quickly communicate the task, location, and resource requirements for all critical M/S units or resources. This assists the TF in tracking and logistically supporting engineer assets as they are shifted across the battlefield during preparation for defensive operations.
- **Glide Path** (See Figure 3, page 66). This graphical tool displays actual versus estimated production. Countermobility or survivability effort can be tracked on a glide path. It allows the leadership to determine if units are producing at the level estimated and to project the actual end state. The glide path can identify when decision points are reached to shift key assets to achieve the desired amount of countermobility or survivability effort. This product will allow leadership the opportunity to adjust resource allocation or the tactical plan based on the current production level and an extrapolated estimate of final production for M/S resources.
- **Commander's Card** (See Figures 4 and 5, page 67). This graphical tool keeps the TF commander abreast of the progress of the key M/S assets within the TF sector. It serves as a "blueprint" of the planned engineer effort in sector. The TF's current operations cell and the ETOC update the card at a regular interval, designated by the TF commander.

Publishing the Engineer-Company OPORD. An ETOC should be trained to create and publish the engineer-company OPORD, supplemented with supporting terrain-analysis products, a consolidated graphics overlay, and a comprehensive risk-management document. The engineer annex created during the TF orders process can serve as the base for

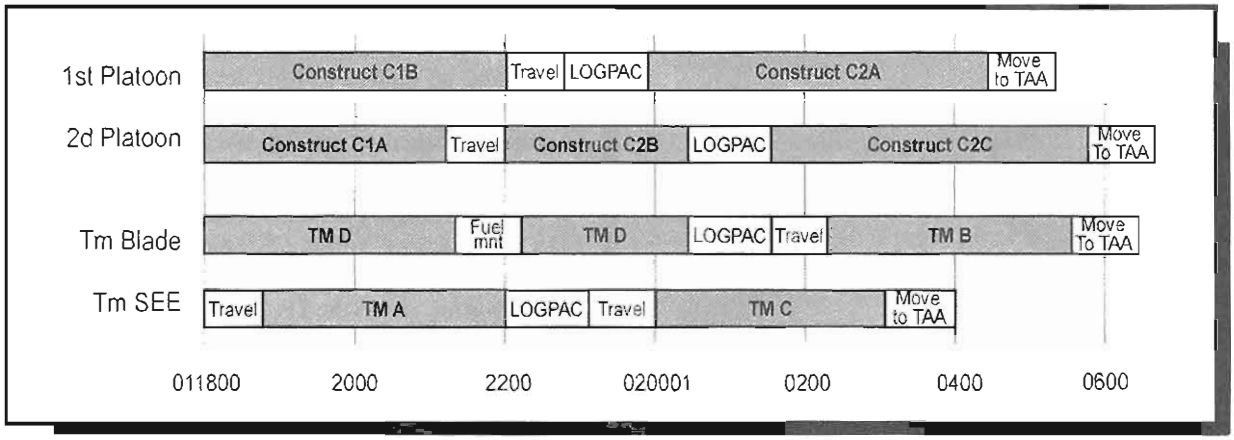


Figure 2. Example Gantt Chart

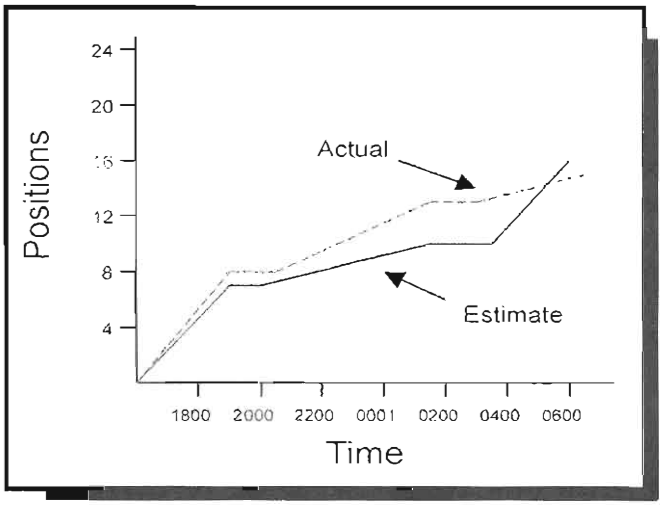


Figure 3. Example Glide Path

this product. By using the engineer annex as the base document and adding the engineer-commander's intent, paragraph IV (Service Support), and paragraph V (Command and Signal)—related to the engineer company—a company-level order is created before publishing the TF OPORD. Executing this parallel planning by the ETOC will ensure that the engineer commander is prepared to issue a full company OPORD before task-organizing subordinates to supported maneuver units.

Usable terrain products must be provided to the subordinate units as part of the company OPORD package. This will allow the engineer leaders in the company to better understand the critical aspects of the terrain they will be operating on and communicate those factors to the maneuver elements that they support. Placing these products directly in the hands of the engineer units will ensure that they are fully leveraged to support completion of the critical M/S tasks.

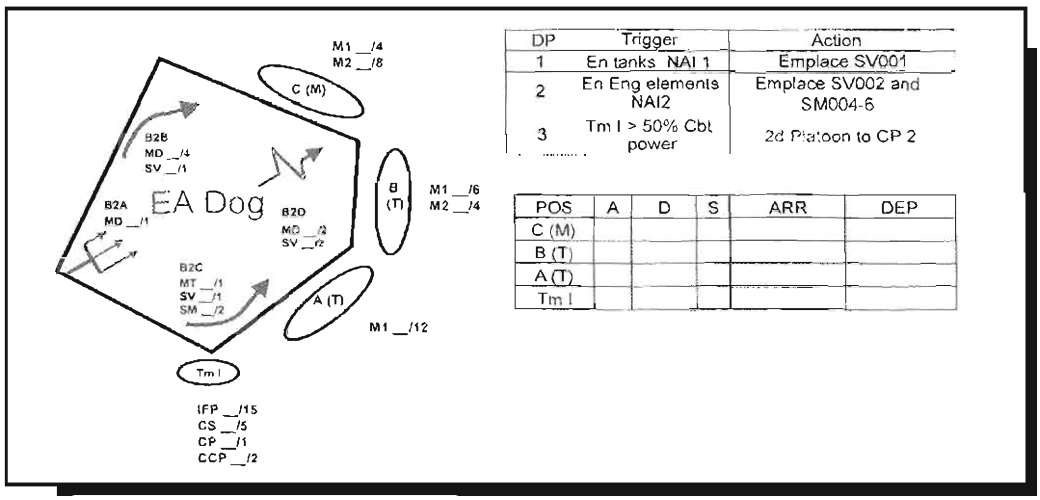
The ETOC has the capability to consolidate all available TF graphics and create a product that is usable by key leaders within the engineer company. This consolidated graphics product should contain information from the following sources:

- TF situation template.
- TF reconnaissance-and-surveillance overlay.
- TF maneuver overlay.
- TF fire-support overlay.
- TF combat-service-support overlay.
- TF M/S overlay.

By using the professional experience of the personnel in the ETOC, and access to the mentioned products, a single graphical product can be created that is tailored to the needs of the engineer leaders. This product can then be issued along with the company OPORD before task organization takes effect. The ETOC can also create a comprehensive risk-management product that the company commander can brief and distribute to the subordinate leaders. By combining the risks and the control measures published by the supported TF and the parent engineer battalion, along with those identified by members of the ETOC, the company-level risk-management product should minimize any loss of combat power or chance of mission failure.

ETOC Individual-Skills Training. Due to the small number of personnel assigned to an ETOC and the requirement to support continuous operations, all personnel assigned to the engineer CP must be trained and ready to execute any task required. To be an effective member of the ETOC team, each member must be trained and certified to execute the following tasks before an NTC rotation:

- Operate all assigned vehicles—preventive maintenance checks and services (PMCS).
- Operate all assigned equipment (communications, automation, TerraBase)—PMCS.
- Perform specific tasks in TOC relocation battle drill.
- Serve as radio/telephone operator—understand how to receive and send reports at both company and battalion levels.
- Understand military maneuver graphics and all reports required by higher and lower echelons—battle tracking.
- Conduct shift-change briefing or brief critical M/S events/issues to TF battle captain or TF commander.



DP	Trigger	Action
1	En tanks NAI 1	Emplace SV001
2	En Eng elements NAI2	Emplace SV002 and SM004-6
3	Tm I > 50% Cbt power	2d Platoon to CP 2

POS	A	D	S	ARR	DEP
C (M)					
B (T)					
A (T)					
Tm I					

Figure 4. Example 1, Commander's Card

DP	Trigger	Action
1	En tanks NAI 1	Emplace SV001
2	C (M) set SBF 1	2d Platoon move to CP 2
3	Misfire lane #1	Breach lane #3

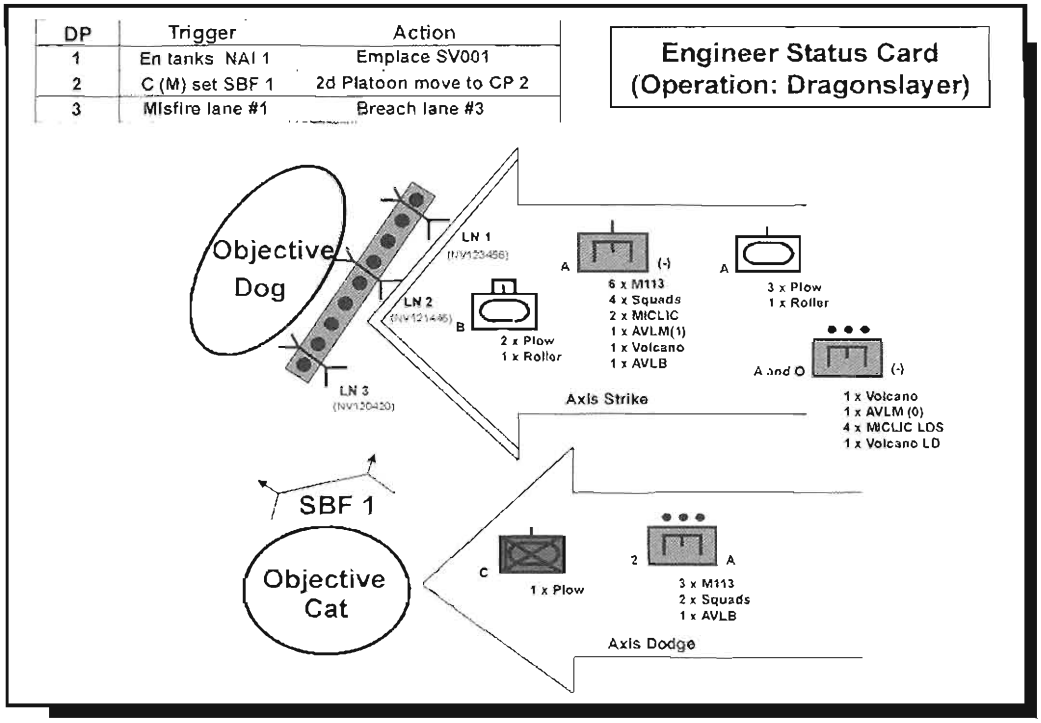


Figure 5. Example 2, Commander's Card

Conclusion

Adhering to these recommendations and executing the critical tasks do not guarantee success at the NTC. These are recommendations that will greatly increase the potential for successful engineer operations in support of armor, mechanized infantry, or light infantry TFs. True success at NTC is achieved by continuously improving through each mission and then taking lessons learned back to the home station and creating a comprehensive training program to prepare for real-world contingency operations.

Lieutenant Colonel Magness is the engineer battalion S3 trainer on the Sidewinder Team at the National Training Center at Fort Irwin, California. Previous assignments include brigade and battalion S3, 4th Infantry Division, Fort Hood, Texas; company commander, 16th Engineer Battalion, 1st Armored Division, Germany; and platoon leader and battalion staff officer, 17th Engineer Battalion, 2d Armored Division. LTC Magness holds a master's from the University of Texas and is a graduate of the United States Military Academy and the Command and General Staff College .

Captain Ray is a task force engineer observer/controller on the Sidewinder Team at the National Training Center at Fort Irwin, California. Previous assignments include company commander, 84th Engineer Battalion, Fort Richardson, Alaska; platoon leader and battalion staff officer, 91st Engineer Battalion, 1st Cavalry Division; and platoon leader, 2d Engineer Battalion, 2d Infantry Division. CPT Ray is a graduate of the Engineer Officer Basic and Advanced Courses and the Colorado School of Mines.

ENGINEER UPDATE

Commercial numbers are (573) 596-0131, ext. xxxxx, and Defense System Network (DSN) numbers are 676-xxxx unless otherwise noted.

Directorate of Training (DOT)

Note of Appreciation. Thank you to the many leaders who have participated in the electronic virtual-task and site-selection boards and surveys in recent weeks! These are critical components of training development and we do need your input.

Active Duty Service Obligations (ADSO) Change to Partially Funded Degree Programs. A change to Army Regulation 350-100, *Officer Active Duty Service Obligations*, indicates that officers participating in a partially funded program incur a three-for-one ADSO for time spent in civilian education with a minimum ADSO of 2 years.

POC is CW4 Frederick Kerber, 34088; DSN -4088; or e-mail *kerberf@wood.army.mil.*

Ranger Coding. The Infantry School initially approved the Engineer School's request to Ranger-code 240 noncommissioned-officer positions in light, airborne, and air-assault units. However, the action is currently on hold until TRADOC develops a support plan that meets the Vice Chief of Staff of the Army's guidance to balance Ranger coding between light and mechanized units.

POC is MSG James Keesee, 35850; DSN -5850; e-mail *keeseej@wood.army.mil.*

Command Sergeant Major (CSM) Fall Conference. The United States Army Engineer School's CSM and the Engineer Personnel Proponency Office are planning to hold the CSM Conference in Carlisle Barracks, Pennsylvania, 24-28 September 2001. Engineer CSMs of all components will be invited.

POC is SGM Wade Kerr, 37232; DSN -7232; e-mail *kerrw@wood.army.mil.*

Military Occupational Specialty (MOS) 12C Fast Track. This MOS is included in the Fast Track and Retention in Excellence Program due to Skill Level 10 being overstrength. Thirty-nine 12C10s have been identified for redistribution. The Personnel Command has notified the soldiers identified as being overstrength and encourages them to voluntarily request reclassification into a shortage MOS. If these soldiers fail to reclassify, an MOS may be identified for them. We encourage those who are eligible to request reclassification into 52E.

POC is SGM Wade Kerr, 37232; DSN -7232; e-mail *kerrw@wood.army.mil.*

Army Engineer Doctrine. Joint Publication (JP) 4-04, *Joint Doctrine for Civil Engineering Support,* can be accessed by going to the draft publications section located on the joint doctrine URL site. The World Wide Web URL address is *(http://www.dtic.mil/doctrine/jel/operations.htm).* You can also find JP 3-34, *Engineer Doctrine for Joint Operations*, at this site.

POC is Mr. Reggie Snodgrass, 37762; DSN -7762, or e-mail *snodgrar@wood.army.mil.*

Access to Manuals. Not all engineer materials have been posted. If you require materials which have not yet been posted, contact this office. For a list of engineer manuals on the General Dennis J. Reimer Library, go to *www.adtdl.army.mil/atdls.htm* and click on "Enter the Library." Select "Field Manuals" on the left drop-down menu and "Engineer" on the right drop-down menu. Click "Submit."

POC is Mr. Reggie Snodgrass, 37762; DSN -7762, or e-mail *snodgrar@wood.army.mil.*

Combined Arms Obstacle Breaching Newsletter. The Center for Army Lessons Learned, in cooperation with the U.S. Army Engineer School, is publishing a new newsletter featuring tactics, techniques, and procedures designed to assist in training combined-arms teams for combined-arms obstacle breaching. This publication is a direct result of experiences in the trends reversal process and should provide commanders and staff in the field with a valuable training tool. The publication is due out in July 2001.

POC is Mr. Reggie Snodgrass, 37762; DSN -7762, or e-mail *snodgrar@wood.army.mil.*

Engineer Lessons Learned. We have updated the Doctrine Development Division Lessons Learned Web site. Several units have now sent electronic copies of their respective standing operating procedures (SOPs,) which can be found on the Engineer School Web site. Please continue to forward any engineer lessons learned from exercises and operations. Others may benefit from your experiences.

POC is Mr. Reggie Snodgrass, 37762; DSN -7762, or e-mail *snodgrar@wood.army.mil.*

Webster University Master's Program. Webster University now offers a Master of Arts (MA) in Public Administration. It will allow nontechnical degree holders to undertake postgraduate studies during the Engineer Captain's Career

Course (ECCC). Participants will take 12 semester hours during ECCC (Phase One) and three semester hours during CAS3 (ECCC Phase Two). They will complete the program over 5 weeks at Fort Leonard Wood with six semester hours of coursework.

POC MAJ Steve Cross, 34128, DSN -4128, or e-mail *crosss@wood.army.mil.*

Countermine POC for Questions. We are ready to tackle any countermine or mine-awareness questions you may have and will get you an answer as quickly as possible. Please call our office or send questions via our Web site.

POC is Mr. Mike White, 36199, DSN -6199, or e-mail *whitemi@wood.army.mil.*

Humanitarian Demining Operations (HDO) Training. Our basic HDO course continues to receive positive feedback from teams in the field (mostly special-forces types). Therefore, we are constantly updating our HDO course. We also encourage comments and information from the field on humanitarian demining.

POC is SGM Kevin Fee, 36199, DSN -6199, or e-mail *feek@wood.army.mil.*

Directorate of Environmental Integration (DEI)

Training Circular (TC) 3-34.489, *The Soldier and the Environment.* This publication was released in April 01 and can be accessed at the Directorate of Environmental Integration's site through the Fort Leonard Wood home page. TC 3-34.489 contains information on personal and professional responsibilities for protecting the environment that soldiers can use to make responsible decisions about the environment. It is the companion to FM 3-100.4, *Environmental Considerations in Military Operations* (Jun 00).

POC is Dr. Rebecca Johnson; 34119, DSN, -4119. or e-mail *johnsonr@wood.army.mil.*

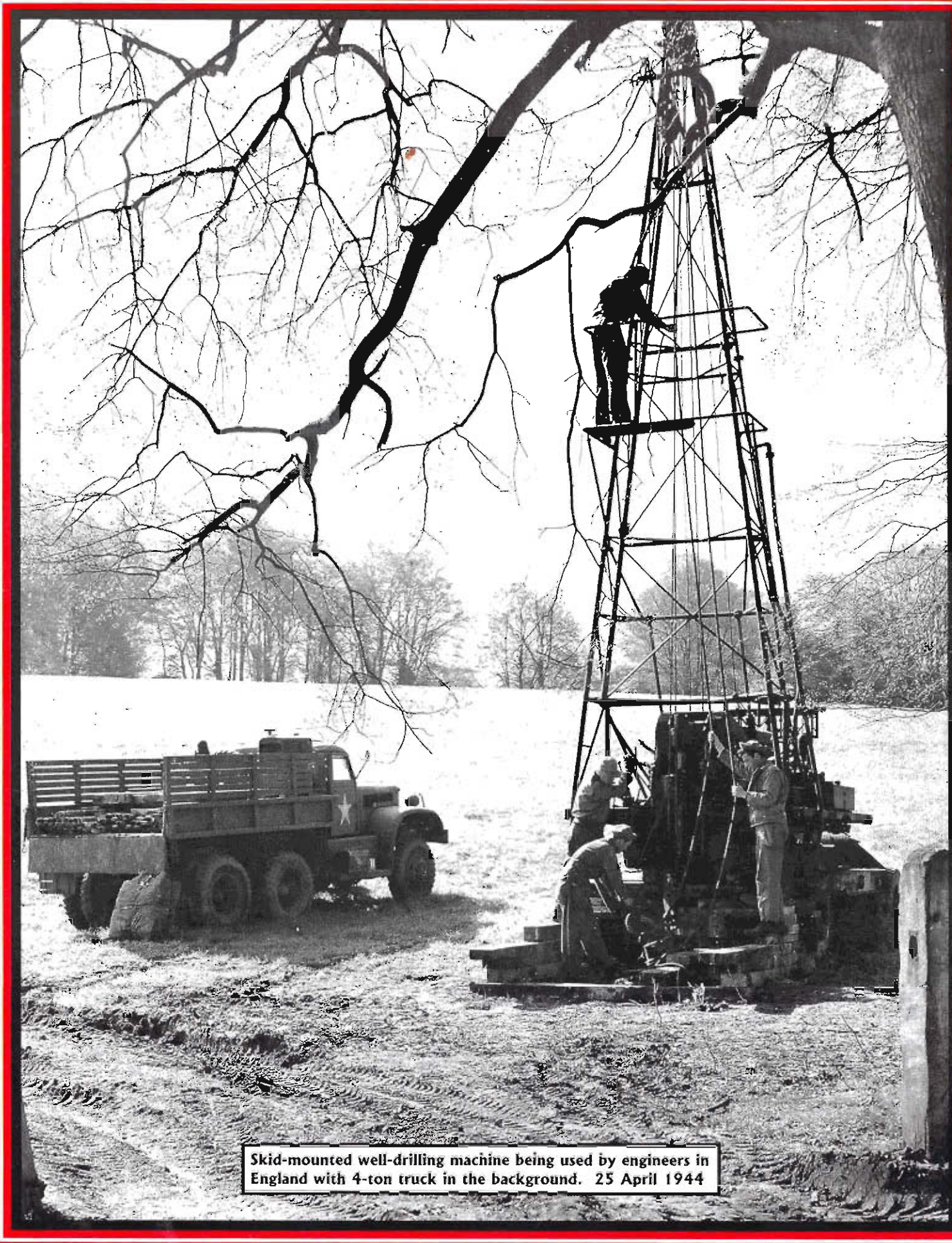
News and Notes

International Society for Terrain-Vehicle Systems (ISTVS) Conference 2002 Vehicle and Terrain Mechanics in the 21st Century Virtual World—Call For Papers. The 14th International Conference of the ISTVS will be held at the Vicksburg Convention Center in Vicksburg, Mississippi, U.S.A., near the U.S. Army Engineer Research and Development Center, from 21 through 25 October 2002. This conference will provide a forum to promote advancement on all aspects of design, development, research, and operations of vehicles and machinery for agriculture, earthmoving, construction, forestry transportation, and military fields. Some specific topics will include terrain and vehicle modeling; terrain, vehicle, and operator interaction simulation and physical evaluation; simulation-based vehicle design and evaluation; and autonomous vehicles, robotics, and intelligent mobility support systems. English will be the official language for this conference; simultaneous translation will NOT be provided. Final versions of the papers shall be in English, in DIN A4 format, and ready to be printed and shall not exceed 10 pages, including tables and figures. The abstracts shall be in English, should not exceed one page, and shall meet the following essential requirements:

- The content shall be of original nature and not published elsewhere.
- Reports about ongoing development and research programs shall show clearly the progress made since earlier publications.
- Contributions on economic and/or strategic considerations shall be related to the conference topics.
- The primary author shall submit his/her complete address and a brief curriculum vitae together with the abstract.

Submit the abstracts as an attached document, using a common word-processing program, to *sshoop@crrel.usace.army.mil.* Include a complete mailing address and short biography of the presenting author. The format for the abstracts is as follows: title case, 16 point bold; author names, 12 point, underline the presenting author; e-mail for presenting author, 12 point; suggested conference topic area, 12 point; text Times New Roman, 12 point, single spaced with 6 point after each paragraph; timetable for preparation of papers; and 1-inch margins on all sides on A4 or 8.5- x 11-inch paper. The timetable is 15 September 2001, deadline for the abstract; 15 November 2001, notification of authors about acceptance of papers; and 1 May 2002, deadline for ready-to-be-printed papers. For more information, go to *www.crrel.usace.army.mil/web-lab/pamb/ISTVS.*

POC is Dr. Sally Shoop, (603) 646-4321 or e-mail *sshoop@crrel.usace.army.mil.*



Skid-mounted well-drilling machine being used by engineers in England with 4-ton truck in the background. 25 April 1944

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