Engineer

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Preparing for the next millenium

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CLEAR THE WAY

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

The slogan *"One Regiment, One Team, One Fight"* embodies the Engineer Regiment's vision. The Senior Engineer Officer Board of Directors carefully crafted the vision in Washington, D.C., in September. Its purpose is to ensure that our regiment remains relevant to all our military forces, major Army command (MACOM) staffs, Directors of Public Works, Department of Defense civilians, private industries that serve or support military units, and Corps of Engineer organizations around the world. The vision statement describes how an organization will look, what it will do, and how it will operate. It states what we continually strive to achieve. Our new vision statement is:

> **The U.S. Army Engineer Regiment**
>
> **The World's Premier Engineer Team:**
>
> - Full-Spectrum, Total Force—Vital to the Army and the Nation
> - Values Based – Respected, Responsive, Reliable
> - Visualizing and Enhancing Terrain to Ensure Mission Success
> - Meeting Tomorrow's Challenges Today – Deployed or at Home, in Peace or in War
>
> **One Regiment, One Team, One Fight**

Our next step is to staff this vision statement with regimental leaders at all levels to gain an understanding of what each bullet means to the various organizations within the regiment. As stated during the 1998 ENFORCE Conference, the vision is effective only if the officers, noncommissioned officers, and Department of the Army civilians understand it. To that end, I ask all of you to continually communicate this vision to soldiers and civilians throughout our diverse regiment.

The Engineer School continues to field new equipment to maintain a vital force structure. Our top five priorities remain the Grizzly, the Wolverine, the Digital Topographic Support System (DTSS), the Maneuver Control System-Engineer (MCS-ENG), and a modernized engineer squad vehicle (ESV). I ask your support to communicate the importance of these systems to key Army, Department of Defense, and political leaders. Brief descriptions follow.

The Grizzly is a complex obstacle-breaching vehicle that is based on a refurbished M1 chassis. It integrates advanced countermine and counterobstacle capabilities in a single, survivable system.

The Wolverine is a heavy assault bridge that is based on an M1 chassis. It is designed to transport, launch, and retrieve a military load class 70 bridge across gaps up to 24 meters.

The DTSS integrates commercial off-the-shelf hardware and laboratory-developed software to form a package that provides direct access to data acquired by national systems and delivered by tactical exploitation of national capabilities assets. Soldiers utilizing the DTSS have the capability to produce soft and hard topographic products, such as digital terrain elevation data map substitutes and three-dimensional terrain products.

MCS-ENG is an engineer-specific software system that is subordinate to the Maneuver Control System (MCS). The MCS is a command and control system that provides the maneuver commander and his staff (Corps level and below) with automated assistance to execute precise, near real-time command and control of combat forces.

A modernized ESV is critically needed to enhance engineer survivability and give engineer units an armored capability for providing mobility and countermobility support to the maneuver forces. The leading contender for a modernized ESV is the Bradley fighting vehicle. The long-term solution is to co-develop an ESV variant of the future infantry vehicle (see article, page 7).

As part of OPMS XXI, we recently updated the Engineer chapter in DA Pam 600-3. The most significant change expands opportunities for majors to become branch qualified. Branch-qualifying positions for majors now include assistant division engineers, directors of public works, and deputy district engineers, as well as the traditional S3 and XO positions. This change recognizes the importance that these positions have in supporting the total force and the considerable responsibility they demand. I believe that this change will result in officers spending more time in branch-qualifying positions for the betterment of the organization and themselves.

As I travel around the world and visit military units, I have an opportunity to meet some of the outstanding soldiers, sailors, airmen, and Marines who trained here at Fort Leonard Wood. I never fail to be amazed at their high quality. Thank you for a job well done.

Engineer

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Front Cover: *Through Army XXI reorganization, experimentation, deployments, and training, engineers prepare for the next millenium.*

Back Cover: *A historical example of the Army value "Respect."*

FEATURES

DEPARTMENTS

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The Army XXI Division:

Engineer Relevancy in the Age of Information Technology

By Major General Robert B. Flowers, Mr. Vern Lowrey, and Colonel Bruce Porter

Engineers continue to prove their professional excellence and relevance in ongoing missions and training throughout the world. Today, Army engineers are deployed in more than 70 countries to support operations ranging from building roads to clearing landmines to producing terrain visualization products. In the coming months and years, Army engineers have yet another challenge to meet—the Army XXI division (see Figure 1).

Since 1993, the Training and Doctrine Command (TRADOC) has been in the process of restructuring for tomorrow's Army. Through numerous seminars, analyses, and Advanced Warfighting Experiments, we designed a new heavy division. In June 1998, Army Chief of Staff General Reimer approved the Army XXI division design, which will be fielded initially by the 4th Infantry Division at Fort Hood, Texas. The division will reorganize starting in October 1998 and will be evaluated during a series of experiments and exercises that culminate in a Division Capstone Exercise (DCX) to validate the design sometime during the summer of 2001.

The U.S. Army Engineer School will thoroughly evaluate the 4th Infantry Division engineer structure from now through the DCX. The school will properly collect and analyze data that may lead to appropriate recommendations to the Army Chief of Staff concerning the Army XXI engineer structure. **The school does not support efforts to convert other heavy divisions to the Army XXI structure until the design has been thoroughly evaluated by the Army and appropriate enablers are available.**

TRADOC Commander General Hartzog wrote in the July-August 1998 issue of *Army RD&A* that this design is "...unique because of its smaller size (about 15,000 soldiers), its smaller and more compact combat elements (45 combat platforms in

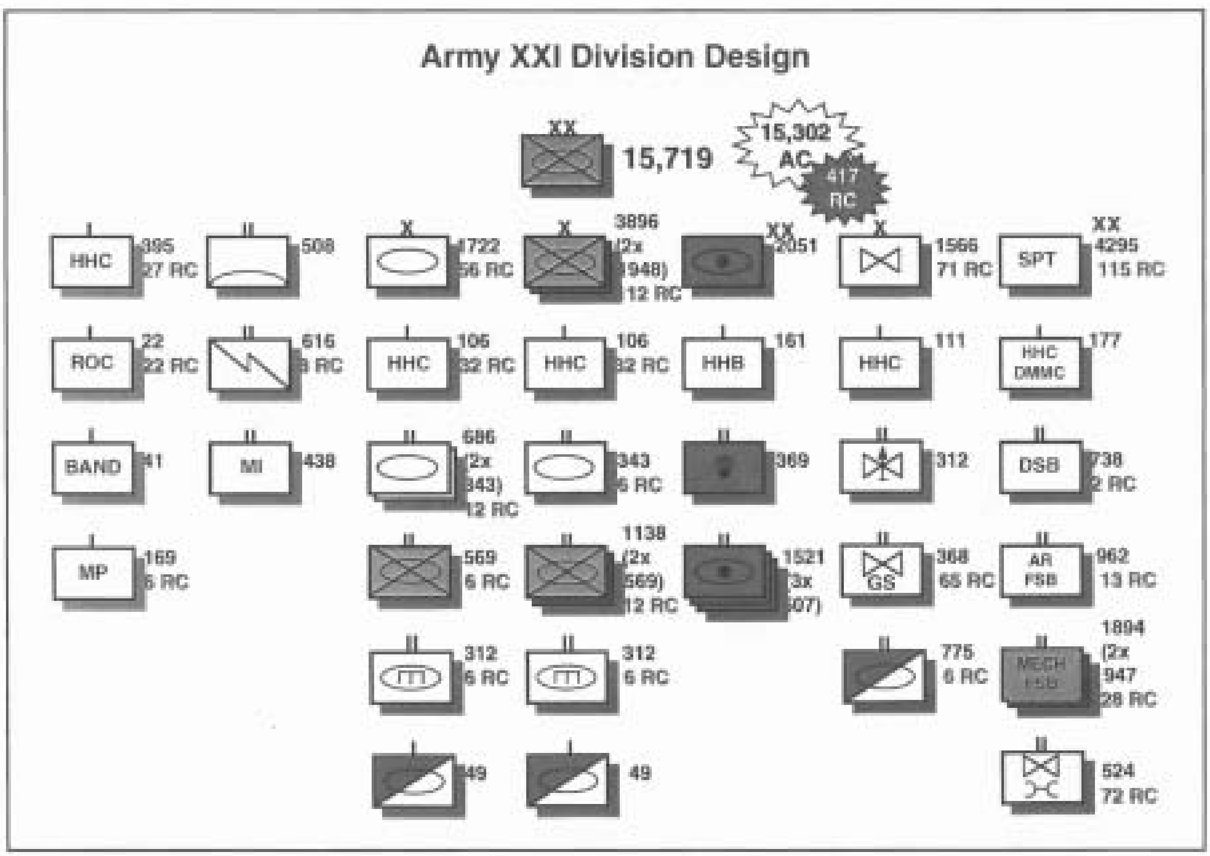

Figure 1

> *"Let me emphasize to everyone that the loss of the division engineer brigade headquarters in the Army XXI division design is not a "done deal!" The Engineer School will continue to gather evidence through ongoing experimentation. We critically need help NOW from engineer commanders in the field to help retain the engineer brigade structure in the Army XXI and other heavy divisions in the future. We ask that you work your recommendations through your major Army command headquarters (i.e., FORSCOM, USAREUR, or the National Guard Bureau) to the Army Chief of Staff. We also ask that you keep key Engineer School personnel informed of your actions. We must work together to achieve our common goal."*
>
> *Major General Robert B. Flowers*

maneuver battalions), and its reliance upon digital technology and computers. Its size makes it more rapidly deployable. Its ability to share information horizontally and vertically across the battlefield makes it capable of sustaining a rapid tempo of planning, preparing, and executing operations as well as sustaining and recovering from operations. Its modular organization contributes to its versatility for specific missions. The division is agile and lethal and increases warfighter survivability, and it has the organizational capability for what is called "mental agility."

Army XXI Division Engineer Structure

The Army XXI division has three major changes in engineer structure compared to the current Army of Excellence division:

- An engineer staff element is part of the division headquarters and headquarters company (HHC)—versus the current separate division engineer brigade headquarters. (The Engineer School's goal remains to reinstate a division engineer brigade headquarters as part of the Army XXI division validation process. We will accomplish this through the DCX.)
- An engineer battalion is assigned to each brigade combat team (BCT) in the division—rather than being assigned to the division engineer brigade headquarters as it is today.
- All combat service support (CSS) (less medical) for the engineer battalion is provided by the base support company (BSC) of the BCT forward support battalion—versus the current engineer battalion with its own CSS.

Doctrinal and Organizational Impacts

Army XXI division engineers will be required to change the way they operate doctrinally based on organizational changes in the Army XXI division design (Figure 2). The major organizational changes affecting doctrine include the division engineer staff element, the division engineer battalion, echelon above division (EAD) engineer support, and CSS operations. Implications of these changes follow.

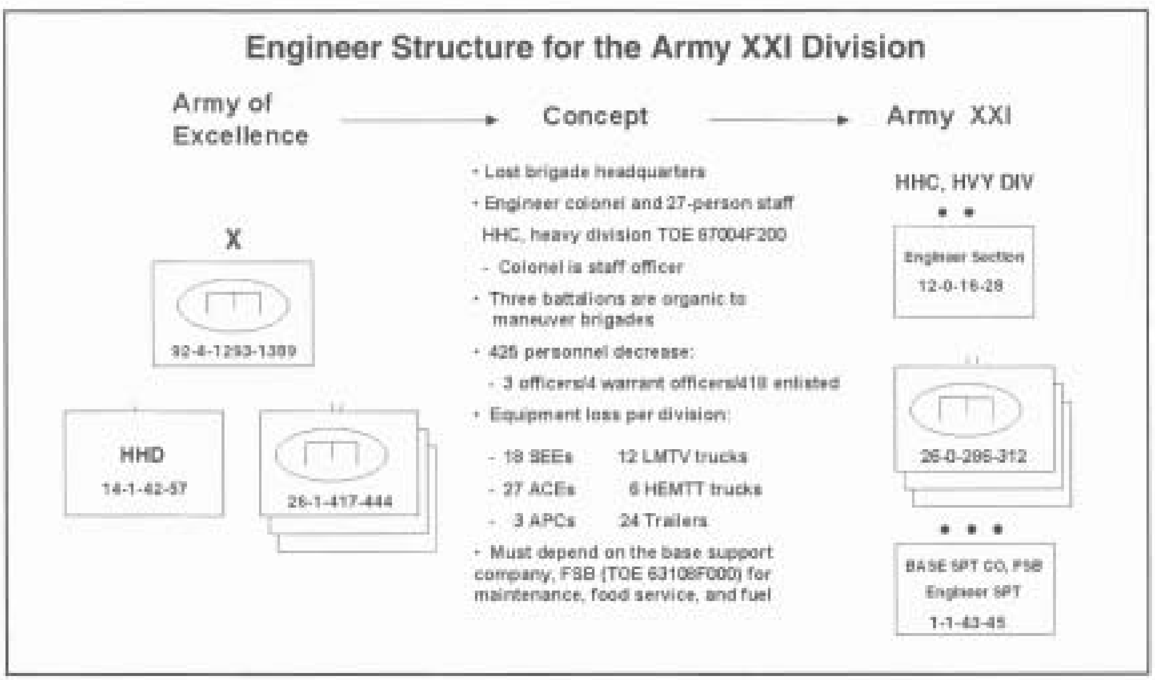

Figure 2

Division Engineer Staff

The Army XXI division engineer staff element is under the control of the division engineer officer, who remains a colonel. The engineer staff is embedded in division command posts, currently the tactical and main command posts. The engineer staff provides digital engineer input to division orders and writes the engineer annex. The staff determines additional engineer capabilities needed from EAD based on division requirements. The engineer staff maintains situational understanding of the organic division and augmenting EAD engineer operations through division digital reporting procedures. All engineer staff recommendations flow through the division G3 for action or decision by the division commander. The engineer staff normally works to integrate an engineer command and control headquarters—such as an engineer group (combat), which is task organized from EAD to support the division.

Heavy Division Engineer Battalion

Army XXI division engineer battalions are now under the BCT commander (Figure 3). They support the commander's intent by providing responsive mounted obstacle breaching and emplacement, such as Volcano-scatterable minefields. The Army XXI division engineer battalion is fully mounted and uses Grizzly breachers, Wolverine heavy assault bridging, and M9 armored combat earthmovers (ACEs) in support of brigade offensive operations. The Army XXI engineer battalion no longer has small emplacement excavators (SEEs). It has one less squad per engineer platoon, no tactical command post capability, and fewer ACEs. The engineer battalion can receive additional engineers from EAD for increased obstacle reduction and creation capability, deliberate defensive operations, operations in restricted terrain, lines-of-communication (LOC) construction, and maintenance and repair in the brigade battlespace.

The Engineer School and 4th Infantry Division Engineer Brigade are evaluating the TRADOC-approved concept of using an M2 Bradley fighting vehicle as an engineer squad vehicle to possibly replace the M113A3 armored personnel carrier (APC) in Army XXI division engineer battalions. (See article on page 7.)

The engineer battalion commander is dual-hatted as the brigade engineer and the engineer battalion commander. The engineer battalion provides an assistant brigade engineer staff element that operates in the brigade command post. The ABE provides digital engineer input to brigade orders and writes the engineer annex. He determines additional engineer capabilities needed based on brigade requirements and passes them to the division engineer. The assistant brigade engineer maintains situational understanding of organic and augmenting EAD engineer operations through brigade digital reporting procedures. The engineer battalion staff writes digital engineer orders to companies in support of task-force operations.

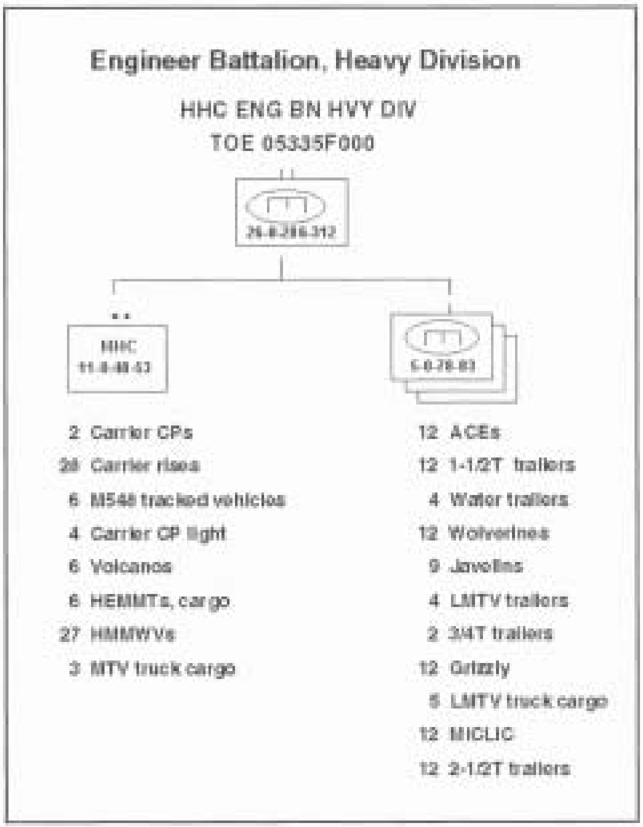

Figure 3

EAD Engineer Support

Army XXI division engineers are structured to provide only minimal obstacle-creation and obstacle-reduction capabilities. Any additional engineer support needed by the Army XXI division, such as bridging and heavy construction equipment, must come from EAD engineer forces. The Engineer School is working with TRADOC as part of the Corps XXI redesign process to determine EAD engineer doctrine and organizations required to support the Army XXI division and other maneuver forces. The EAD engineer support will come mainly from the Reserve Components of the U.S. Army Reserve and Army National Guard.

EAD engineer support normally will require an engineer headquarters element (such as an engineer group) to command and control EAD engineers operating in the Army XXI division's battlespace. Some EAD engineer units may not be digitized and thus will be unable to "plug" into the Army XXI division information networks. Extensive liaison capability may be required to effectively integrate EAD engineers with the Army XXI division.

EAD engineer support to the Army XXI division is primarily in the areas of terrain visualization, supplemental obstacle-reduction capability, mobility support through restrictive terrain, emplacement of deliberate defenses, and force protection. Additionally, EAD engineers will construct, repair, and maintain combat trails, LOC facilities, routes, bases, and forward aviation support sites.

Terrain Visualization. It is the Engineer School's intent to provide digital terrain analysis and data-management capability to each BCT, the aviation brigade, and each division command post. This capability will be in the form of terrain analysis teams that use the Digital Topographic Support System. The Engineer School is working this initiative as the "Concept for the Redesign of Topographic Analysis Teams (Heavy)" through the Corps XXI redesign process with TRADOC and the Department of the Army. An article describing this concept will be published in a future issue of *Engineer*.

Obstacle Reduction. The Army XXI division engineer structure provides minimal mounted capability to reduce obstacles in support of task force attack operations. Reduction of other obstacle systems in the division area falls to supporting EAD engineer units. These units create additional lanes through obstacle systems to clear logistics base sites for occupation and open LOCs. Fixed- and float-bridging support continues to be provided by multirole bridge companies from EAD.

Restrictive Terrain Operations. The Army XXI division requires extensive EAD augmentation for operations in restrictive terrain, such as urban areas. For engineers, this includes the requirement for dismounted sappers to assist with reconnaissance and obstacle clearance in buildings. EAD engineer equipment will reduce and clear rubble along urban routes.

Deliberate Defense Operations. The Army XXI division engineer structure maintains minimal digging and dismounted sapper capabilities. These engineers have only Volcano mine systems to support limited hasty defense operations. This means that EAD engineers must provide the heavy engineer equipment (bulldozers and other earthmoving equipment such as SEEs and scrapers) needed to support a division deliberate defense. Major EAD engineer tasks in support of deliberate defense operations include the emplacement of vehicle fighting positions, dismounted infantry fighting positions, and conventional obstacles.

Force Protection. EAD engineers will provide the majority of engineer force-protection support to Army XXI division operations, including the construction of logistics-based security systems; tactical clearing of landmines and unexploded ordnance; construction of chemical decontamination sites; environmental hazard remediation; and camouflage, concealment, and deception support. The Army XXI division will conduct nonlinear and distributed operations over large areas with bypassed and other enemy forces operating at will throughout the division's battlespace. Supporting EAD engineers must secure themselves against these threats up to level II because Army XXI division security forces (military police and maneuver) will not be readily available to support the EAD engineer effort.

Construction, Repair, and Maintenance. The Army XXI division will operate over areas up to 200 kilometers wide and deep. This will require exclusive EAD engineer support to construct, repair, and maintain extended division LOC facilities, bases, routes, ports, and airfields. These missions will have a significant security risk to our soldiers and equipment because of bypassed enemy forces, irregular operations, and the lack of division maneuver and military police forces throughout most of the battlespace. EAD engineers must be able to secure themselves against higher-level threats than currently is possible and maintain continuous communications with division command posts.

Combat Service Support

The Army XXI division has consolidated CSS for armor, infantry, and engineer battalions. This support is based on situational understanding of the CSS status of each unit. For example, as an engineer company runs low on fuel, that information will be transmitted digitally to the supporting CSS unit for its response. CSS units use distributed operations and velocity management tools to provide responsive support for supply, maintenance, transportation, food service, fuel, and medical support. Army XXI division engineer line companies will receive CSS (less medical) primarily from the engineer support platoon of the BSC of the brigade forward support battalion. The engineer battalion HHC will be supported by elements of the BSC. EAD engineers operating in the Army XXI division area will continue to receive support from an appropriate EAD CSS unit, such as a corps support battalion.

General Supply, Food Service, Fuel, Water, Repair Parts, and Ammunition. When engineer operations are centrally located in the BCT area, the engineer support platoon will coordinate with the supply and transportation platoon of the BSC and send normal logistics packages out of the brigade forward support area. Most supplies will be pushed to the brigade support area or forward support area by EAD units. Then the supply and transportation platoon will move them to the engineer company.

Maintenance. All required engineer maintenance support resides in the BSC. It has a maintenance section in the engineer support platoon that includes an engineer maintenance technician, senior mechanic, and three engineer combat repair teams. Each team has improved mobility with a tracked vehicle and two wheeled vehicles and is designed to provide on-site support to a single engineer line company. Scheduled maintenance such as periodic services and maintenance problems that are beyond the capability of the combat repair teams to resolve will be provided by other elements of the BSC. The engineer support platoon may be augmented by other maintenance elements of the BSC to form a unit maintenance collection point that services all engineer vehicles from the line companies. Alternatively, engineer combat repair teams may combine with task force forward support companies to provide maintenance support. The engineer battalion HHC will be supported directly from the BSC maintenance platoon.

Medical Support. A combat medical section with 10 medics is organic to each Army XXI division engineer battalion. This organization allows for a combat medical section of three medics to be task organized with each engineer line company; doctrinal employment is one combat medic per engineer platoon. Four of the 10 medics in the engineer battalion remain on active duty, and the other six will be in the Reserve Components. Medical evacuation support will be coordinated through the task force medical platoon or forward support battalion medical company.

Training and Leader Development Impacts

Army XXI division engineers must continue to train with the combined-arms team and focus training on mobility tasks. The Army's increasing reliance on systems such as air Volcano, artillery-delivered scatterable minefields, and Raptor intelligent combat outposts require that engineers be well-versed in aviation, artillery, and intelligence functions. Increased training will be required for terrain visualization and digital engineer planning and execution using digital command and control systems. Training with Army XXI division combat service support agencies will be required to properly sustain and maintain the engineer force. The noncommand operational relationship between the division engineer staff and engineer battalions under the control of the BCTs must be fostered and developed during training. EAD engineers must be included with Army XXI division engineer training at every opportunity, such as division warfighters, combat training center rotations, and during the DCX. Many challenges will arise as we integrate Reserve Component medics and EAD engineers with Army XXI division engineer training. The Engineer School is developing new strategies to assist Army XXI engineers, including Classroom XXI distance-learning capabilities, new training simulators, and digital doctrine and training products.

Materiel Impacts

Army XXI engineers will have the same enabling digital command and control technologies as those available to the rest of the division. These include appropriate Army Battle Command System components such as the Maneuver Control System, All-Source Analysis System, and Force XXI Battle Command Brigade and Below Systems. The Digital Topographic Support System will enable the Army XXI division to properly portray terrain in these digital command and control systems. EAD engineers supporting Army XXI will require similar digital command and control components to obtain and maintain situational understanding with the Army XXI division.

Soldier Impacts

Army XXI division engineer soldiers must continue to master basic warfighting skills, which are prerequisites for gaining digital proficiency. They will require increased skills in the operation and maintenance of digital command and control equipment. Engineer soldiers will be required to maintain assigned equipment without ready access to mechanics and spare parts. They will be required to operate in isolated locations and without responsive security support. Engineer School personnel will address these challenging realities as they participate in the ongoing Corps XXI redesign process.

Conclusion

The Army Engineer School continues to stay in the forefront of all actions associated with the standup, training, and validation of the Army XXI division design. Insights gleaned from our efforts will be used to ensure that engineers remain relevant with future light-force and strike-force redesign efforts. If you have questions, call Vern Lowrey at DSN 676-4082 or commercial (573) 563-4082 or Pete Malley at DSN 676-7282 or commercial (573) 563-7282.

Major General Flowers has served as Commandant of the U.S. Army Engineer School and Commander of the U.S. Army Engineer Center and Fort Leonard Wood since July 1997.

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Colonel Porter is the 4ID Engineer Brigade commander, Fort Hood, Texas.

The Engineer Bradley Fighting Vehicle

By Major Aniello L. Tortora and Major Thomas Quigley

This article presents preliminary observations regarding the possible replacement for the M113 Armored Personnel Carrier. The Engineer School is continuing to explore materiel and doctrinal concepts related to the Engineer Bradley Fighting Vehicle. Additional information will be published as it becomes available.

To be a relevant force multiplier in the 21st century Army, combat engineers need a mobile and survivable platform from which to fight. We believe that the vehicle tentatively called the Engineer Bradley Fighting Vehicle (EBFV) is the answer. Since the mid-1980s, combat engineers have struggled to keep pace with the modernized forces they support, which are equipped with M1 Tanks, M2 Infantry Fighting Vehicles, and M3 Cavalry Fighting Vehicles. Too often, combat training center rotations demonstrate that engineer equipment is outdated and will not satisfy the demands of combat in the 1990s, nor will it meet the needs of our 21st century Army. The M113 Armored Personnel Carrier is a perfect example: It is slow, has a high deadline rate, provides little protection, and serves only as a troop and cargo carrier.

The Army is transitioning from a mechanized to an armored warfare force. In mechanized warfare, soldiers move to an objective in a vehicle and dismount to conduct their mission. In armored warfare, soldiers move on the battlefield in a survivable, firepower-laden platform that allows them to conduct their mission while mounted and under armor. The implication for combat engineers is that we need to progress from a sapper-based force to an equipment-based force. Moreover, our equipment must provide the functions needed to accomplish our mission.

The characteristics of the Force XXI battlefield will demand even more from combat engineers. Like the maneuver forces we support, combat engineers need platforms with speed, versatility, and survivability. Force XXI technologies will allow greater dispersion, enable distributed operations, and increase the tempo of battle as never before. All these Force XXI enablers put demands on providing mobility to the force unlike any previous doctrinal change. Equipping combat engineers with the Engineer Bradley Fighting Vehicle is a step in the right direction. It is essential to the future of combat engineer forces and to the success of maneuver forces.

Concept Experimentation Plan

This article discusses the initial results of an ongoing Bradley Concept Experimentation Plan conducted by the Engineer Brigade of the 4th Infantry Division and the U.S. Army Engineer School. The end state for the evaluation is twofold: to determine if the Bradley is suitable for combat engineers and to determine the advantages and disadvantages of the Bradley as a combat engineer platoon vehicle. Throughout the Bradley experimentation, the focus of the Engineer Brigade was to provide the engineer community with feedback in three areas:

- Tactics, techniques, and procedures (TTPs) for conducting combat engineer missions using Bradleys.
- The load plan, so engineers can carry what they need to execute their combat engineer missions.
- The level of gunnery proficiency engineers must achieve and how engineer training is balanced with gunnery training.

In February 1998, A Company, 588th Engineer Battalion, made history when it fielded nine M2A0 Bradley Fighting Vehicles. The Engineer Brigade received the Bradleys on loan from the 49th Armored Division, Texas National Guard, at Fort Hood.

The structure of the combat engineer company was minimally changed with the fielding of the Bradley. The number of personnel assigned to the combat engineer platoon was decreased to match force-structure authorizations in the conservative heavy division's modified table of organization and equipment (MTOE). For example, engineer platoons changed from three to two squads. Bradleys were substituted for the company's M113s. The company commander received a Bradley, and four were assigned to each line platoon—one for the platoon leader, one for the platoon sergeant, and one to each of the two sapper squads.

Two points are worth noting regarding the structure of the Bradley engineer company. First, the engineer Bradley is not called a squad vehicle. It is tentatively called an Engineer Bradley Fighting Vehicle. This name is in keeping with today's offensively oriented doctrine where the engineer platoon, not the squad, is employed as the basic breaching and reduction unit. This is also true of countermobility operations, which focus on emplacing scatterable mines. The engineer platoon sites and marks these obstacles. Second, reducing the engineer platoon from three to two squads was not precipitated by the transition to Bradleys: It is the result of a previously implemented MTOE change.

New Equipment Training

The evaluation began in March 1998 with new equipment training (NET) and culminated in August 1998 with A/588th's participation in National Training Center Rotation 98-10. The Bradley NET team from Fort Benning, Georgia, conducted the training in two phases.

- The first phase included 18 days of training on driving and licensing, maintenance, and turret operation; gunnery skills with a Unit Conduct-of-Fire Trainer (UCOFT); and Multiple Integrated Laser Engagement System (MILES) gunnery.
- The second phase was eight days of Bradley gunnery qualification training: one day of Bradley Gunnery Skills Testing and a UCOFT refresher; one day on Table V; and two days each on Tables VI, VII, and VIII.

No training was conducted on the tube-launched, optically tracked, wire-guided (TOW) missile system since it was determined this is not a weapon system engineers are expected to use to accomplish their mission. Use of the TOW launcher and the type of munitions engineers might employ in the future need further evaluation.

A Bradley vehicle transporting bundles of wire on its trim vane.

The NET was fairly easy for combat engineer soldiers and leaders, who quickly adapted to the new equipment and skills. In addition to the dedicated NET team, the company borrowed other resources to accomplish the training. A qualified Bradley master gunner was needed at both company and battalion levels to train gunnery skills and to plan, prepare, and help execute gunnery qualification. The company also required a dedicated UCOFT to prepare for gunnery training and maintain gunnery skills. For the test period, the unit acquired a master gunner from the Engineer School and a UCOFT from 2d Brigade, 4th Infantry Division.

Between phase I and phase II of the NET, A/588th conducted company/team lanes training with Task Force 1-67 Armor to prepare for the National Training Center. Representatives from the Maneuver Support Battle Lab and the Engineer School were on hand to examine the Bradley's performance. A/588th focused on validating load plans and on the TTPs for conducting missions in offensive and defensive operations. The company took this training a step further by conducting a one-week platoon lanes field training exercise (FTX) to further refine the TTPs needed to execute their mission at the National Training Center.

Preliminary CEP Results

Combat engineer soldiers embrace the Bradley because it provides them speed, mobility, protection, and firepower not possible in an M113. Engineer leaders champion this vehicle because of its versatility and potential. Maneuver forces are advocates of combat engineers in Bradleys because EBFVs can maintain the pace and tempo of maneuver forces and provide enhanced mobility and countermobility support.

Tactics, Techniques, and Procedures

The 588th Engineer Battalion is developing detailed TTPs for the Bradley Engineer Platoon and Engineer Company. Converting from M113s to Bradleys has not generated dramatic changes in TTPs. Most of the TTPs used for operations in M113s translate satisfactorily for operations in Bradleys. In some areas, however, new TTPs are being developed to support enhancements provided by the more survivable and versatile Bradley. Lane-marking and row minefield-emplacement TTPs require minor modifications. Interestingly, we found row minefield emplacement easier and more productive in the Bradley than in the M113.

Mobility

Increased speed, armor, and firepower allow combat engineers to work, maneuver, and protect themselves simultaneously. The turret and main gun of the Bradley are extremely valuable to combat engineers and increase their capability and versatility. Engineers in M113s command and control mobility and countermobility assets, but they rely on maneuver forces to protect them. This reliance often drains the already-stretched firepower of infantry and armor forces. Engineers in Bradleys can better protect themselves during movement and when breaching and reducing obstacles. Thus, the Bradley Engineer Company and Battalion are better suited to perform as a breach force during battalion and brigade deliberate breaches.

The 588th Engineer Battalion also experimented with V-type surface mine plows manufactured by Pearson Engineering. One plow was borrowed from Fort Leonard Wood and three are on loan from the Land Forces Canada. These plows have potential for maintaining mobility of the force en route to an objective. The blades can clear rubble and skim scatterable mines from level, hard-packed surfaces. They plow well in soft soil where adequate spoil can be maintained before the blade. The blade would be even more useful if it floated along its horizontal axis so it could be employed along semilevel surfaces, such as combat trails. The blade currently does not perform well on uneven surfaces or in rocky areas. More experimentation with other blades is required to fully develop this mobility asset.

Countermobility

The Engineer Bradley Fighting Vehicle increases our capability to conduct countermobility operations as well. While the EBFV platoon is capable of conducting conventional mine operations, the focus of the countermobility effort centers on the rapid emplacement of dynamic obstacles. Engineer platoon-, company-, and battalion-sized countermobility organizations can be formed with the capability to operate independently on the battlefield. If these organizations are equipped with EBFVs and scatterable mine systems, they could protect themselves during movement and while emplacing and marking obstacles.

The potential exists for adding other engineer systems to the EBFV. One possibility is to replace the TOW launcher with a weapon system that employs a high-explosive munition similar to the 165-millimeter high-explosive "bunker buster" round on the Combat Engineer Vehicle. An EBFV demolition gun could be used to reduce roadblocks and other obstacles. Another opportunity worth considering is to design and mount a small panel for Volcanos on the EBFV. Each Bradley engineer platoon would then have a rapid scatterable mine capability.

Sustainability

While not directly related to TTPs, but often having a tremendous impact on how we conduct a mission, sustainability is an area where EBFVs are winners. During a two-week company/team lanes FTX, one Bradley was deadlined. An M113 company had six M113s deadlined at various times during the same period. As we adopt the Force XXI centralized logistics support concept and move from supply-based to distribution-based maintenance, an economy of scale is created through the use of a common chassis. This makes the Bradley more sustainable in the heavy division than M113-type vehicles. Although Bradleys are more expensive to maintain than M113s, the increase in survivability, capability, and sustainability more than justifies the additional cost.

Load Plans

Soldiers from A/588th Engineer Battalion developed standard load plans for the EBFV that facilitate the successful execution of combat engineer missions. Every piece of platoon equipment was examined to determine what an engineer platoon needed in combat. TOW storage racks were removed from the M2A0 Bradley to increase interior space, and the exterior was adapted to carry wire, pickets, and tools. Although Bradleys do not have as much interior space as M113s, the EBFVs can carry the engineer equipment necessary for combat. The EBFV load plans were explored again during National Training Center Rotation 98-10.

A/588th personnel also developed plans to modify the interior and exterior of the Bradley to increase space and utility. Through an agreement with the Bradley project manager and Red River Army Depot, these plans were used to modify an M3A0 Cavalry Fighting Vehicle. Soldiers from A/588th worked with a team at Red River to complete the modifications. Bench seats with storage boxes replaced individual seats, and shelves and cabinet-type storage boxes replaced excess TOW racks and ammunition boxes. Posts were welded on the exterior of the vehicle to carry pickets and lane-marking materials, and the trim vane was used to carry concertina wire. A larger bustle rack also was installed.

These were simple and inexpensive modifications that could be completed within the battalion. M2 Bradleys can be similarly modified to increase space and function. M2 ODS Bradleys (those modified for use in Operation Desert Storm) already have more interior space than earlier M2 models as a result of similar modifications.

Gunnery

Another tremendous success story for the EBFV and combat engineers was gunnery. Confident and motivated engineers conducted Bradley gunnery only six weeks after the vehicle was introduced, and they produced astounding qualification scores. All crews qualified on their first attempt (Q1 rating), with one crew qualifying as "distinguished" and two crews qualifying as "superior." This record is rarely achieved in the division.

Engineers conducted their gunnery according to FM 23-1, *Bradley Gunnery.* A/588th soldiers practiced firing using Tables V, VI, and VII and then qualified on Table VIII. These tables should not be modified for engineers, because engineers encounter the same types of engagements while conducting their missions.

The 588th is also developing a platoon live-fire table for combat engineers. Bradley platoon gunnery for infantry soldiers consists of Table XI, *Platoon Practice*, and Table XII, *Platoon Qualification*. Qualification is based on the platoon's ability to execute collective tasks in a live-fire environment. Similarly, the engineer platoon Table XII focuses on offensive and breaching operations under live-fire conditions. A Bradley engineer Table XII serves as an excellent graduation exercise from platoon lane training and also prepares the engineer company to participate in the maneuver task force Combined Arms Live-Fire Exercise.

Enhancing the Combined Arms Team

The EBFV has made engineers a more valuable part of the combined arms team. It is the platform from which to launch combat engineers into the Army After Next. Inexpensive and simple modifications to the Bradley have alleviated load-plan fears. Plows and other attachments offer advantages for the combined arms team and will enable the engineer force to move from the mechanized to the armored way of warfare. The Bradley provides a more survivable platform for our soldiers. In our experience, gunnery was not a distracter to training. We believe it has potential to improve engineer training by merging gunnery with engineer lane training.

For current Engineer Bradley Fighting Vehicle information and photos, visit the Engineer Brigade, 4th Infantry Division (Mechanized), web site at *http://hood-ivygreen.army.mil/engineer*. Send comments and input to the brigade S3 e-mail address provided on the web site or directly to *tortoran@hood-emh3.army.mil.*

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Major Quigley is the executive officer, 588th Engineer Battalion. Previous assignments include S3, 588th Engineer Battalion; division comptroller, 4ID; budget analyst, Army Budget Office, Pentagon; Engineer Assignment Officer, PERSCOM; company commander, 4th Engineer Battalion; platoon leader and company executive officer, 293rd Engineer Battalion. MAJ Quigley holds master's degrees in business administration from Troy State University and in national security and strategic studies from the Naval War College.

Book Review

On Killing: The Psychological Cost of Learning to Kill in War and Society, by Lieutenant Colonel David Grossman, Little, Brown & Company Limited (Canada), 1995, 366 pages. The ISBN is 0-316-33000-0 for a hard cover and 0-316-33011-6 for a paperback.

In his book *On Killing: The Psychological Cost of Learning to Kill in War and Society*, Lieutenant Colonel David Grossman offers a fascinating and perceptive insight into the mental anguish and emotional impact of violence. Grossman's study is somewhat unique in that he does not try to explain what makes soldiers kill, but rather how they are able to overcome an inherent resistance to killing fellow men. This book is a compelling work for anyone in the military or law enforcement, especially those responsible for training soldiers to kill the enemy.

S.L.A Marshall's famous work, *Men Against Fire*, documented astonishingly low firing rates for American riflemen during World War II. According to Marshall, only 15 to 20 percent of U.S. combatants in World War II fired their weapons at the enemy. Grossman points out that this reluctance to kill is not unique to World War II, and he provides psychological and sociological reasons for soldiers' actions and reactions in combat. He cites situations throughout history when "warriors" have apparently refused to kill, even when faced with mortal danger.

According to Grossman, "Since World War II, a new era has quietly dawned in modern warfare: an era of psychological warfare—psychological warfare conducted not upon the enemy, but upon one's own troops." When S.L.A Marshall went to the Korean War to conduct the same type of investigation as he had in World War II, he found that 55 percent of the infantrymen were firing their weapons. In some units, almost 100 percent were firing! The question was, What made the difference in the soldiers' attitudes?

Desensitization to killing is the first element to the improved firing rate. Thinking of enemies as "inhuman" or calling them by disparaging names, such as gooks, Krauts, Japs, or Commies, seemingly is innocuous behavior, but that behavior helps a 19 year old overcome his natural aversion to killing.

Conditioning soldiers is another element. Both Pavlovian classical conditioning and Skinnerian operant conditioning have roles in training soldiers to kill without thinking about it. Grossman does not claim that the armed forces intentionally condition their soldiers to kill, but he provides examples of its existence. One example is modern firing ranges, where every aspect of killing is rehearsed and visualized. These actions provide soldiers with realistic and interesting stimuli. When the soldiers do well, they are regularly rewarded and praised by superiors and peers.

Thorough training also provides a denial defense mechanism for dealing with the extreme trauma of killing. Soldiers have practiced killing so much that when they actually do, it's no big deal, it's almost like being on the range. There are several documented examples of soldiers talking about killing as being like shooting E-type silhouettes on the rifle range. This denial allows soldiers to psychologically deal with the act of killing.

Grossman diagrams what he calls the "Anatomy of Killing." The significant elements in this theory include the demand of authority, group absolution, total distance from the victim (both physical distance and emotional distance), target attractiveness of the victim, and the predisposition of the killer. According to the author, only 2 percent of our population can kill without any real feeling of remorse. Of this group, only a few are able to effectively function in a regulated, military environment. The rest of the population (98 percent) face extreme difficulty in overcoming the natural abhorrence to violence and dealing with the traumatic aftermath of killing. The elements in Grossman's model dynamically interact with one another as a soldier decides whether or not to squeeze the trigger.

Grossman includes lengthy discussions of post-traumatic stress syndrome in Vietnam veterans. His analysis provides reasons for the seemingly disproportionate number of Vietnam veterans suffering from mental illness and substance abuse. As a society, we must understand the consequences of sending soldiers to war, what they endure on the battlefield, and how to accept them back into society.

The author concludes with a look at American society and how popular culture is "desensitizing" America's youth. Grossman claims that some of the same conditioning techniques that allow soldiers to kill on the battlefield are partly responsible for kids killing each other in the streets. The author ends with dire warnings about the future and somewhat radical solutions to the dangers of violence in movies, music, and television.

LTC Grossman is able to take a scientific work and make it readable, interesting, and easily understandable. He uses historical anecdotes and personal accounts from hundreds of interviews to give the book a personal and authentic feel. *On Killing* does not in any way come across as a sterile, clinical analysis of soldiers' psyches. It is a compelling analysis of what is required to turn a normal 19-year-old American into a soldier, capable of killing or maiming his fellow man, and return him to a productive life in society. This book is a must-read for anyone responsible for training, leading, and commanding combat soldiers.

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OPERATION DESERT THUNDER:

COALITION TASK FORCE-KUWAIT ENGINEER OPERATIONS

By Lieutenant Colonel William Bowers, Major Michael Lynch, and Major Donald Johantges

"Saddam must have realized from past experience that moving his troops against Kuwait's border would be a fruitless exercise, so he didn't bother. He seemed to have learned from 1994 and 1996 that the United States would win any 'race for Kuwait.' This time, he merely dispersed his armored and mechanized forces throughout Iraq to protect them from air attacks. It was at this point that American ground forces began to arrive in Kuwait. Saddam Hussein probably wondered at the purpose of this deployment of land power, for he was not directly threatening Kuwait with his ground forces. We can't know for sure what conclusions he drew from this development, but shortly after Third Infantry Division and First Marine Expeditionary Force units began taking up residence in Kuwait, he struck a deal with U.N. Secretary General Kofi Annan. The crisis was over."

Third Army Staff Member

A series of Iraqi provocations against Kuwait in November 1997 resulted in a crisis that lasted until March 1998. Defending Kuwait was the responsibility of Coalition Task Force-Kuwait (CTF-K), commanded by the U.S. Army Central (USARCENT) Commander. CTF-K consisted of units from all service components as well as representatives from 10 other countries. The United States responded also to help deter Iraqi aggression and reassure the coalition partners—or defend Kuwait should that become necessary. More than 11,000 U.S. personnel and 35,000 coalition personnel participated in this operation, which came to be known as Desert Thunder.

Engineer Mission

The USARCENT Assistant Chief of Staff, Engineers was the C7 of CTF-K. He and his staff simultaneously deployed forces; provided facility support for reception, staging, onward movement, and integration; supervised engineer operations and planning; and supported intelligence planning with topographic supplies.

The CTF-K C7 engineer mission was to establish and manage the commander's engineer policies and guidance. This included staff supervision of combat, combat support, and combat service support activities. Construction contracting assets and other activities in the areas of combat, civil, electrical, and topographic engineering; force protection; and real estate planning also required intense management.

Deployment

The deployment process began with an analysis to determine engineer requirements to ensure mission success. Since this was a short-notice deployment, a crisis action planning cycle was used. With only a few days to plan, the foundation was initially based on doctrinal allocations. The analysis began by examining the forces allocated for the operation. The CTF-K engineer did not use the time-consuming Joint Engineer Planning and Execution System (JEPES) because of the short planning period. During deliberate planning the JEPES model is used to help ensure that all engineer requirements are identified.

The staff, which was still in Atlanta, developed the units' construction needs based on requirements for previous deployments. Then staff personnel contacted Corps of Engineers assets in Kuwait to determine which of those construction projects the Corps would perform. This modification to the deployment plan met the commanding general's guidance of "just enough, just in time." Several unknown factors—such as the availability of host-nation facilities and equipment, presidential selective reserve call-up, and support from other coalition countries—were critical and estimates were factored in for them.

After the CTF-K engineer section identified its requirements to support the operation, it was the services' responsibility to provide resources. A daily dialogue developed between CTF-K and the services' engineer action officers so we could monitor the engineer force flow.

Sequencing the arrival of engineer units in country and balancing those arrivals against available host-nation support was a challenge. Combat engineer units had to move with their respective maneuver elements. Fire-fighting units arrived in conjunction with aviation elements. Topographic engineers were integrated in the flow to support the headquarters elements and components. Division headquarters controlled divisional assets of the combat and topographic engineers, while echelon-above-division assets—such as fire-fighting teams, corps topographic engineers, personnel from the prime-power detachment, and the 416th Engineer Command—required detailed coordination daily between the CTF-K engineer and force providers.

After arriving in country, the engineer assessment team realized that engineer support to bed down the force would be the most critical "do not fail" task. Recognizing the extent of this challenge, the CTF-K engineer adjusted the staff deployment flow. He brought in facilities and construction staff support early to provide engineer contracting expertise and other technical skills.

Facilities Support

A modern headquarters requires an immense amount of electrical power. All CTF-K staff sections use both secure and unsecure computers, telephones, and facsimile machines extensively, as well as a coffeepot, refrigerator, and microwave oven. The high demand for electrical power in fixed facilities makes an electrical engineer an invaluable member of the staff. To meet that demand, the CTF-K coordinated to deploy power-distribution experts from the 249th Engineer Battalion (Prime Power). Together, they successfully managed electrical problems within Camp Doha, which was established after Desert Storm as a long-term USARCENT camp, and identified potential problems at other facilities. Military engineer expertise is especially important when deploying to areas with different cultures. Because of many religious holidays, host-nation contract personnel may not be available to take care of daily problems.

Engineer Operations

Over the next two weeks, the engineer section grew to 11 personnel, with USARCENT providing the core of engineer staffing. Personnel from CENTCOM's Joint Crisis Action Center and the 416th Engineer Command (Forward) completed the staff.

Sufficient facilities and construction staff personnel did not deploy early enough in the flow as the CTF-K headquarters was established. This placed a heavy burden on the limited staff in the CTF-K engineers' facilities and construction division. As large numbers of personnel surged into and through Camp Doha, the number of infrastructure breakdowns increased significantly—particularly in electrical power and sewage disposal.

Combat units transitioned quickly through Camp Doha and then moved directly into occupied base camps or kabals in the Kuwaiti desert. A kabal is enclosed by earthen berms

A joint bed-down facility in northern Kuwait.

The kabal's shower point is upgraded by using shower trailers that provide climate control and heated water.

that establish the perimeter for force protection. In Operation Desert Thunder, most kabals were large enough to accommodate a battalion-sized task force. The task force kabal is a self-contained support area with living tents, mess facilities, motor pools, and recreation facilities. The commercially leased tents were equipped with wood floors, field showers, and burnout latrines. A commercial generator connected to a power grid provided electrical power for the area.

The Kuwaiti government and people were eager to assist the coalition force with facilities and construction support. Numerous construction contractors were available, which took some of the construction burden from deployed engineers. In addition, the Kuwaiti government gave U.S. forces access to several military facilities, thereby eliminating the immediate need for leasing real estate and using expensive transportation assets for supplies and equipment.

Occupying host-nation installations greatly reduced the scope of engineer construction. Use of these facilities throughout Kuwait City was coordinated through the U.S. Embassy, Office of Military Cooperation-Kuwait. The CTF-K engineer staff assessed many unused facilities in the city to determine the repairs necessary to make them functional as billets, office space, dining facilities, recreation areas, etc. Required repairs typically involved water, sewer, or power upgrades. If a facility was deemed inadequate, the engineer section wrote a scope of work to bring it up to standards outlined in the Civil Engineering Support Plan for Operation Desert Thunder. Upgrading wooden field showers in the kabals to trailers with electric water heaters and air conditioning is an example. In most cases, work was contracted through host-nation construction firms or performed by host-nation contract engineer assets.

Each facility was also evaluated using the U.S. Central Command (USCENTCOM) force protection construction standards, which outline the type of construction and standoff distances. This evaluation helps ensure that U.S. personnel are not exposed to unnecessary risks due to catastrophic structural failure caused by weapon systems or truck bombs.

Intelligence Planning

Intelligence preparation of the battlefield (IPB) was another key task in Kuwait. Topographic products to support CTF-K operations were in high demand throughout the deployment, especially early in the IPB process. The CTF-K staff included a topographic manager from the 132nd Engineer Battalion, who worked with the terrain teams. In addition, the 100th Engineer Company (Topographic) organized and deployed a 10-person team to support the CTF-K. The terrain team established joint operations with the National Imagery Mapping Agency team and elements from the supporting military intelligence brigade to allow use of intelligence communications systems with bandwidth capability to obtain real-time imagery. Together these teams provided automated and conventional terrain-analysis support with equipment that included multispectral image processors, large-format plotters, tangent scanners, and a database of the joint operational area.

Environmental Management

Environmental management, an important area early in any deployment, was overseen by a civilian contractor from USARCENT. The Overseas Environmental Baseline Guidance Document specifies standards we must maintain during contingency operations. The CTF-K environmental officer established procedures for hazardous- and solid-waste collection and disposal, spill prevention, and cleanup. As units arrived, the environmental officer briefed commanders on the procedures.

USARCENT environmental specialists inspected the training areas periodically. Typical deficiencies noted during these inspections were unchecked petroleum, oil, and lubricant releases; improper solid-waste disposal; improper secondary containment; and a lack of hazardous-materials training and waste-management training. Units must conduct proper environmental operations when training overseas, just as they do when training in the United States.

Soldiers of the 317th and 11th Engineers construct berms to improve force protection.

Forming the Coalition

After force bed down and the IPB process were well underway, forming the coalition became the CTF-K staff's top priority. Participating coalition countries represented the entire world, and each had unique tactics, techniques, and procedures. Only a few foreign representatives had any knowledge of U.S. engineer doctrine. Without standard procedures for obstacles—especially mines—there is always a potential for fratricide. To help mitigate that risk, the CTF-K engineer staff produced a minefield data booklet in both English and Arabic. The booklet contained standard diagrams to mark coalition minefields and lanes through those minefields, as well as information on engineer obstacle-effects graphics.

CTF-K engineers sponsored and participated in a series of meetings with coalition partners to improve their understanding of U.S. Army engineer doctrine, capabilities, and limitations. Most importantly, the CTF-K C7 sent an engineer liaison officer to the Kuwaiti Engineer Brigade. This officer helped close the doctrinal gap and reduce friction associated with intercultural communications.

Lessons Learned

Several important lessons resulted from our experience in Kuwait:

- Dedicate one officer to develop and manage the Time-Phased Force Deployment Data when preparing for deployment. That officer must maintain daily contact with planners for the Joint Operations Planning Execution System and the force provider. (In our case, the force provider was FORSCOM.)
- Ensure that the engineer staff is multifunctional. To support contingency operations, the section must include combat, facilities, construction, and environmental engineers. Facilities and construction engineers must deploy early and possess electrical engineering expertise to handle the bed down of the initial surge of forces.
- Use available adequate host-nation structures. To speed contracting for facilities that do not meet our standards, prepare generic construction statements for repetitive requirements.
- Use contract construction as much as possible to reduce the number of deployed engineer troops and promote the philosophy of "just enough, just in time."

Conclusion

The CTF-K is an organization unique in our nation's military history. Never before have we formed a forward-deployed, joint, multinational, ground-combat-oriented, and rapidly expandable deterrent force. CTF-K proved its worth during Operation Desert Thunder by contributing to a show of force that ultimately succeeded in deterring Iraqi aggression and compelling compliance with U.N. mandates. As long as it continues to stand, CTF-K will fulfill this role. This unique organization allows the United States to achieve unprecedented levels of interoperability with foreign militaries in a region that is of vital importance to our national security.

Lieutenant Colonel Bowers was chief of the Engineer Plans and Operations Division for CTF-K from February to April 1998.

Major Lynch was the engineer plans officer for CTF-K from February-May 1998. He is a graduate of the Command and General Staff College.

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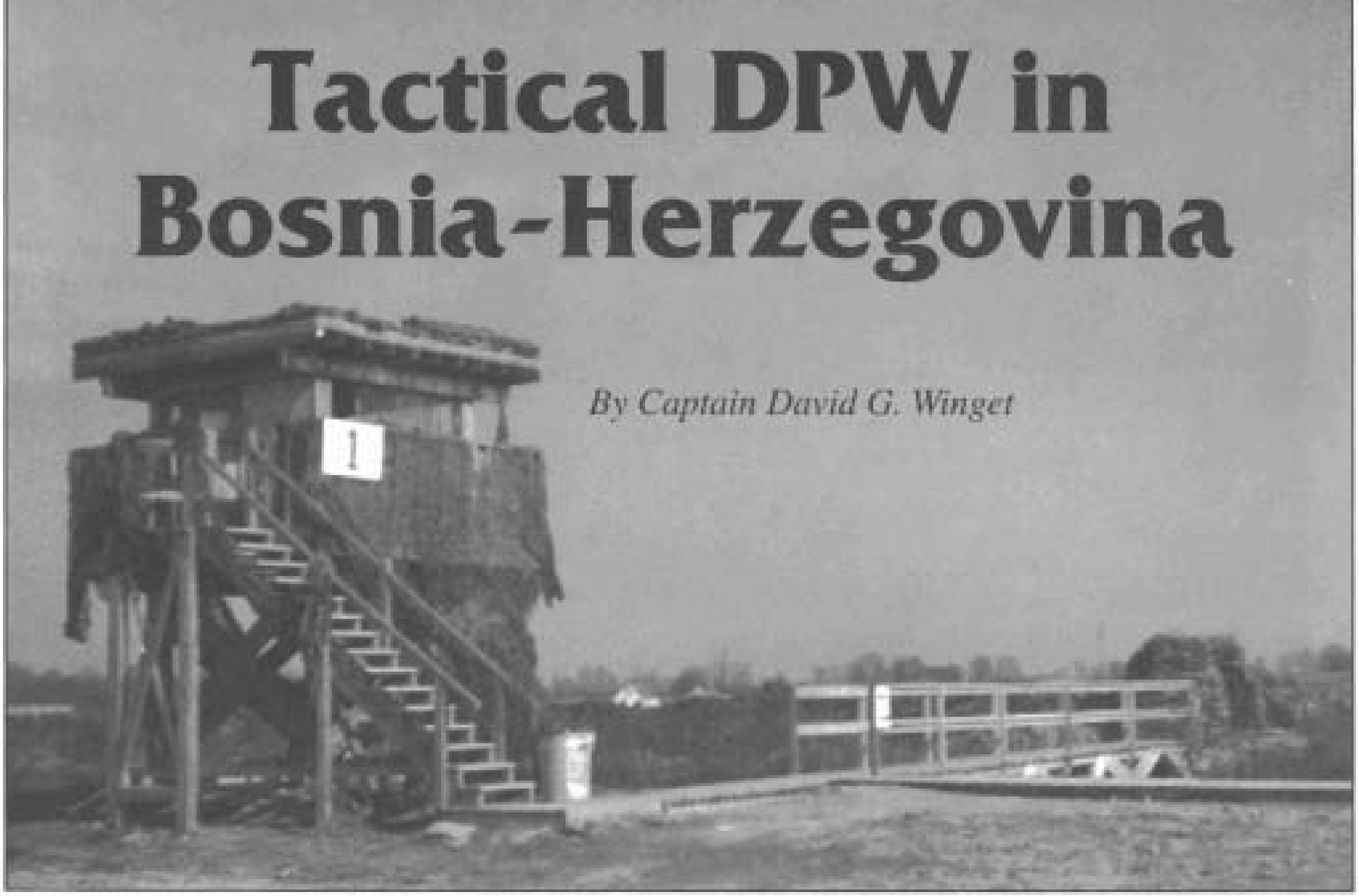
Tactical DPW in Bosnia-Herzegovina

By Captain David G. Winget



On permanent military bases, a Directorate of Public Works (DPW) controls construction projects. The DPW structure—consisting of a military director with mostly civilian engineers—was designed to provide construction support to one base in a secure environment. In a potentially hostile environment such as Bosnia-Herzegovina, the DPW organization is not practical. There, several base camps—ranging from a platoon-sized element on a hilltop to a division headquarters housing more than 2,000 people—are spread over 100 miles. A new structure was required to support the diverse multinational force.

The American sector of Bosnia, Multinational Division-North, includes elements from the 1st Armored Division, the 2nd Armored Cavalry Regiment, the 401st Expeditionary Air Base Group, a Nordic/Polish Brigade, a Russian Brigade, and a Turkish Brigade. American units form Task Force Eagle, which is spread over 13 main base camps and five hilltops in support of the NATO peacekeeping mission. Because this situation made the usual DPW structure impractical, the Base Camp Coordinating Agency (BCCA) was created in January 1996. Staffed mostly by armed military engineers with up-armored HMMWVs, the BCCA became a tactical DPW responsible for all base camp facilities and occupied hilltops in the American sector.

The BCCA's scope and responsibilities are similar to those of a DPW, but they are modified for use in a deployed environment. The agency supports Operation Joint Guard by providing facility engineer planning and operations, project management, and Joint Acquisition Review Board administration. The BCCA also assists with development and maintenance of base camp standards, base camp assessments, environmental engineering, ammunition surveillance, real estate acquisition, fire inspection and prevention, and financial oversight of the operation's sustainment contract. Located in Tuzla Main, the BCCA staff normally ranges from 11 to 14 personnel. The agency reached a peak of 24 personnel in September 1996 to facilitate base camp decommissioning and closure when the Implementation Force of 20,000 downsized to the Stabilization Force of 8,500. The BCCA currently is staffed by seven active duty military personnel on temporary change-of-station orders and four civilians.

Organization

The BCCA chief, a lieutenant colonel, serves as a special staff officer on the Task Force Eagle staff. He is Task Force Eagle's single point of contact for all base camp facilities, which are managed by six organic and three nonorganic sections within the BCCA.

Plans Section

This section develops plans and orders for future operations, forecasts necessary construction support for these operations, and coordinates with Task Force Eagle staff. Identifying issues, collecting information, and developing courses of action are integral parts of the planning process. When the Operation Joint Guard mission was extended, a process action team was formed to set new standards for construction. The team expects to increase the level of force protection and the standard of living. By proposing and analyzing several courses of action, the team can develop economical solutions to meet future needs in a less temporary environment. The plans section recently acquired AutoCAD software, which allows it to develop standard designs for projects such as medical aid station bunkers, barracks-style living containers, and chapels. In addition, the section helps each base camp develop a master plan for site layout that will meet future needs with an organized and economical solution.

Multinational Division-North soldiers construct a 100-man bunker.

Operations Section

This section conducts day-to-day operations for the BCCA and collects detailed information on base camp population, capacities, life-support capabilities, and other key factors affecting the success of Task Force Eagle. The section also develops and maintains the *Base Camp Standards*, a document that governs base camp facilities and services and defines the minimum construction standards authorized within the limits of good fiscal stewardship. This document is continually updated to conform to current conditions, military needs, and available resources, based on the changing mission of Operation Joint Guard.

Project Management Section

Construction projects are processed through this section, which validates the need for new work through interaction with the customer. Section personnel determine the scope of work needed and ensure that the work complies with *Base Camp Standards*. The section also provides technical construction expertise and identifies economical ways to meet requirements. After determining requirements, section personnel pass specifications and drawings to contracting officers or military engineers for execution. They also track projects on a theater-wide database and hold weekly in-progress reviews with the contractor to update statuses and identify potential problems.

Base Camp Assessment Team (BCAT)

The BCAT inspects each base camp and occupied hilltop monthly to ensure that occupants comply with standards. Traveling in a convoy of four up-armored HMMWVs, the team focuses its inspections on force protection, environmental compliance, safety, fire prevention, and ammunition storage. After completing an inspection, the BCAT conducts an outbriefing with the base camp mayor and tactical commanders. The team provides guidance and assistance to unit representatives in each area inspected.

Environmental Section

This section provides technical oversight of Task Force Eagle operations to ensure that U.S. personnel conduct operations in a manner that protects human health, complies with appropriate environmental regulations, and is consistent with responsible environmental stewardship. A Corps of Engineers civilian environmental specialist provides guidance on hazardous materials and hazardous waste management, pollution prevention, and waste minimization. He also oversees environmental baseline and closure studies and periodic sampling of Task Force Eagle sites. For new construction, the environmental specialist identifies environmental concerns and develops courses of action to address those concerns.

Contingency Real Estate Support Team (CREST)

These civilian members of the Corps of Engineers secure leases for land to support operational requirements and work with landowners to address their concerns. Team members write leases, investigate property titles, and assess damages to help settle claims.

Nonorganic Sections

Nonorganic sections that work closely with the BCCA include a prime power platoon, a military fire-fighting platoon, and a quality-assurance specialist, ammunition surveillance (QASAS) representative. The prime power unit operates the tactical power plant for Tuzla Main and provides liaisons to the BCCA to assist with electrical projects. Firefighters participate in BCAT inspections, develop the fire-fighting plan for Task Force Eagle, and provide expertise in fire-protection standards for contingency projects. The QASAS representative serves on BCATs and helps plan ammunition holding areas.

Construction Projects

The BCCA divides construction work assignments into three categories: troop labor; Brown & Root Services Corporation, which holds the sustainment contract for Operation Joint Guard; and local contractors. Military construction assets located in Multinational Division-North include elements from a mechanized combat engineer battalion and an attached Navy Seabee company. The engineer battalion reviews all approved construction requests before the BCCA gives them to a contractor to determine if it has the assets required for the job. If the engineer battalion does not, projects are given to Brown & Root. The BCCA occasionally deals directly with local contractors.

Construction projects originate with work requests from units, base camp mayors, or division staff members. The project management section validates the requests, assigns a priority to them, and forwards them to military engineers or the Defense Contracting Management Command for execution by Brown & Root. Projects costing less than $2,500 are executed immediately under the authority of the BCCA chief. For those costing more than $2,500, a Rough Order of Magnitude is prepared and sent to the Joint Acquisition Review Board for consideration. The board recommends approval or disapproval to the division chief of staff, who holds approval authority for projects costing up to $50,000. Projects exceeding $50,000 are approved by the United States Army-Europe.

Foreign nation support is another type of construction request. Foreign units in the American sector sometimes must rely on Brown & Root for construction support. As long as Americans do not benefit from the project, this type of request requires no approval and is paid for by the foreign nation. After a Rough Order of Magnitude is prepared, a representative from the nation signs an agreement to reimburse the United States for expenses.

The BCCA handles a variety of projects, such as force-protection upgrades, quality-of-life improvements, and mission support. Base camp design is focused on force protection to withstand terrorist attacks as well as provide a safe working environment for soldiers. Several projects involve hardening structures with a force-protection wall of bastions and constructing bunkers, crash-resistant gates, and fighting positions. The average tour of duty in Bosnia ranges from 6 to 12 months, so quality-of-life improvements are critical to maintaining morale. Current quality-of-life projects include upgrading 48 living tents to wooden seahuts (512-square-foot, plywood, one-room structures with electrical outlets and a heating, ventilation, and air-conditioning unit); constructing a morale, welfare, and recreation tent for soldiers; and upgrading gyms and TV/game rooms. Mission support includes a wide range of construction projects—from a railhead loading site to a life-support area for a gunnery range.

Construction Challenges

Political, military, and environmental conditions in Bosnia-Herzegovina cause several engineering challenges. Therefore, the BCCA must constantly re-evaluate and improve construction designs to ensure they are compatible with the ever-changing environment. As with all engineering projects, the overriding factor is cost, and the goal is to achieve the best solution for the lowest price.

Temporary Construction

Army engineers must restore land to its original state after closing a base camp, so a major engineering challenge for the BCCA is that all construction must be temporary. As a result, concrete is used only occasionally in prefabricated slabs or barriers. Gravel over geotex is often substituted for concrete because it is easily removed. Most structures also are temporary and are easily removed—such as tents, wooden seahuts, or containerized units—but a few are pre-existing permanent facilities. When a base camp closes, construction materials are reharvested for future projects. An environmental survey is then conducted and compared to the baseline survey conducted before occupation, while the CREST team gathers photographs to assist in settling damage claims with landowners.

Winterization

Due to the extremely cold winters in Bosnia-Herzegovina, winterization techniques are incorporated in construction projects. For guard towers, a sliding plexiglass window that can be closed to contain heat or opened during emergencies is installed on each wall. Three coats of paint are applied to wooden structures to protect them from rain, snow, and ice. Tents are upgraded to tier three standards, which include plywood floors and walls, roof trusses to support snow loads, electrical outlets, and lights. They are heated with two kerosene heaters. Tents that are not occupied for a few days—and therefore not heated—often require repairs due to heavy snow loads that accumulate on roof trusses.

Ground Conditions

A high water table and poor soil conditions in Bosnia also present challenges. Sand for sandbags and soil for fill material must be purchased and transported to construction sites. Perhaps the largest cost associated with most construction projects is the enormous amounts of gravel used to stabilize soil. Bunkers and fighting positions must be constructed aboveground, and all structures must have large footings on a thick foundation of gravel.

Utility Costs

Since Operation Joint Guard has been extended, the BCCA is seeking ways to reduce utility costs. One method under consideration is to convert from generator to commercial power where feasible and use generators for backup power in critical areas. Another option is to convert to well water rather than use bottled potable water and nonpotable water delivered by Brown & Root. The BCCA is investigating the feasibility of digging test wells at some base camps. For force-protection reasons, however, a water source outside the base camp is not practical. To save heating costs while upgrading soldiers' quality of life, the BCCA may discontinue using tier three tents and use seahuts or containerized living units, which are electrically heated. Finally, mobile generator-powered sets on base camp perimeters are being replaced with fixed poles with lights that operate from commercial power or a central generator.

Coordination

When a project is assigned to both Brown & Root and military engineers, the BCCA must ensure that they coordinate between construction phases through preconstruction conferences and in-progress reviews. Details are worked out with a representative from the engineer battalion and a Brown & Root liaison, and any conflicts are resolved. For example, approximately one million landmines and various unexploded ordnances remain in Bosnia-Herzegovina from the war. New construction sites that have not been cleared of mines require surface clearance. Before Brown & Root can start a new project in an uncleared area, they must coordinate through the BCCA to have military engineers clear the ground.

Conclusion

The BCCA is a nondoctrinal organization that has served and continues to serve its purpose in support of Operation Joint Guard. The agency continues to assess the evolving mission and to plan for future requirements, while providing construction support and base camp assessments to Task Force Eagle. Faced with many challenges in construction design and changes in standards, the agency maintains flexibility and continually seeks to provide the best possible product at the lowest cost. It accomplishes this goal by maintaining a close working relationship with Brown & Root, the Defense Contracting Management Command, military engineers, base camp mayors, and the tactical commanders. The BCCA organization provides a template that can be used for base camp management during future multinational stability and support operations.

Captain Winget is attending the Engineer Officer Advanced Course. He was assigned to the 20th Engineer Battalion, 1st Cavalry Division, and was on temporary orders to support the 1st Armored Division as Project Manager for the BCCA during Operation Joint Guard. From February to June 1997, he supported Operation Intrinsic Action in Kuwait. CPT Winget is a graduate of the United States Military Academy.

Lessons Learned

The following lessons learned during Operation Joint Guard may assist units deploying to support other stability operations:

Sustain

- ❐ Ensure that troop engineer units, the contractor, and the BCCA coordinate daily to resolve problems and develop better solutions.
- ❐ Allow troop engineers first choice of every project to reduce costs and sustain unit training.
- ❐ Colocate the troop engineer construction management section and the BCCA in the same building to facilitate information flow and shared assets and equipment.
- ❐ Staff the BCCA with officers holding a degree in engineering and who understand tactical operations.
- ❐ Develop a thorough and regular base camp inspection program to maintain high levels of safety, force protection, environmental standards, ammunition safety, and fire prevention.
- ❐ Establish a mayor (who is not occupied with command responsibility) to be the single point of contact for each base camp. That individual will assist in communication with customer units and resolve issues between units at each camp.
- ❐ Obtain support from the Corps of Engineers for equipment, personnel (real estate and environmental specialists), and other expertise.
- ❐ Ensure that the BCCA works directly for the senior commander on the ground, not for a higher headquarters, to ensure that construction supports the commander's intent.

Improve

- ❐ Provide additional personnel so the BCCA can expand its responsibilities and provide a better product at a lower price. For example, provide engineers to perform independent government estimates on projects and clerical and administrative personnel to assist in day-to-day operations so engineers can focus on construction.
- ❐ Create a BCCA structure as early as possible in the deployment to manage initial base-camp construction and develop a plan for overall base-camp layouts. Base camps built without detailed plans often must be relocated at additional expense.
- ❐ Develop a flexible master plan for base-camp layout that allows for expansion.
- ❐ Determine the initial standards of living and level of force protection—in as much detail as possible—and establish a board to review these standards quarterly to consider changes in funding and mission requirements.
- ❐ Organize personnel into two teams—with all personnel in each team from the same unit if possible—and replace only one team at a time to maintain continuity.
- ❐ Plan for a minimum overlap of two weeks between outgoing and replacement personnel.
- ❐ Delegate approval authority for projects costing less than $100,000 to the highest commander on the ground, because he has a better picture of the situation than higher headquarters. This method allows for quick approval of high-priority projects.
- ❐ Ensure that all military engineers in a joint operation (Army, Navy, Air Force, and Marines) work together under one engineer commander for facilities construction. This alignment facilitates a coordinated engineer effort, maximizes efficient use of assets, and prevents differing standards of living for military personnel.

Underground Combat:

Stereophonic Blasting, Tunnel Rats, and the Soviet-Afghan War

By Lester W. Grau and Ali Ahmad Jalali

The U.S. Army fought subterranean battles in the tunnels of Vietnam. Following a few tear-gas grenades or a charge of C4 plastic explosive, "tunnel rats" would go underground to find Viet Cong or North Vietnamese combatants or materiel. Small, slender soldiers armed with flashlights and.45-caliber pistols would crawl into the Vietnamese tunnels for reconnaissance and possible close combat. Almost all of the Vietnam-era tunnel rats have left active duty now, but the need to train for this type of underground combat remains. The U.S. Army's experience with tunnels was not unique. From 1979 to 1989, the Soviet 40th Army waged war against the mujahideen in Afghanistan. Part of this war was fought in the tunnels of Afghanistan, which were larger and far more extensive than those in South Vietnam.

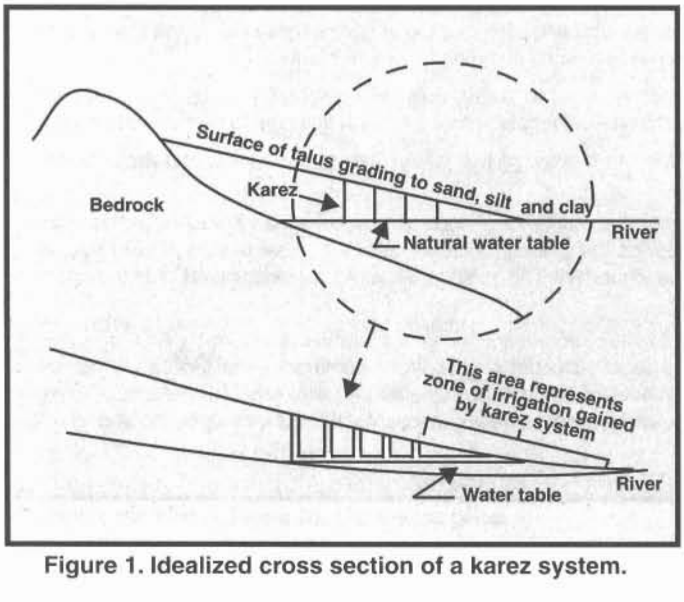


Figure 1. Idealized cross section of a karez system.

Welcome to the Underground

In the Middle East, water is life itself. Over the centuries, the inhabitants of Iran, Afghanistan, and Western Pakistan have taken some extraordinary measures to preserve and conserve this precious resource. Since many of the rivers are seasonal, rural inhabitants have found ways to prolong their agricultural water supply during the dry months. Open-ditch irrigation is used in the northern part of Afghanistan, where the water table is relatively shallow, but in eastern, southern, and southwestern parts of the country the extensive underground *karez* system (a man-made water system) is necessary.[1] When flying over these regions, the neat lines of mounds that lead from the foothills across the desert to the "green zones" of vegetation surrounding towns and villages are a common sight. The mounds are entrances to shafts that intersect the water table and that are connected to each other by tunnels (Figure 1). The deepest shaft highest

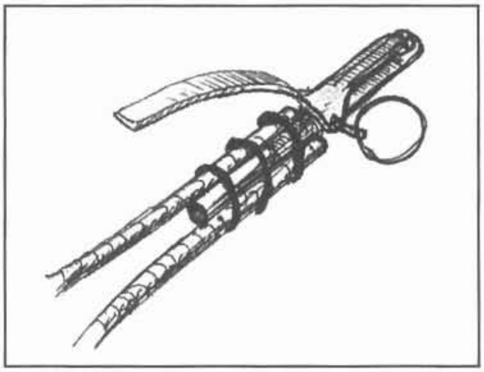


Figure 2

on a hillside intersects the water table. Water moves through the tunnels and into irrigation ditches and fields near the towns and villages.[2] Some of the karez tunnels stretch for several kilometers underground. Some historians claim that the karez system was already working when Alexander the Great went through Afghanistan in 328 B.C.[3]

The karez tunnels are dug by farmers. Occasionally they use large ceramic tile drainpipes to shore up weak sections of the strata. Digging the tunnels is dangerous work because the shafts usually range from 9 to 15 meters deep, with some more than 30 meters deep. The tunnels are labor- and maintenance-intensive. Silt that collects in them must be cleaned out annually and hauled to the surface by a windlass equipped with goatskin bags.[4]

The karez tunnels also have another use. Since ancient times, villagers have used these underground waterways for shelter against invading armies. Chroniclers of Afghan history in medieval times refer to the use of the karez by civilians and combatants during the invasion of Genghis Khan's Mongol armies in 1221 A.D. The Mongols set out to destroy all major cities in Afghanistan and neighboring areas and made every effort to massacre the inhabitants to the last man.[5] The Mongols did not go into tunnels after the refugees. Rather, a day or two after destroying a town, the Mongols sent a small detachment back to the area to cut down any resurfaced survivors. They did this to ensure that no potential resistance against Mongol rule remained. The Mongols had learned during earlier campaigns that the official surrender of a city did not guarantee permanent submission of the area, because the inhabitants often rose against the invader after his main force moved on.

During the Soviet occupation, both villagers and local mujahideen guerrillas used the karez system as a hiding place. Since the towns and villages are close to the karez, they provide ready-made shelters from bombing and artillery attacks. Guerillas dug caves in the sides of the shafts, where they hid weapons and themselves, and used the karez tunnel network to move undetected to and from ambush sites and attack positions. According to mujahideen eyewitness accounts, Soviet forces passing through an area usually did not try to flush out the refugees and guerrillas hiding in tunnels. However, in major cordon-and-search actions, the Soviets and Afghan communist forces made special attempts to destroy the underground mujahideen.[6]

Underground Warfare 101

In the mid-1980s, the Soviets conducted a tunnel-neutralization course in Paghman Province, about 14 kilometers northwest of the capital city of Kabul. The course was designed for Afghan special-forces soldiers and was similar to courses provided for Soviet sappers in Afghanistan. The training was necessary because men do not readily go underground to fight. Tunnels are ideal locations for booby traps, knives thrust from a side tunnel, and cave-ins.[7] Additionally, tunnels teem with snakes, scorpions, and other creatures.[8] After a short course in theory, participants in the tunnel-neutralization course moved to the field for practical applications.

The soldiers conducted a reconnaissance to find shaft entries, which usually were marked by mounds. The Soviets taught the soldiers to form into two covering groups and hold two adjacent shafts simultaneously. Since civilians often hid in the karez, the first step was to yell into the shaft and demand that anyone sheltering inside come out.[9] The soldiers were taught to yell without exposing themselves to answering gunshots from inside the karez. If no one answered or came out, the next step was to throw two RGD-5 concussion grenades in the karez.[10] After the grenades exploded, it was customary to again demand that the occupants surrender because the karez was about to be blown up.[11]

The depth of a shaft was determined from the sound of a falling rock tossed inside. After determining the depth, soldiers used a mirror to reflect sunlight down into the shaft and examine it. If there were areas they could not examine, the soldiers tied a cord to a grenade, lowered the grenade to the suspect area, and detonated it. Only then would soldiers lower a blasting charge on detonating cord. They usually used captured TC-2.5 or TC-6.1 Italian antitank blast mines because many of them were available.[12] The soldiers then lowered the first charge to the bottom of the shaft. Next they prepared a second charge using three or four meters of detonating cord and 800 grams (two and three-quarters pounds) of high explosive. Then they tied or taped the detonation cord to a standard hand-grenade fuze (Figure 2). They would weight the firing assembly with a rock or wedge it near the mouth of the shaft. Two trained soldiers could prepare a 20-meter shaft for detonation in about three minutes. All that remained was to pull the ring on the firing assembly. After four seconds, the charges would explode. During the explosion, it was necessary to stand at least five or six meters from the mouth of the shaft, because the explosion caused rocks to fly from the shaft like a volcano.[13]

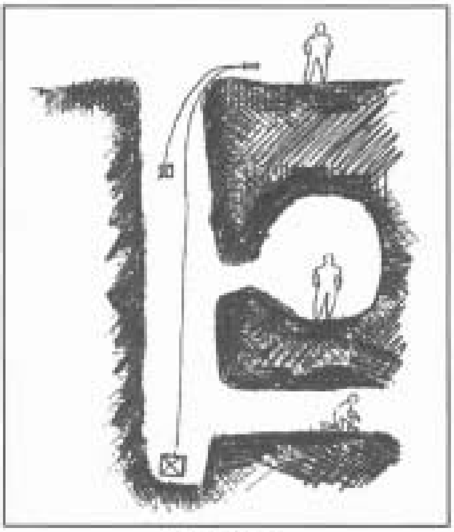


Figure 3

The Soviets' placement of the charges was particularly effective because the top charge exploded a fraction of a second earlier than the bottom charge. The top explosion tightly plugged the shaft with gases. When the bottom charge exploded, shock waves from it would rebound off the higher gas mass and rush back down and against the sides of the shaft and tunnels. This movement created a deadly overpressure between the two charges. The Soviets called this the "stereophonic effect" (Figure 3).[14]

The stereophonic effect can be multiplied by preparing two adjoining shafts for simultaneous detonation. The Soviets prepared each site as described above. Then they joined the detonation cord at the midpoint between the two shafts and taped the detonation cord to a standard hand-grenade fuze. When the charges were set off, a wider area of overpressure and destruction occurred. The Soviets called this the "quadraphonic effect" (Figure 4).[15]

A Fistful of Roman Candles

After the dust settled, the Soviets tossed a smoke pot down each shaft. The smoke is nontoxic and ventilation in a karez system is excellent. If the smoke disappeared, it meant that some tunnels were intact and that the search team could go in without wearing respirators. Search teams consisted of three or four men. Two of them would search to the front while the rest guarded their backs from a sneak attack from the rear. The lead man had a line tied to his leg. If the lead man found enemy materiel, he tied the line to it and rejoined the team so they could all drag it out. If the lead man was killed or wounded, his team members used the line to drag him back.[16]

The search group was armed with knifes, entrenching tools, hand grenades, pistols, and assault rifles.[17] A flashlight was taped to the forestock of the automatic rifles. The magazines of the assault rifles were loaded with tracer ammunition.

The Soviets developed a psychological weapon for underground combat using their SM signal mines. The SM is basically a Roman candle that shoots a series of red, green, or white signal stars from five to 20 meters. The signal mine simultaneously emits a siren-like sound. Although designed for trip-wire release by an unwary enemy, the SM can be safely ignited while holding it in one's hand. The Soviets taped from three to six signal mines together and, holding them in one hand, they ignited and fired them into a tunnel. A brilliant shaft of light, screams of sirens, and a fountain of signal stars filled the tunnel for nine seconds. The signal stars ricocheted off the tunnel walls like tracers. When the mines stopped, the Soviets found the unsuspecting foe covering his head with his arms, even though there was no real danger unless a signal star hit someone in the eye.[18]

Flame, Fuel-Air Explosives, and Fuel

Flamethrowers were also used against those hiding in the karez. The Soviets had replaced their short-range LPO-50 backpack flamethrowers with the RPO-A flamethrower. The RPO-A is a disposable system with a maximum range of 1,000 meters, a maximum effective range of 600 meters, and a minimum range of 20 meters. The round is 93 mm in diameter. It has three types of projectile: thermobaric (fuel-air), incendiary, and smoke.[19] The fuel-air round was most effective against the karez. The problem was that flamethrower gunners drew more enemy small-arms fire than radiomen. An incendiary round from an RPO-A could clear out any opposition on the surface around a shaft entrance, but no flamethrower gunner wanted to lean over the mouth of a karez to fire down the shaft—the gunner might be shot before he could fire a round. The Soviets developed the following method for these tunnels: Soldiers first secured the shaft entrance and then locked and cocked an RPO-A

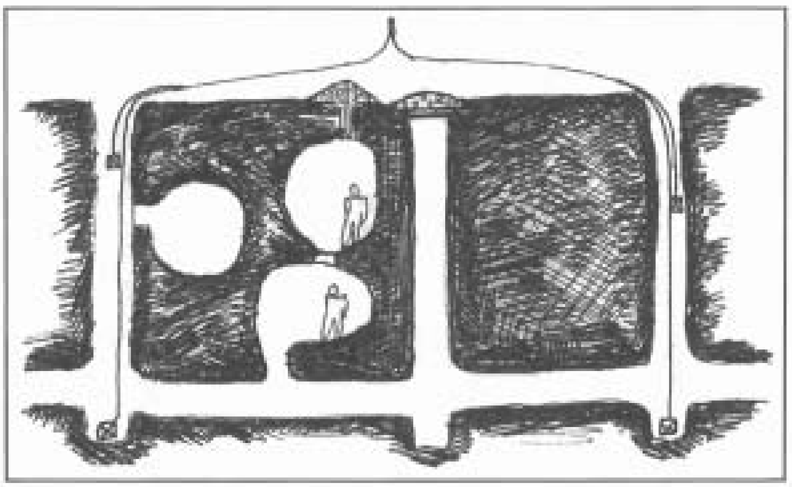


Figure 4

flamethrower with a thermobaric round. After tying two lowering lines on the RPO-A and a string on the trigger, they slowly lowered the RPO-A down the shaft until it faced a tunnel. Then they pulled the trigger string to fire the thermobaric round down the tunnel. The resulting overpressure of the fuel-air round was devastating for anyone in the vicinity.[20]

In the early days of the war, the Soviets reportedly used POL (petroleum, oil, and lubricants) products against those hiding in the karez. In the spring of 1982, Soviet soldiers entered the village of Padkhab-e Shana in Logar Province. A karez passes through the village and many villagers took refuge in it. According to eyewitness reports, "…villagers who fled spoke of soldiers wearing gas masks, pouring mysterious things into an underground irrigation canal where villagers, including children, were hiding. Our investigation showed that the soldiers had actually used gasoline, diesel fuel, and an incendiary white powder, an evil-smelling [substance] designed to ensure that the gasoline would properly burn in a tunnel with little oxygen. After the 105 people, including the little children, were burned to death, the population in a panic decided to run away to Pakistan."[21]

There were also many reports that Soviet forces used chemical agents during the early part of the war to flush out or kill mujahideen hiding in the karez.[22]

Tunnel Rats and Future Conflicts

Digging the enemy out of tunnels appears to be a constant factor in guerrilla warfare, and the combat engineer always seems to be the first soldier called for the task. Differentiating innocent civilians from combatants underground will prove to be a challenge for combat engineers. Since underground combat will not disappear from the future battlefield, we must prepare for the task. In the quest for high-technology answers to the complex problems of tomorrow's battlefields, there are few high-technology solutions for underground combat. After all the charges are blown, determined soldiers still must go underground to meet equally determined opponents. Specially trained soldiers will be better prepared to cope with future subterranean combat, which will remain the realm of raw courage, cunning, and nerve.

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Mr. Ali Jalali, a journalist, has covered Afghanistan and Central Asia for the past 15 years. He served as a colonel in the Afghan army and was a member of the Afghan resistance during the Soviet-Afghan War. Mr. Jalali has completed the Infantry Officer's Advanced Course at Fort Benning, Georgia; the British Army Staff College at Camberley; the Soviet Frunze Academy in Moscow; and the Naval Post-Graduate School in Monterey, California.

Photos and artwork courtesy of the Russian *Soldier of Fortune* magazine, No. 11, 1994.

Endnotes:

[1]*Karez* is the Pashto term for the man-made underground water system. *Qanat* is the Arabic term used in Iran and Afghanistan. Louis Dupree, *Afghanistan*, New Delhi: Rama Publishers, 1980, page 40. Figure 1 is from page 41.

[2]Ibid.

[3]A. Bek, "Smertel'naya volna: Podzemnaya voyna v Afganistane" [Deadly wave: Underground combat in Afghanistan], *Soldat udachi*, [*Soldier of Fortune*], November 1994, page 4. This article is based on Colonel Bek's article and diagrams 2, 3 and 4 are Colonel Bek's.

[4]Dupree, page 40.

[5]Ali Jalali, *The Military History of Afghanistan*, Volume 1, Kabul, 1964, pages 437-442.

[6]Accounts of mujahideen commanders from Ghazni Province made to Ali Jalali in 1984.

[7]Bek, page 5. Lieutenant Colonel Bek ran this school.

[8]Afghanistan has two species of cobra, the deadly krait, and many types of vipers. Dupree, 53.

[9]Most Afghans would state that they seldom, if ever, gave warning.

[10]Fragmentation grenades, such as the cast-iron body Soviet F-1, are fairly ineffective underground.

[11]Bek, page 5.

[12]The Italian TC 6.1 mine has about six kilograms (13.2 pounds) of explosive. Soviet engineers often used a box of TNT in lieu of a mine.

[13]Bek, page 5.

[14]Ibid.

[15]Ibid.

[16]Ibid, pages 5-6.

[17]The entrenching tool was a weapon of choice for Soviet soldiers in hand-to-hand combat. Elite forces normally kept a razor-sharp edge on their entrenching tools.

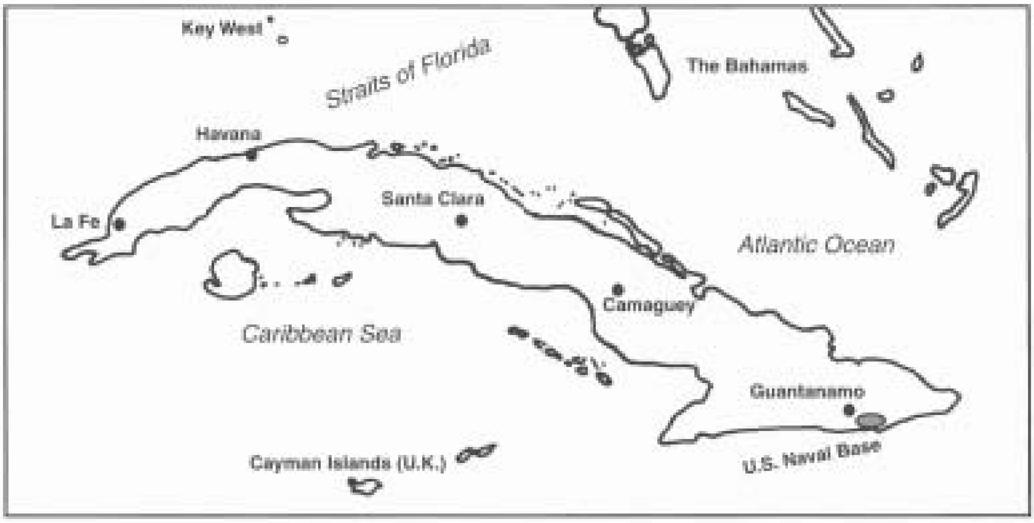
[18]Bek, page 6.

[19]Terry J. Gander and Ian V. Hogg, *Jane's Infantry Weapons 1995-1996*, Surrey: Jane's Information Group Limited, 1995, pages 203-204.

[20]Russian General Staff material that Mr. Grau is translating and editing for publication.

[21]Mike Barry, *International Afghanistan Hearing*, edited by the Committee for International Afghanistan Hearing, Oslo, 1984, as cited by M. Hassan Kakar, *Afghanistan: The Soviet Invasion and the Afghan Response, 1979-1982*, Berkeley, 1995, pages 234-235.

[22]State Department Special Report # 106, *Afghanistan: Three Years of Occupation*, Washington: U.S. Government Printing Office, December 1982, page 5.



Guantanamo Bay:

Combat Engineering Don't "Gitmo" Better Than

By Captain Anthony J. Monaco, USMC

Commonly dubbed "Gitmo," the U. S. Navy's unique base on Cuba's southeastern coast has long been a showcase of naval expeditionary engineering capabilities. Originally seized by Marines as an advanced base for the Santiago Campaign of the Spanish-American War in 1898, Guantanamo Bay has been well used throughout the last century. The sheltered harbor, its position near the windward passage (an important maritime route between the United States and Central and South America), and its proximity to the Panama Canal make the base strategically important. Its airfields and extensive supply, repair, and training facilities make Gitmo an excellent forward-based naval facility. In 1961, though, the base was forced to turn its focus inland after escalating tensions between the United States and the Cuban revolutionary government resulted in a serious threat to base security. In response to that threat, Gitmo severed all local ties, closed its gates, and assumed a defensive posture. Since then, Gitmo has been surrounded on three sides by a less-than-cordial neighbor—the Cuban Army's Guantanamo Division.

In this real-world setting, U. S. sailors and Marines, though vastly outnumbered by their potential adversaries, continue to prepare to impede a Cuban attack on the base. The tenuous defense has relied heavily on combat engineers to shape a maneuver-constrained battlefield and to protect the force from the direct- and indirect-fire advantage afforded

A Russian-made H1P8 helicopter patrols Gitmo's perimeter. A U.S. observation post is on the left and a U.S. minefield is in the foreground. Two Cuban observation posts are at the top of the hill.

the Cubans by their superior numbers and occupation of high ground around the base's perimeter. Along with providing a more credible defense, U.S. Navy and Marine countermobility and survivability efforts at Gitmo have firmly established combat engineering's value as a combat multiplier. This article describes these combat engineering efforts and shows their arduous, occasionally ingenious, and at times costly development and integration into the defense. Some valuable lessons learned along the way are highlighted.

Weather, Terrain, and Obstacles

Gitmo is unique in the Caribbean in that it is not lush and tropical like nearby Jamaica and the Bahamas. Because of its seaside location, tropical heat and humidity are prevalent. Mountain ranges across Cuba's eastern end and mountains in Hispaniola block storms and rain, rendering the Guantanamo region semiarid. In most places, Gitmo resembles Arizona's desert more than it does a Caribbean island. Dense, gnarled chaparral, mangroves, and various scrub trees flourish in this climate. Because of the nearby ocean and intense tropical sun, the salt spray on vehicles, equipment, field fortifications, and obstacles is highly corrosive. There is no cool, dormant season to provide a break from the weather. High temperatures in the summer average in the mid- to high 90s, while winter highs average in the high 80s to low 90s. The temperature rarely drops below 70 degrees. Adding to its desert-like character is the lack of any naturally occurring freshwater source within four miles of the base.

Defenders usually pick terrain that affords them a distinct advantage over would-be attackers, but little about Gitmo's terrain favors the defense. From the island's eastern mountains and five key high points just outside the base, Cubans can view almost everything that occurs within Gitmo's fences. Terrain on the base is rugged and unwieldy due to the confluence of volcanic and coral geographies. Steep hills with loose, rocky slopes cover much of the base, although salt marshes and mangrove swamps also are common. Despite the relatively small amount of rainfall—an average of 23 inches per year—erosion control and soil stabilization are perpetual necessities on the many combat roads and trails in the defensive area. Even from the best positions on base, defenders must cover at least a dozen mechanized, small-unit avenues of approach that funnel into the base from concealed positions inside Cuba.

Several man-made obstacles and physical limitations further constrain American defenders. The first is the base's boundaries, which were set by treaty in 1934. The United States anticipated having to defend against an attack from the sea, so it took only the land needed for a coastal defense of the base and harbor. The boundaries were drawn along straight north-south or east-west lines, often cutting directly over the top of key terrain features and stopping short of several prominent, and later tactically critical, hills and ridges. When the threat shifted inland, the boundaries drawn three decades earlier became an instant liability to the land-based defense. In 1983, Castro eliminated the possibility of Americans branching into Cuba to gain valuable maneuver space by seeding the Cuban side of the perimeter with thousands of landmines.

Another lasting effect of the treaty is that the base boundaries do not encompass the entire bay, merely the lower bay. The bay divides the naval base into two distinct sides, called *leeward* and *windward*. No bridges connect the two sides and travel between them is limited to boat and helicopter. The channel to the upper bay contains an important Cuban agricultural port and must, by treaty and international maritime law, remain open—at least during peacetime. The effects of this diplomatically imposed obstacle on maneuver and the defense are especially constraining.

In total, Gitmo's intense, difficult climate, coupled with its rugged, unforgiving terrain and vegetation are natural enemies. In the preparation and maintenance of a sound defense, these factors exact a heavy toll on both men and machines. At best, the terrain and weather are equally harsh to attacker and defender. At worst, adding the diplomatic foibles of yesteryear, they favor the attacker. He holds key terrain outside the base and can direct a multipronged attack through many avenues of approach to literally push the undermanned Marines and sailors into the bay from whence they came in 1898.

Developing a Defense, 1958-1964

The buildup of Gitmo's initial land-based defense corresponds with the rise in national-level tensions with Cuba and the general panic over the spread of communism in our backyard between 1958 and 1964. Before the late 1950s, the base had no well-delineated perimeter road, and its boundary was marked only by an unsubstantial picket fence. Marines occasionally patrolled the perimeter on horseback. Marine engineers conducted training at Gitmo but were not used or needed in its defense before this period. In June 1958, Castro's rebels elevated local tensions when they kidnapped a group of 28 Marines and sailors who were returning to the base from liberty in Guantanamo City. (They were returned in July 1958.) Castro officially claimed control of Cuba on 1 January 1959, and Cuban-American diplomatic relations plummeted until 4 January 1961, when President Eisenhower terminated them completely. In concert with this termination, the base closed its gates, began regular patrolling of the perimeter, and started work on its defense. The Bay of Pigs fiasco in April 1961, the Cuban Missile Crisis in October

Photograph courtesy U.S. Navy

General L.F. Chapman, Commandant of the Marine Corps, is briefed on Gitmo's defensive preparations in 1971.

1962, and various provocations by Castro's forces around Gitmo's perimeter during this period yielded an urgency to defense planning and preparations on the base.

The United States initially reacted to the tension threatening Gitmo in the early 1960s by throwing large numbers of combat and combat support troops into the fray. Although the naval base commander was responsible for defending the base's 17.4-mile perimeter, he exercised it through the commander of Ground Defense Force, a Marine colonel who was commanding officer of Gitmo's Marine Barracks. The force, equipped and manned to hold out for up to a week without reinforcements, was comprised of a regimental-sized infantry component augmented by several provisional Navy companies. It boasted an impressive array of combined arms—from Marine artillery, tank, antitank, and engineer units to Navy attack airplanes and gunfire platforms. A Seabee battalion dug in the force and created the initial field fortifications and revetments.

The initial defense reflected the prevalent tactical thought of the period. Navy and Marine planners deployed a large, static force in hold-at-all-cost positions along the entire perimeter and strengthened it with impressive firepower. Engineer efforts, always the most time-intensive on the battlefield, were limited because the defenders, aptly figuring on the inevitable Cuban attack, were only willing to gamble on a minimal amount of preparation before the defense needed to be set.

Field fortification construction and minefield emplacement topped the engineers' tasks. Marine infantry—trained and supervised by Marine engineers—installed protective, standard-pattern minefields during lulls in the tension. Everything about these initial minefield efforts reflected the urgency of the defensive situation. The minefields did not maximize use of the terrain or incorporate sufficient man-made, nonexplosive obstacles. Minefield records were hastily drawn and often incomplete. Probably because of working long hours in the Cuban heat at a dangerous, unforgiving task, two junior Marines were killed in separate minefield accidents within a three-month period. As further evidence of the haste of these efforts, Marine Barracks staff members studying the continued requirement for landmines at Gitmo in late 1966 could find no record of the initial emplacement authority and few records on the initial efforts.

Changing the Focus, 1965-1966

As tensions around the perimeter relaxed about 1965, the American troops protecting Gitmo were slowly parceled out elsewhere. As American involvement in Southeast Asia grew, only a skeleton of the former force was left to defend against the still-credible Cuban threat. At this point, combat engineering earnestly entered the forefront of defensive preparations at the naval base. The new situation demanded that defenders make the best possible use of all combat multipliers. General Douglas MacArthur's prophecy began to be fully realized at Gitmo in 1965: "*...It is certain that in future wars, even more than in the past, endeavors will be made by every possible means to prevent or delay the march of the enemy's troops by throwing obstacles in the way and by cutting such lines of communication as they might use.*"

The new defensive situation, featuring the tropical version of a Soviet-styled mechanized force, provided the impetus for a large-scale, combat-engineer-intensive defense retooling. The Marine Barracks exchanged its obsolete continuous perimeter defense for a mutually supporting strongpoint defense that relied heavily on an obstacle belt to disrupt, channel, or turn potential attackers. To effect this end, Marine engineer companies from Camp Lejeune, North Carolina, rotated to Gitmo in 1965 to plan and construct a more tactically sound obstacle belt around the perimeter. This retooling took more than a year of steady work to complete.

Engineer tasks were plentiful and the pace of implementation rapid. Seabees continued to assist the Marines with survivability efforts by fortifying strongpoints and artillery, mortar, and tank positions. They also expanded the network of combat roads and trails on rugged ground in and around the strongpoints, making reinforcement and maneuver between them more feasible.

Navy and Marine planners determined that landmine warfare was still a vital component of the Gitmo defense. They also recognized that the minefields emplaced from 1961 to 1962 were sorely in need of rehabilitation and better incorporation into a long-term defense plan. Marines removed or modified the minefields and emplaced several new ones. Guided this time by sound obstacle-employment principles and not nearly as hurried as their predecessors, the Marines tied 21 minefields, covering more than 600 acres of ground, into natural terrain obstacles such as salt marshes and steep hillsides. More than 41,000 M15 Heavy Antitank Mines, M14 "Toe Popper" Antipersonnel Mines, and M16 Bounding Fragmentation Antipersonnel Mines were used in these minefields. The Marines also built and incorporated substantial wire entanglements, tank ditches, and other nonexplosive obstacles into the obstacle belt. These efforts allowed the smaller, yet better-protected force to deploy behind a solid, well-planned, complex obstacle belt; fight a combined arms defense, albeit at closer range than desired; and reasonably expect to deter Cuban forces until help arrived from the United States.

Refining the Plan, 1967-Present

The Marine Barracks, later called the Marine Barracks Ground Defense/Security Force (GD/SF), continued to refine its defense plan. The more reasonable "live to fight another day" precept led the GD/SF to develop a delaying defense and abandon the outmoded "die-in-place" one. Along with the old strongpoints, this defense ultimately incorporated the more fluid concepts of battle positions, planned engagement areas, counterattacks, and phased fallback positions. The combined effects of this defense bought the time needed to evacuate noncombatants and allow reinforcements to build up in the rear area.

Refinements to the defense plan generated more engineer tasks. Though not in the numbers of the early and mid-1960s, Marine and Seabee engineer units continued to answer the call with regular deployments to the base, making the "smarter-not-harder" defense possible.

Field Fortifications

A prime focus for the deployed engineers was to maintain and upgrade the many field fortifications. Because of harsh environmental conditions, the fortifications—most of which relied on structural-grade timbers—had to be continually checked, repaired, and often rebuilt in order for them to remain an effective part of the defense. The destructive effects of the omnipresent Cuban termites and carpenter ants compounded the situation. These pests destroy wood structures at an alarming rate. To combat their effects, Marines treated fortification timbers with thick applications of creosote.

Obstacle Belt

Marines and sailors continued to work together to maintain and improve the obstacle belt. The minefields remained the focus; Marine engineers and Navy corpsmen, ordnancemen, and explosive ordnance disposal technicians worked together daily in minefield rehabilitation operations. One of the more ingenious additions to the countermobility plan was the "Valley of Balls" reinforcing obstacle, the product of a Gitmo-unique recycling effort. From the early 1900s until the end of World War II, the entire Atlantic Fleet sailed to Guantanamo Bay for training and anchored throughout the bay. To accommodate this massive force, the Navy placed several hundred floating anchorages—large, steel spheres and cylinders—in the bay for ships to tie to. Once the fleet stopped deploying to Gitmo in large numbers after World War II, the Navy tried to rid the bay of the anchorages, which had outlived their usefulness and were hazardous to boat traffic. The solution was to use the anchorages as antivehicle obstacles. Placed in offsetting rows along vulnerable terrain—in this case two small valleys—the anchorages further strengthened the effort to deny attackers the use of key avenues of approach.

Observation Posts

Another sizable engineer task during this period showcases the well-known "can-do" motto of the Seabees. During their regular deployments, Seabees built 10 substantial timber-tower observation posts along the perimeter. Designed and built to withstand the effects of hurricane-force winds, these towers were significant undertakings. They were fitted with steel plating at the top to protect sentries from small-arms potshots from the other side. Placed on the highest ground available along the perimeter and usually standing about four stories high, the posts partially mitigated the American disadvantage in observation. The posts were crucial to the 24-hour surveillance of the perimeter. From these towers, guards could gain early warning of potential Cuban hostilities and constantly monitor daily activities of Cubans for later analysis by intelligence personnel. The towers also allowed Marines to effectively control the heavy influx of Cuban asylum seekers who came through the fence line in the early to mid-1990s.

Gitmo's Own Engineers

Early in 1968, the Marine Barracks received its own permanent combat engineer unit for rehabilitating the base's 700 acres of minefields. Called the Minefield Maintenance

Engineers upgrade the obstacle belt in 1997.

(MFM) Section, the unit included highly trained landmine warfare experts, all of whom held the rank of sergeant (E5) and above. The MFM Section relieved deploying Marine engineers of dangerous minefield work. Previous landmine operations had caused heavier-than-expected casualties to these units, claiming five lives and wounding several others between November 1965 and November 1966.

The MFM Section continued to upgrade and expand the minefields to better meet the needs of the defense plan, raising the total number of mines to more than 55,000, the total minefield acreage to more than 700, and the total number of minefields to 26. The MFM Section's daily efforts centered on locating and removing old mines and replacing them with newer, more effective ones, ensuring that Gitmo's minefields remained the highly effective backbone of the obstacle belt. One maintenance rotation, which involved removing and replacing all the mines and inspecting and repairing the infrastructure of each of 26 minefields, took seven years to complete. Between 1967 and 1990, minefield operations continued to provide a sober reminder of the price of maintaining Gitmo's defense. During this period, six more Marines and five Cuban fence jumpers were killed and several other personnel were injured.

Adding the MFM Section also provided the GD/SF with a combat engineer capability to supplement its battle plans. Their integration increased the plan's flexibility and resulted in the development of several unique, ready-made obstacles. The obstacles, positioned for rapid tactical employment throughout the base, did not prohibit normal traffic patterns or other routine occurrences.

The preplanned obstacles illustrated more of the combat engineers' innovative contributions to Gitmo's defense. Similar in concept and design to the obstacles employed by U.S. Army engineers in Korea and West Germany during the Cold War, they included road craters and bridges that were prechambered for demolitions placement and falling blocks. Their construction emphasized quick, foolproof employment. The most prevalent of these obstacles were the prechambered road craters known as *blow holes*. Blow holes consisted of polyvinylchloride (PVC) pipe placed in the ground across the width of a road to maintain the holes into which cratering charges could be placed and ignited. The holes were tied together with a concrete cap, and metal lids were placed over the ends of the pipe. Everything was flush with the road surface. The prechambered bridges crossed antitank ditches, which were vital to the defense but obtrusive to the everyday business of perimeter surveillance. To blow the bridges and complete the obstacle, an MFM team would place predetermined quantities of demolitions in cradles welded to the underside of the bridge, tie the charges together, and fire the obstacle. In keeping with the foolproof use of these obstacles, instructions for blowing the bridge were stenciled on one of its abutments. The last of these obstacles were the falling blocks, called *monoliths*. Consisting of large concrete columns, they could be felled by a small "kicker" charge placed in a space at the bottom of each column. The columns would then fall inward and block the road.

The basic battle concept was for the MFM Section to be employed in mobile, four-man teams that served in general support of the GD/SF fight. The teams would be dispatched to initiate these obstacles at decisive junctures in the foreseen defensive battle, thus cutting off certain avenues of approach. This concept was especially important in Gitmo's shallow defensive area, because it allowed maximum use of the limited maneuver space for as long as possible and then quickly denied the enemy use of the same terrain as he pressed into the base. In case of a quicker-than-expected break in the lines, engineers could be employed as infantry—a bonus for the already lean defense force.

The Current Situation

Defensive operations at Gitmo have fallen to the same downsizing ax as the rest of America's military. Cuban forces around the base also have undergone changes, having lost their Soviet benefactor. However, the need for a credible defense has not dissolved and preparations continue, though on a more modest scale than in previous eras. Chief among these efforts—and one only recently completed—was the Seabee's repair and upgrade of the perimeter road. This road, the lifeline of the perimeter, had always been subject to damage from erosion and heavy tactical vehicle traffic. It was dangerous to drive on at night, the peak time for patrolling, and was badly in need of repair. The Seabees implemented a comprehensive plan to fix the problem that integrated soil stabilization, culverts, concrete ditches, gabions, and a double-bituminous, surface-treated road along the entire 17.4-mile perimeter. The Seabees have also completed another timber observation post and started building several storm shelters along the fence line for Marine sentries and patrols.

Countermobility operations have taken the biggest hit recently. The president's decision in May 1996 to ban the use and stockpiling of all antipersonnel mines was manifested in a directive to completely remove Gitmo's minefields. The MFM Section is carrying out this operation, but the work is necessarily deliberate, slow, and thorough and is not scheduled for completion until after the year 2000. The GD/SF continues to search for a viable replacement for the minefields and is considering scatterable mine systems like the Volcano and the Modular Pack Mine System or perhaps a nonexplosive alternative. Survivability maintenance has been affected too, but recent developments from the Army's experiences in Bosnia show promising applications at Gitmo. Survivability and countermobility projects continue to accumulate because too few engineer units are available to accomplish all of the proposed projects.

Lessons Learned

The evolution of Guantanamo Bay's defense has yielded the following combat engineering lessons:

- *Integrate combat engineers into the defense.* This includes individual engineers on the ground who coordinate with infantry as well as engineer leaders who integrate engineers into operations plans. The Marines' experience at Gitmo clearly shows the value of a combat multiplier that is often not fully employed in peacetime exercises, because many combat engineering tasks are too time intensive to complete.
- *Keep combat engineers in general support of the force.* At Gitmo, the MFM Section showed that they were more flexible if they stayed in general support of the GD/SF during defensive exercises rather than be task organized to subordinate units.
- *Integrate engineer and fire-support planning.* This lesson is especially obvious at Gitmo, where Marines can stand on an obstacle, look down the avenue of approach it seeks to deny, and clearly see the desired combined-arms effect.
- *Stress the importance of realistic "hands-on" training for junior sailors and Marines, training which often is not possible in the United States.* Because the defense mission takes top priority in Gitmo, there are few constraints—environmental or otherwise—to hamper digging, building, demolishing, etc. The operational nature of the mission infuses defenders and those who have deployed to Gitmo with a singular focus and sense of purpose. The result is that generations of Marines and sailors have taken valuable lessons learned at Gitmo to Vietnam, Beirut, the Persian Gulf, Somalia, and elsewhere.
- *Ensure that engineer leaders receive fire-support training.* Simulating the placement of demolitions in front of enemy and friendly lines when both sides are manning their positions—essentially working in "no man's land"—is a good way to remind everyone to brush up on call-for-fire and close air and radio communications skills.
- *Appreciate the difficulty, danger, and long-term consequences of minefield operations.* Conventional minefields require an incredible amount of resources and time to emplace and maintain. Minefields also present problems long after they have ceased to be tactically beneficial, regardless of the type of mine systems used. Friendly minefields produce casualties among even the most seasoned troops. These realistic considerations must be factored into our tactical planning.
- *Encourage innovation.* Some of Gitmo's most effective obstacles resulted from unlikely materials or bold ideas.
- *Stress simplicity.* Seemingly simple engineer tasks, such as priming a road crater or locating and removing mines from thick undergrowth, are not so simple when performed in view of an enemy guard tower. Working at Gitmo, with the nearby threat, shows how difficult it would be to do the same tasks in a combat situation.
- *Develop a unit standing operating procedure (SOP).* Although the MFM Section essentially followed established landmine warfare doctrine, the doctrine was by no means comprehensive enough by itself. The MFM Section found it necessary to develop thorough, stringent procedures for daily minefield operations. The use of the SOP by all Marines, regardless of rank, was undeniably a major factor in minimizing minefield casualties.
- *Minimize the potentially debilitating effects of terrain and weather on a defensive posture.* If not for a dedicated maintenance effort, there would no longer be any worthwhile positions or obstacles at Gitmo.
- *Emphasize the true relevance of the tenet "Every Marine a Rifleman."* The defense plan at Gitmo relies on the use of every Marine, regardless of specialty.

The Future

The defensive situation around the perimeter of the Guantanamo Bay Naval Base is one of only a few Cold War conflicts yet to be resolved. The future of the base and its defensive operations are currently unclear, and significant changes are likely as relations with Cuba

(Continued on page 32)

TerraBase II, Version 3.0

Supporting the Terrain Visualization Expert

By Mark Adams and Lieutenant Colonel Earl Hooper

The U.S. Army Engineer School continues its efforts to develop TerraBase II as an easy-to-use, low-cost, PC-based terrain evaluation tool for the engineer force. This software assists in training engineers to be terrain visualization experts and provides a personal software tool to evaluate and view digital terrain data products. TerraBase II is tailored specifically for military applications and requires minimal training. This article reviews the capabilities provided by version 2.2 and describes improvements available in the new 3.0 release.

"Terrain visualization is the responsibility of commanders and staffs across the spectrum of today's Army. To effectively see the impact that terrain has on units conducting and supporting military operations, all commanders and their staffs must be aware of the effects of terrain. The terrain expert is the engineer."

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

Version 2.2 Capabilities

TerraBase II has been the instructional standard for the Engineer School since the summer of 1997. The Engineer School distributed the original 2.04 version of TerraBase II on a Terrain Visualization Training CD-ROM (see *Engineer*, August 1997, pages 38-39). The 2.2 version of the software was distributed via the web in April 1998. TerraBase II quickly reached the field with our graduating students and through the Terrain Visualization Center web site.

With TerraBase II, version 2.2, engineers can produce a variety of tactical decision aids (TDAs) to assist with terrain visualization. These include line-of-site displays, weapons fans and range circles, visible area plots, oblique and perspective views, elevation and slope tints, contour and reflectance plots, point elevations, and fly-throughs. TerraBase II also performs coordinate datum transformations and calculates sunrise-sunset day length, moonrise-moonset, and over-the-ground distance.

TerraBase II, version 2.2, a users' guide, and a set of battle drills are available from the Terrain Visualization Center web site at *http://www.wood.army.mil/TVC*. Each battle drill contains an abstract and step-by-step procedures to help new users develop basic TDAs.

The primary data requirements are imagery and elevation data products from the National Imagery and Mapping Agency (NIMA - formerly the Defense Mapping Agency), U.S. Geological Survey (USGS) and a variety of commercial products. The 2.2 version uses—

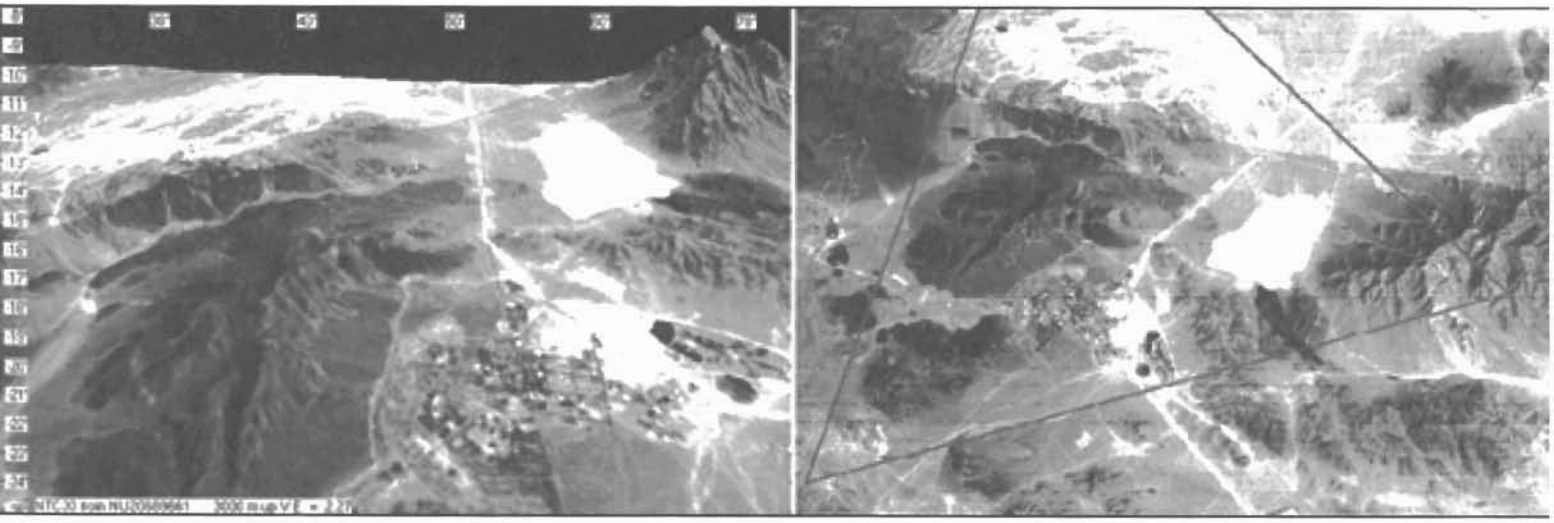
- NIMA digital terrain elevation data (DTED).
- USGS digital elevation models (DEM).
- NIMA controlled-image base (CIB).
- USGS digital orthophoto quads (DOQ).
- LANDSAT (land satellite) multispectral imagery (MSI).
- SPOT (Systeme Probatoire d' Observation de la Terre) satellite imagery.
- Indian reconnaissance satellite (IRS) imagery.

Version 3.0 Updates

Since the release of versions 2.04 and 2.2, a steady stream of questions, requests for assistance, recommended improvements, and bug reports flowed into the Terrain Visualization Center. The most useful information consistently came from users in the field, who add tactical significance to the TDAs produced with TerraBase II. The result of this input is TerraBase II, version 3.0. From the users' perspective, most of the improvements are evolutionary. Although many processes are simplified, the look and feel of TerraBase II remains unchanged. The following paragraphs summarize the most significant updates in version 3.0.

New Formats

Field users frequently requested map-based product formats. The 3.0 version adds digital map formats from NIMA and USGS that can be used to create TDAs, including perspective and fly-through products. New formats available in release 3.0 are—



An NTC fly-through (left view) with a corresponding two-dimensional track (right view).

- ***NIMA standard data types:*** Arc Digitized Raster Graphics (ADRG) maps, Compressed Arc Digitized Raster Graphics (CADRG) maps, and Compressed Digitized Raster Graphics (CDRG) maps.
- ***USGS standard data type:*** Digitized Raster Graphics (DRG) maps.
- New commercial and allied imagery in GeoTiff georeferenced formats.

Revised User Interface

Version 3.0 includes an expanded and simplified user "options" interface, improved pull-down menus, and a Graphics User Interface (GUI) for the most popular TDAs. This version also includes an updated coordinate conversion module and a "hot key" to execute the Topographic Engineering Center GEOTRANS software. The GEOTRANS software adds a Universal Polar Stereographic capability for the coordinates in polar regions, a few minor secondary grids, and the ability to batch-process coordinate conversions.

Improved TDA Presentation

Version 3.0 allows users to drape any of the tactical overlays (weapons fans, point elevations, annotations, custom grids, etc.) on elevation data, imagery, or maps to create two-dimensional, perspective, and oblique views. A curved-path fly-through is now possible with automatic smoothing of directional changes. The new fly-through interface simultaneously displays, frame by frame, both the fly-through three-dimensional view and the two-dimensional map track (see figure). Resolution restrictions on three-dimensional perspectives and fly-throughs are relaxed to take advantage of high-end PC capabilities.

GPS Connectivity

Military and commercial Global Positioning Systems (GPS) now can be connected to laptop computers and—in real time—display track, bearing, and speed, with updates every two seconds. The track can display over elevation data, imagery, and maps. Way points recorded using a military precise lightweight GPS receiver (PLGR) now can be downloaded and displayed in TerraBase II over elevation data, imagery, or maps. In a reverse role, routes planned with TerraBase II can be uploaded as way points to a PLGR for navigation.

Other Improvements

The help files in version 3.0 are greatly expanded and contain an automatic help feature for new users. Major changes in data retrieval and manipulation are embedded in the software that allow NIMA, USGS, and GeoTiff products to display in their native formats. Although TerraBase II still uses an internal.idx format for some products, most products load directly without the need for conversion. This capability greatly enhances the speed of creating TDAs and reduces file-storage requirements. Most importantly, it takes advantage of the geocontrol embedded in products from primary data providers.

Availability

TerraBase II, version 3.0 beta, may be downloaded from the new Terrain Visualization Center web site at *http://www.wood.army.mil/TVC/index.htm.* A revised users' guide and an updated set of battle drills are planned for release by the end of 1998. A new two-CD-ROM set is projected for completion early in 1999. The first CD-ROM will contain a self-paced interactive training program, while the second one will contain the TerraBase II software and an expanded set of training data. The Engineer School continues to support earlier TerraBase II releases, battle drills, and users' guides until version 3.0 is available on CD-ROM and the Terrain Visualization Center web site.

Sample digital elevation and satellite imagery data coverage for several CONUS training posts is available from the Terrain Visualization Center web site. The key source of data for training and operations continues to be the NIMA. Units can use their Department of Defense Activity Address Code (DODAAC) to order digital and hard-copy products from NIMA on a 30-day turnaround cycle. As of 1 April 1998, NIMA products are ordered and delivered through the Defense Logistics Agency and requested by national stock number using the Standard Army Retail Supply System. Department of the Army Deputy Chief of Staff for Logistics message (DALO-SMP, DTG 140858Z April 97) provides instructions. Map stock and issue procedures follow AR 710-2, *Inventory Management Supply Policy Below the Wholesale Level*. Mapping, charting, and geodesy products are stocked at Class II, IV, and VII supply points at Corps and the Theater Army Area Command. The Defense Supply Center web site at *http://www.dscr.dla.mil/PC9/dscr_maps.htm* provides information on the new ordering and distribution process. All NIMA products are provided at no cost to support military requirements.

Joint Venture

The TerraBase II developmental effort continues as a joint venture between the Engineer School's Department of Training and Doctrine Development (responsible for all training, instructional materials, and training support), the Terrain Visualization Center (responsible for software development management, priorities, and field technical support), and the U.S. Naval Academy (responsible for programming and software development).

Engineer School personnel are grateful to Dr. Peter Guth of the U.S. Naval Academy for his extraordinary skill and dedication to this project and to the U.S. Naval Academy for its flexibility and support of Dr. Guth's efforts This relationship allows TerraBase II to develop and respond quickly to user feedback. TerraBase II, version 3.0, is indicative of this cooperative relationship.

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Lieutenant Colonel Hooper is Chief of the Terrain Visualization Center, U.S. Army Engineer School. Previous assignments include operations officer, 30th Engineer Battalion (T)(A) and Corps engineer plans officer, XVIII Airborne Corps, Fort Bragg, North Carolina; and commander, 814th Engineer Company (AFB), Hanau, Germany. LTC Hooper is a graduate of the Airborne School, Ranger School, and Command and General Staff College. He holds an industrial engineering degree from the University of Central Florida and a master's degree in systems management from the Florida Institute of Technology.

(Continued from page 29)

continue to improve. That the defense has never been compromised, despite occasionally fierce posturing throughout nearly four decades, is testament to the resolve and skill of its defenders. Gitmo's tangible, unique defensive preparations, which showcase the competence and ingenuity of Marine engineers and Seabees, have shown that combat engineering is essential to mission success.

Captain Monaco is assigned to the 2d Combat Engineer Battalion, 2d Marine Division, Camp Lejeune, North Carolina. Previous assignments include OIC, Minefield Maintenance Section and Barracks Engineer, Marine Barracks, Guantanamo Bay, Cuba; platoon commander, engineer officer, and S3A, 3rd Light Armored Reconnaissance Battalion, 1st Marine Division, 29 Palms, California; and platoon commander, 9th Engineer Support Battalion, 3rd Force Service Support Group, Okinawa, Japan.

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CTC Notes

National Training Center (NTC)

Breach Planning at the Brigade Level

By Captain Fred Erst

During offensive operations, maneuver brigades often struggle with isolating the point of penetration and massing sufficient combat power at the decisive point on the battlefield. As a result, many brigades are unable to set the conditions for the fight before committing to the breach and are rapidly destroyed by the defending enemy. Many of these problems can be traced back to ineffective breach planning by both the maneuver brigade and the engineer battalion.

The maneuver brigade staff does not consistently recognize or include the breach as a significant phase of the operation during course-of-action (COA) development and war gaming because enemy obstacles are not adequately depicted in the brigade's situation template (SITEMP). The brigade's main effort is not weighted with sufficient combat power to conduct a penetration and lacks the additional mobility assets required to provide redundancy at the breach. While the assistant brigade engineer (ABE) understands how to use reverse breach planning, the brigade staff does not use the reverse planning process to develop the brigade's scheme of maneuver. The breach plan does not address brigade responsibilities for a task-force breach nor does it specify how the brigade intends to synchronize the SOSR (suppress, obscure, secure, reduce) fundamentals.

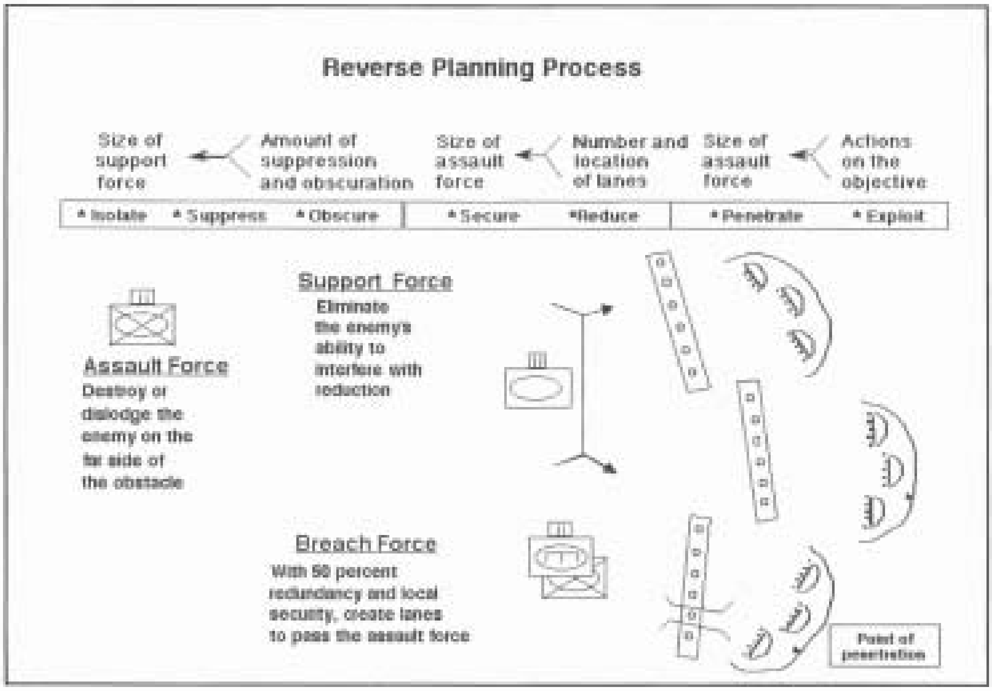
To improve breach planning at the brigade level, the engineer battalion and maneuver brigade staff should focus their efforts on the following five areas:

- Engineer Integration in the intelligence preparation of the battlefield (IPB)
- Breach organization and mass
- Reverse planning process
- Actions at the breach
- Brigade responsibilities at the breach

Specific actions for each area follow.

Engineer Integration in the IPB. Effective breach planning must begin during the brigade's IPB process. The ABE and engineer battalion S2 must develop and use the engineer battlefield assessment to provide the brigade commander and staff with a common vision of how they believe enemy engineers and the terrain will shape the battlefield. The ABE and engineer S2 must work closely with the brigade S2 to template all possible enemy obstacles throughout the depth and width of the battlefield based on each enemy course of action. To provide the necessary focus during the brigade planning process, they must ensure that enemy tactical and situational obstacles are included in the brigade SITEMP. This includes minefields emplaced by the mobile obstacle detachment, the universal mine layer, and rocket-delivered scatterable mines, as well as expected enemy positions and weapons systems. A detailed brigade SITEMP is an essential part of developing an effective breach plan. The brigade SITEMP provides the common vision of the enemy needed to drive the brigade's reverse planning process, task organization, and reconnaissance planning early in the military decision-making process.

Breach Organization and Mass. The *size* of the enemy force overwatching the obstacle drives the *type* of breach the brigade conducts (brigade versus task force). The brigade staff must consider the enemy's ability to mass combat power and reposition his forces or commit his reserve. The brigade must then develop a scheme of maneuver to mass sufficient combat power at the decisive point on the battlefield. FM 71-3, *The Armored and Mechanized Infantry Brigade*, states "Massed combat power is directed against an enemy weakness. The location selected for breaching depends largely on a weakness in the enemy defense where its covering fires are minimized. If the attacker cannot find a



natural weakness, he creates one by fixing the majority of the defending force and isolating a small portion of it for attack. The need to generate enough mass strongly influences which echelon can conduct a breaching operation...A task force has sufficient combat power to attack an obstacle defended by a company."

The success of a task force breach depends on the brigade's ability to isolate that portion of the enemy defense that the lead task force has the ability to penetrate. Otherwise, the brigade must organize for a brigade-level breaching operation. A brigade with one armor and one infantry task force can designate one unit as the support force and the other as the assault force. The brigade can then use the engineer battalion (with a security and reduction element) to serve as the breach force. By organizing for a brigade-level breach, the brigade can mass the combat power and mobility assets needed to successfully isolate and penetrate a motorized rifle battalion defense.

Reverse Planning Process. The reverse planning process is an essential tool in building an effective plan (see figure above). The end state is not the breach; rather it is getting the assault force onto the objective to destroy the enemy. By starting at actions on the objective and working back to the line of departure, the staff can allocate combat power, mobility assets, and indirect fires (suppression/smoke). The following list is based on the technique shown in FM 90-13-1, *Combined Arms Breaching Operations,* and is supplemented with lessons learned during breaching operations:

1. Actions on the objective drive the size and composition of the assault force, the assault force objective, and the point of penetration (POP).

2. The size of the assault force and location of the POP determine the quantity and location of lanes.

3. Lane requirements, type of obstacles, and type of terrain/soil drive the amount and type of mobility assets (i.e., size and composition of the reduction element) task organized to the breach force.

4. The size and composition of the security element in the breach force are based on the enemy's ability to interfere with obstacle reduction.

5. The amount of suppression and the size, composition, and location of the support force are driven by the enemy's ability to mass fires and interfere with the breach at the reduction site.

Actions at the Breach. The brigade's operations order (OPORD) must specify brigade actions at the breach required to achieve SOSR for either a brigade- or task-force level breach. An effective technique is to sketch these actions at each expected breach site based on the templated obstacle, the specific terrain, and the enemy positions. The actions are found in FM 71-1, *Tank and Mechanized Infantry Company Team*, and can be applied to brigade or task force breaching operations.

- The reconnaissance force identifies the reduction site.
- The support force occupies positions and begins suppressive and obscuration fires.
- The breach force establishes near-side security at the reduction site.
- The breach force reduces the obstacle.
- The breach force proofs and marks lanes and establishes far-side security.
- The asssault force assaults and secures the objective.

SOSR Criteria

Decisions	Criteria
Determine the point of penetration and reduction site	- Reconnaissance force identifies obstacles and enemy positions.
Commence suppression and obscuration fires	- Observers are in position. - Support force crosses phase line.
Support force occupies support-by-fire (SBF) position	- Critical friendly zone (CFZ) is in place over the SBF position. - Obscuration is in place to screen support force movement. - Support force maintains more than 70 percent of its combat power.
Commit the breach force	- Suppression and obscuration are adjusted and effective. - CFZ is in place over the reduction site. - Engineer preparations are complete. - Fire-control measures are in effect.
Commit the reduction element	- Breach force near-side security is in position. - Security element controls the reduction site by fires or occupation.
Commit the assault force	- Lane is reduced, proofed, and marked. - Far-side security is in position.

The staff should develop a time line for these actions at the breach to ensure that the brigade maintains momentum during the attack. The brigade OPORD should specify the task and purpose of each element of the breach organization needed to achieve SOSR. The staff should also develop and track criteria for achieving SOSR to assist the commander in determining if breach conditions have been achieved. A method for establishing the criteria is shown above. *(Note: These criteria are not all-inclusive).*

Obscuration Plan. The brigade staff should develop a time line for critical actions at the breach for both the support force and the breach force as constrained by available smoke. Specify the task and purpose of both projected and generated smoke. Allocate or task organize smoke assets to the support force and the breach force based on those requirements. Develop solid triggers to employ obscuration and specify who controls obscuration. Ensure that the support force commander controls/shifts artillery-projected smoke needed to obscure his movement into the SBF position and set conditions for the breach.

Fire Control Plan. Identify fire-control measures in the brigade graphics such as SBF positions, coordinated fire lines or restricted fire lines, and no fire areas. All elements of the breach organization must specify and discuss direct fire-control measures such as target reference points (TRP); phase lines; and signals to initiate, lift, shift, or cease fires.

Brigade Responsibilities at the Breach. Engineers must ensure that brigade responsibilities during a brigade- or task-force breach are defined in the brigade's breach plan.

Obstacle Intelligence. Current and accurate obstacle intelligence (OBSTINTEL) is necessary to confirm or deny the SITEMP. FM 5-170, *Engineer Reconnaissance*, states that OBSTINTEL allows the commander to refine the plan and set conditions for a successful combined arms fight; maneuver rapidly to the objective; and exploit the opportunities offered by obstacles, terrain, and the enemy. The engineer battalion S2 and ABE must assist in developing the brigade reconnaissance and surveillance (R&S) plan. Task force scouts and the brigade reconnaissance troop must be trained to collect detailed OBSTINTEL. Any effort to conduct engineer-specific reconnaissance must be integrated with the brigade R&S plan. Both maneuver scouts and engineer reconnaissance teams (ERTs) are given parts of the same task to accomplish; both must maneuver through and occupy the same area during reconnaissance missions; and both must be able to report using retransmission, relay, or tactical satellite communications. FM 5-170 also states that integrating maneuver scouts and ERTs provides close cooperation and mutual support, decreases reconnaissance overlap, and reduces the risk of fratricide.

Isolating the Point of Penetration. The brigade plan must synchronize combat multipliers to isolate the point of penetration. The brigade staff must use close air support, artillery, aviation, electronic warfare, scatterable mines, air defense, obscuration, and deception to set conditions for the fight. Additionally, the brigade must continue to fight deep to stop the enemy from repositioning or counterattacking.

Traffic Control at the Breach. The brigade must task military police to provide maneuver mobility support to control traffic at the lanes, especially if the scheme of maneuver involves a passage of lines. The brigade breach plan should also specify a lane-numbering system, identify traffic-control points, and state which lanes will support reverse-flow traffic to evacuate casualties.

Conclusion. To achieve mission success, the maneuver brigade must isolate the point of penetration and mass sufficient combat power and mobility assests at the decisive point on the battlefield. Effective breach planning enables the brigade to maneuver rapidly and pass the assault force onto the objective to destroy the defending enemy. By improving breach planning at the brigade level, the maneuver brigade and engineer battalion can set the conditions for mission success.

Captain Erst is the assistant brigade engineer trainer at the National Training Center, Fort Irwin, California. He previously served as a company commander in the 3rd Engineer Battalion/10th Engineer Battalion and as a platoon leader/company XO in the 4th Engineer Battalion. He is a graduate of the University of Central Florida.

Battle Command Training Program (BCTP)

Improving Efficiency of Engineer Command and Control Nodes

By Lieutenant Colonel Ron Light

Recent BCTP Warfighter exercises indicate that engineers struggle with the functions and roles of engineer command and control (C2) nodes within the division area. Many units' standing operating procedures (SOPs) are incomplete and fail to clarify functions and roles. Details about *which engineer C2 node performs which tasks, where,* often are unclear. Units that have achieved success in the C2 arena blend their own tactics, techniques, and procedures (TTPs) with current engineer doctrine (FM 5-100, *Engineer Operations,* and FM 5-71-100, *Division Engineer Combat Operations*).

The division commands and controls operations through a command group and three command posts (CPs): the division rear CP, the division main CP, and the division tactical (TAC) CP. Engineers integrate the mobility and survivability battlefield operating system (BOS) at each of these CPs. Engineer functions at each C2 node interrelate, and the overall success of efforts to synchronize engineers rests in part with each node. Because staffing levels and experience at each C2 node differ, their productivities also differ. Some of the TTPs units use to increase the synchronization of engineers within the C2 nodes follow.

The Division Engineer Main CP

The division engineer (DIVEN) MAIN CP serves as the nucleus of the division engineer C2 organization. To mitigate staff inexperience and personnel shortfalls, successful units establish the DIVEN MAIN CP as the hub of information collection, analysis, and dissemination. The executive officer (XO) manages the DIVEN MAIN CP and coordinates the efforts of the staff (both officers and noncommissioned officers) during the military decision-making process (MDMP). Soldiers from the S2 and S3 staff sections operate the DIVEN MAIN CP. When conducting the MDMP, the XO includes the S1, the S4, liaison officers, and others in the effort.

At the DIVEN MAIN CP, the S2 and S3 receive reports, develop the situation, and attempt to answer the commander's critical information requirements (CCIR). The staff assembles, packages, and forwards answers to CCIR and other information to engineer C2 nodes. The CCIR form, in part, a filter to screen which information is sent to other C2 nodes, and successful units establish the mechanics of this effort in their SOP. For example, a unit may describe the best way to package CCIR information for the tactical CP engineer. In this way, the DIVEN MAIN CP—

- Maximizes the available staff effort and expertise to collect, analyze, and disseminate information.
- Ties information collection and dissemination to the CCIR.
- Streamlines routine, cyclic reporting requirements for subordinate engineer units.
- Functions as the nucleus of engineer C2 functions in the division.

The Division Engineer Rear CP

Within the division rear CP, the engineer S4 is the officer in charge of the DIVEN REAR CP. The S4 integrates engineer operations among other division logisticians. The S4 understands that main supply routes must remain clear of obstacles, that defensive operations require early planning and transport of Class IV/V obstacle materiel, and so on.

The DIVEN REAR CP requires the same situational awareness as the DIVEN MAIN CP for several reasons. The S4 requires current information so that the DIVEN REAR CP can effectively integrate engineer operations into division plans. Also, the DIVEN REAR CP must be prepared to assume the duties of the DIVEN MAIN CP. And, since the engineer XO assesses the logistics supportability of engineer plans based on the S4's staff estimate, it is essential that the S4's estimate is based on current information.

Accordingly, the DIVEN REAR CP duplicates the battle tracking conducted in the DIVEN MAIN CP. Because staffing at the DIVEN REAR CP often is limited, the integration function of the S4 eventually overtakes the battle-tracking function. When this occurs, the S4 loses situational awareness and the DIVEN REAR CP's plans no longer synchronize with the true picture of the mobility/survivability BOS. The S4's time is best spent integrating engineer operations across the division logistic framework rather than collecting and posting information.

A TTP some units use to maximize the integration function of the DIVEN REAR CP is to proactively "push" information to the DIVEN REAR CP from the DIVEN MAIN CP. Details about which information the DIVEN REAR CP requires and how to package that information are established in the SOP. In some units, the division engineer, the XO, and/or the command sergeant major provide a structured update to their staffs whenever they visit an engineer C2 node. This practice can have a marked positive effect on the situational awareness and battle-tracking accuracy of engineer CPs. To assist in achieving this common picture, the battle-tracking charts at the DIVEN MAIN and REAR CPs are identical.

The Assistant Division Engineer

The assistant division engineer (ADE) is the division engineer's primary point of contact regarding division plans and current operations cells in the division main CP. The ADE plans future engineer operations and often integrates mobility and survivability issues in the division deep operations coordination cell. An effective TTP to maximize the ADE's integration and planning functions is to push critical information to the ADE on the same basis as information flows to the DIVEN REAR CP.

Most units recognize that the ADE cannot perform planning and battle-tracking functions simultaneously. Accordingly, they limit the ADE's duties to planning. In some units the engineer XO, rather than the ADE, is responsible for briefing the division commander during his morning update brief. This frees the ADE to continue planning and provides him with "ground truth" as the DIVEN MAIN CP, through the XO, understands it. The XO pushes information to the ADE throughout the MDMP. This practice allows parallel planning and helps to ensure that the ADE and DIVEN MAIN CP have a common understanding of the enemy, the terrain, and friendly engineers.

It is imperative, however, that the DIVEN MAIN CP pass along only *critical* information. The ADE, like the S4, is not staffed to wade through unit status and logistics reports or dozens of electronic mail messages. Here, as with other engineer C2 nodes, experience and attention to the CCIR help define what the ADE needs to know. What information is important will vary based on the tactical situation and the commander's needs.

The Division Engineer Tactical CP

Most divisions establish a TAC CP as a matter of course. Engineers staff the DIVEN TAC CP within the TAC CP. In some units the engineer S3 works from this CP all of the time. In other units he remains in the DIVEN MAIN CP and assists at the TAC CP during major operations. In either case, the function of the TAC CP is to *fight the close battle*.

According to FM 5-71-100, forward engineer units report directly to the DIVEN TAC CP during the close fight. Action in the TAC CP is fast-paced, and the S3 quickly develops a sense for what information he needs to synchronize these engineers. Information requirements for the DIVEN TAC CP typically are smaller than those for the other engineer C2 nodes. For example, during offensive operations the S3 may only require the location of friendly engineer units; the status of sapper squads, mine-clearing line charge systems, and bridging assets; and the location and type of friendly and enemy obstacles. In some units this information is known as a "slant report." The point is that the S3 must carefully craft the information the TAC CP requires and let the DIVEN MAIN CP process the rest.

Forward units continue to send *routine* information to the DIVEN MAIN CP. Again, the DIVEN MAIN CP pushes information to the DIVEN TAC CP to assist the S3 in fighting the close battle. The S3 and the XO develop the list of information requirements for the DIVEN TAC CP based on the CCIR, and package it in a form that is immediately usable by TAC CP personnel.

As the Army shifts to the new heavy division design and as more information automation equipment finds its way into command posts, the functions of the divisional engineer C2 nodes will evolve. The DIVEN MAIN CP currently is the most robust of these C2 nodes in terms of both manning level and experience. Units that rely on the DIVEN MAIN CP to collect, analyze, and disseminate information enable the other C2 nodes to focus on their primary mission, whether that is to plan future engineer operations, integrate engineer plans into the combat service support structure, or track the close fight. Units that rely on the DIVEN MAIN CP to be the nucleus of the engineer C2 function realize increased synchronization and more effective utilization of engineers across the division.

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

Training Base Expansion: An Active-Reserve Partnership

By Lieutenant Colonel Allen C. Estes and Second Lieutenant Kenneth Caubble

Training units at Fort Leonard Wood experience a surge of trainees each summer that stretches and sometimes exceeds the resources available in the authorized training base. The solution has been a training base expansion (TBE) mission where U.S. Army Reserve soldiers from the 98th Division (Institutional Training) stationed throughout New York state provide the additional capacity. The relationship between Fort Leonard Wood and the 98th Division is one of the best active-reserve partnerships in the Army. Both sides win. The Active Component is augmented during the summer surge, and the Reserve Component receives a top-notch, two-week annual training experience. Their combined efforts result in the Army's newest soldiers.

Organization

Rather than augment existing companies with more drill sergeants, the training battalion activates an additional company for the TBE period. The 98th Division provides enough cadre for a complete training company, which includes a commander, an executive officer, a first sergeant, 12 drill sergeants, a supply sergeant, an operations sergeant, and an armorer. The entire cadre rotates every two weeks. To provide continuity and stability, the activated TBE company has a mix of active and reserve cadre members.

Figure 1 shows the typical TBE company organization, where the 98th Division provides the commander, the first sergeant, and half of the drill sergeants. The Active Component provides the executive officer and the other half of the drill sergeants, including the senior drill sergeant, who coordinates most of the training. The company staff (operations, supply, and armorer) are a mix of Active and Reserve Component personnel. Meanwhile, the rest of the reserve cadre backfills existing companies. For example, if the active executive officer for the TBE company is from Charlie Company, then the reserve executive officer backfills the vacant spot. Each company in the battalion has Reserve Component personnel assigned during the TBE mission.

Fort Leonard Wood's 169th Engineer Battalion (One-Station Unit Training [OSUT]), for example, recently formed an Echo Company, which was led by company commanders from the 1/390 and 2/390th Battalions from the 2nd Brigade, 98th Division. Echo Company was activated on 27 April 1998, executed a complete 13-week cycle of OSUT for 12B

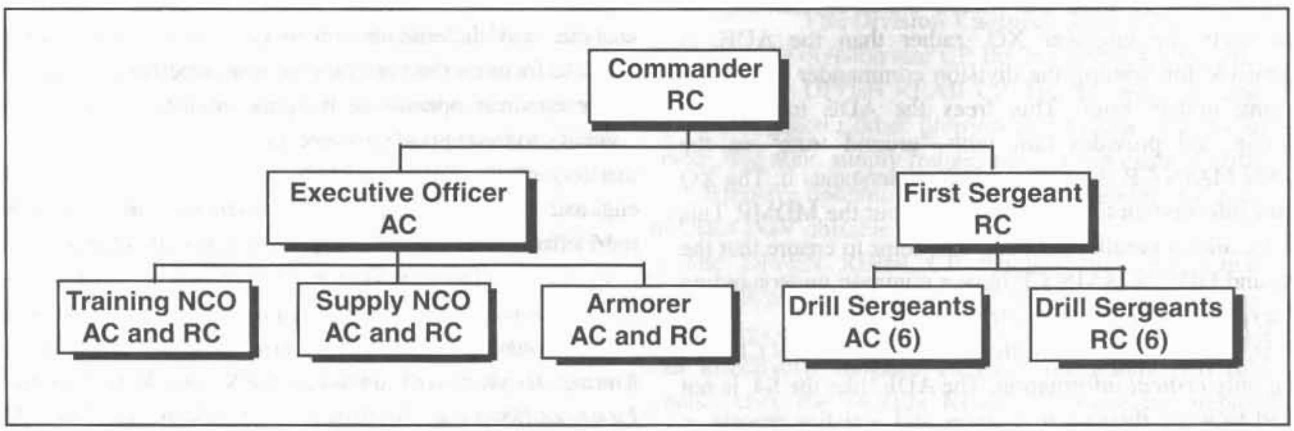


Figure 1. Organization of the TBE company

OSUT trainees negotiate obstacles on the Confidence Course

provides continuity and allows trainees to see some of the same faces throughout the entire cycle. The TBE company conducts the same training to the same rigorous standards as any other OSUT company. The reserve drill sergeants are partners and participate fully—they teach classes, counsel soldiers, run ranges, and perform such mundane details as KP (kitchen police) and CQ (charge of quarters).

There is a one-day overlap between rotations. During that transition period, incoming and outgoing cadre share information, sign over equipment, and conduct a formal but quick change of command. The outgoing rotation conducts an after-action review with the battalion commander and turns over the continuity book. The incoming rotation receives a legal orientation, safety classes, and commander briefings. Meanwhile, soldier training does not cease or even slow down. To ease the transition, reserve soldiers arrive with their driver's licenses, defensive driving course cards, range safety cards, and updated training records.

Combat Engineers and 12C Bridge Crewmembers, and was inactivated on 31 July. The mission included eight separate cadre increments, or rotations, over 16 weeks. Figure 2 shows the role of each increment.

Coordination

The TBE executive officer and senior drill sergeant are critical members of the team since planning must extend past the two-week rotations. Coordination and arrangements for field training exercises (FTXs) and graduation are completed six to eight weeks in advance. Using some Active Component personnel in the TBE company

Preparation

The TBE mission requires significant preparation from both the Active and Reserve Components. The 98th Division prepares extensively throughout the year with

Increment	Week	Activity
1	1 2	Activation ceremony, mission preparation Company fill
2	3 4	Unit-taught subjects, drill and ceremony, Army Physical Fitness Test First aid, map reading, NBC
3	5 6	Rifle marksmanship, weaponeer, zeroing, field fire Rifle qualification, U.S. weapons, hand grenades
4	7 8	Basic FTX, individual tactics, night ranges Confidence Course, bayonet training, hand-to-hand combat
5	9 10	End-of-Course Test, drill and ceremonies competition, basic graduation Demolitions, accident avoidance, combat construction
6	11 12	Landmine warfare, medium-girder bridge, battle drills Bailey bridge and armored vehicle-launched bridge training
7	13 14	Ribbon bridge and armored combat earthmover training Combat engineer FTX, End-of-Course Comprehensive Test
8	15 16	Final inspection, out processing, graduation Inactivation ceremony, closeout procedures

Figure 2. Schedule of TBE increments for a 12B/12C OSUT cycle

weapons qualification; nuclear, biological, and chemical (NBC) training; drill and ceremonies; common task training; field training exercises; physical training; and instruction preparation. The 169th Engineer Battalion and the 98th Division coordinate year-round. As the mission approaches, the 169th sends a mobile training team to New York to answer questions and address specific training needs. This allows face-to-face contact with team members, most of whom have never met. Given the Active Component turnover, it is difficult to use the same experienced personnel from year to year. However, many of the reserve drill sergeants have been coming to Fort Leonard Wood for more than a decade.

The reserve company commander for the first TBE increment goes to Fort Leonard Wood for the cycle laydown. At that time, training events are scheduled, resources are allocated, and training areas are assigned. Once the TBE laydown is complete—along with laydowns for companies that will be backfilled—reserve drill sergeants know which training will take place during their two-week rotation, and they can prepare in detail.

Meanwhile, Echo Company cadre at Fort Leonard Wood prepare the orderly room, purchase supplies, establish accounts, and prepare barracks for the new company. The 98th Division sends a series of S3 liaison officers and noncommissioned officers before activation to help prepare for a successful mission. The 169th and the 98th Division conduct weekly conference calls to coordinate details and provide information for upcoming increments.

The TBE mission culminates with the graduation of the OSUT cycle of trainees, where a motivated and disciplined group of 12B and 12C soldiers are ready to make an immediate contribution to their Army units. The final increment closes the orderly room and billets, replenishes supplies, conducts the inactivation ceremony, and makes initial preparations for next year's mission. After-action comments are compiled and the 98th Division hosts a conference in New York, where all participants discuss lessons learned and suggest procedures to improve the next mission.

Lessons Learned

Key lessons learned from the recent TBE mission follow:

- Coordination among first sergeants on barracks rules, policies, and areas of responsibility is key to success. The TBE company rarely has its own barrack since it would be vacant nine months of the year. If an Active Component company has a small fill of soldiers, that company shares its barrack with the TBE company. If all companies have large classes in session, the TBE company splits and one platoon occupies each of the barracks.
- The 98th Division liaison officer must arrive well before the mission begins. He opens accounts, arranges billeting, coordinates transportation, and ensures that each increment of TBE cadre receives logistical support. The division liaison officer is one of the most important individuals in the entire mission.
- Reserve drill sergeants must do everything expected of active drill sergeants so the two will be viewed as equal in the eyes of trainees. Reserve drill sergeants should pull their fair share of duties but no more. A successful technique is to put TBE drill-sergeant slots on DA Form 6 (Duty Roster) and rotate each increment into those spaces. During physical training, the 1st Engineer Brigade wears specially purchased red road-guard vests with white name tags. The brigade purchased vests for TBE cadre and had name tags made and sewn on before the cadre arrived. Any action that makes the reserve cadre indistinguishable from the active cadre pays big dividends.

Conclusion

The TBE mission can only succeed through teamwork and frequent communication. Reserve Component soldiers must coordinate with their civilian supervisors to attend annual training. Active Component personnel must provide accurate and timely information on the training cycle. There are many moving pieces and lots of opportunities for error. The TBE works because of a spirit of cooperation and constant coordination. The training base expansion is an ideal example of how the Active and Reserve Components can work as equal partners to perform a difficult mission.

Lieutenant Colonel Estes commands the 169th Engineer Battalion at Fort Leonard Wood. Previous assignments include S3, 36th Engineer Group; and S3, 43rd Engineer Battalion. LTC Estes is a graduate of the United States Military Academy and holds a doctorate in civil engineering from the University of Colorado.

Lieutenant Caubble is executive officer of C Company, 169th Engineer Battalion, and serves as executive officer of the TBE company. He is a graduate of the Engineer Officer Basic Course and holds a degree in civil engineering from Arkansas State University.

Cracking the Code on Class IV/Class V Supply Point Operations

By Captain Mark T. Martinez

Cracking the code on how to plan and conduct Class IV/Class V supply point operations on the battlefield can be painful and, if not done correctly, can cause a lot of finger pointing during after-action reviews (AARs). A challenge for any brigade is to develop a standing operating procedure (SOP) for running a Class IV/Class V supply point, identify those responsible for planning and running it (called "pinning-the-rose"), and train those individuals with the rest of the brigade according to the SOP. This article describes how the 3rd Brigade Combat Team (3BCT), 1st Armored Division, Fort Riley, Kansas, cracked this code during their train-up for, and deployment to, the National Training Center for Rotation 98-08.

Doctrine Guidance

What was once known as the engineer forward supply point (run by an overworked, sleep-deprived engineer assault and obstacle platoon leader) is now the task force Class IV/Class V supply point. It is run by the maneuver S4. According to guidance in FM 90-7, *Combined Arms Obstacle Integration*, page C-9, this central receiving point for all obstacle material in the task force sector is established and operated by the task force, not the engineers.

"Pinning the rose" on the task force S4 is sometimes difficult. He is not trained for this task, and his chain of command may view Class IV/Class V operations as an engineer's job. When the task force pawns this task off on its organic engineers, it degrades engineer capabilities on the ground. We must educate our maneuver brethren to correctly use their engineer assets by taking ownership of the Class IV/Class V supply point.

Make It Simple

The first thing engineers must do to educate the brigade's maneuver personnel is to condense complex information in field manuals and all of the algebraic planning factors into easily understood and executable concepts. The 3BCT uses acronyms (Figure 1) to simplify these planning factors and PowerPoint slides to present them.

Simple to Plan

In the 3BCT, each task force S4 and XO is given what the engineers call a "WELCOMES" card that outlines planning considerations a task force S4 must observe to conduct a successful Class IV/Class V supply point. The acronym "WELCOMES" means the following:

W = Work Detail. The 3BCT SOP calls for one noncommissioned officer in charge (NCOIC) and 20 soldiers to form a work detail. The NCO is not an engineer and usually is from the task force S4 shop. The 20 soldiers make up three crews. The unloading crew downloads wire and mines from Corps throughput assets, and the uncrating crew uncrates mines, inspects them, and configures them into push packages. The loading crew then loads the push packages onto task force transportation assets for transport to forward mine dumps.

TF Class IV/V Supply Point Planning Card

W ork detail
E quipment
L ift assets
C ommunication
O rganized layout
M edical support
E ngineer expertise
S ecurity

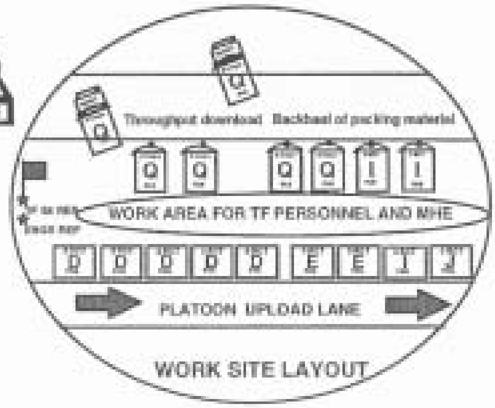


Figure 1

"Planning and running a Class IV/Class V supply point is like having a tooth pulled—no matter how many times you do it, it's still not much fun."
A task force S4

AAR Comment. Use the task force's heavy expanded mobility tactical vehicle (HEMMT) to transport push packages.

E = Equipment. Equipment required to run the supply point includes wire gauntlets for each soldier, banding machines, tin snips, crowbars, and engineer tape. Material required to lay out the site includes bicycle flags or a hand-emplaced minefield-marking set, engineer tape, green and red chemlights, and a picket pounder (Figure 2). A warm-up or sleep tent also may be needed.

AAR Comment. Each TF S4 shop should maintain a footlocker with this necessary equipment that can be easily transported to the Class IV/Class V supply point site.

L = Lift Assets. According to the 3BCT SOP, the task force S4 requests materiel-handling equipment (MHE) and additional transportation assets from the forward support battalion's support operations officer. The Class IV/Class V supply point belonging to the task force responsible for the main effort has priority for receiving lift assets.

AAR Comment. During the planning process, units should war-game and "rock drill" moving the MHE to the Class IV/Class V supply point. Ensure that the forklift operator is equipped with night-vision goggles for night operations.

C = Communications. The task force S4 maintains communications with the task force tactical operations center (TOC). The engineer representative at the Class IV/Class V supply point maintains communications with engineer platoons and the engineer company TOC. The engineer company TOC maintains communications with the engineer S4 on the engineer battalion administrative/logistic (A/L) net. This communication web is driven by the unit's signal plan and varies with each unit.

AAR Comment. A good retransmission plan for the battalion A/L net is essential for this to work.

O = Organized Layout. The 3BCT uses the palletized load system to deliver Class IV/Class V supplies. A standard layout was developed to give the task force S4 a baseline for using this system effectively (Figure 2). During the National Training Center rotation, each task force S4 revised the standard layout according to the mission, enemy, terrain, troops, and time available (METT-T).

AAR Comment. Mark this layout clearly before night operations, because vehicles that wander into the work area after dark pose a serious safety threat to personnel.

M = Medical Support. The task force S4 must coordinate for medical support and develop an evacuation plan. The task force Class IV/Class V supply point NCOIC maintains a list of trained combat lifesavers in each work group and the battle roster of all personnel at the supply point.

AAR Comment. The medical support plan must be synchronized with the task force scheme of support for that phase of the operation.

E = Engineer Expertise. Each engineer company supporting the task force in sector provides an engineer NCO representative to the task force S4. This NCO is not the supply

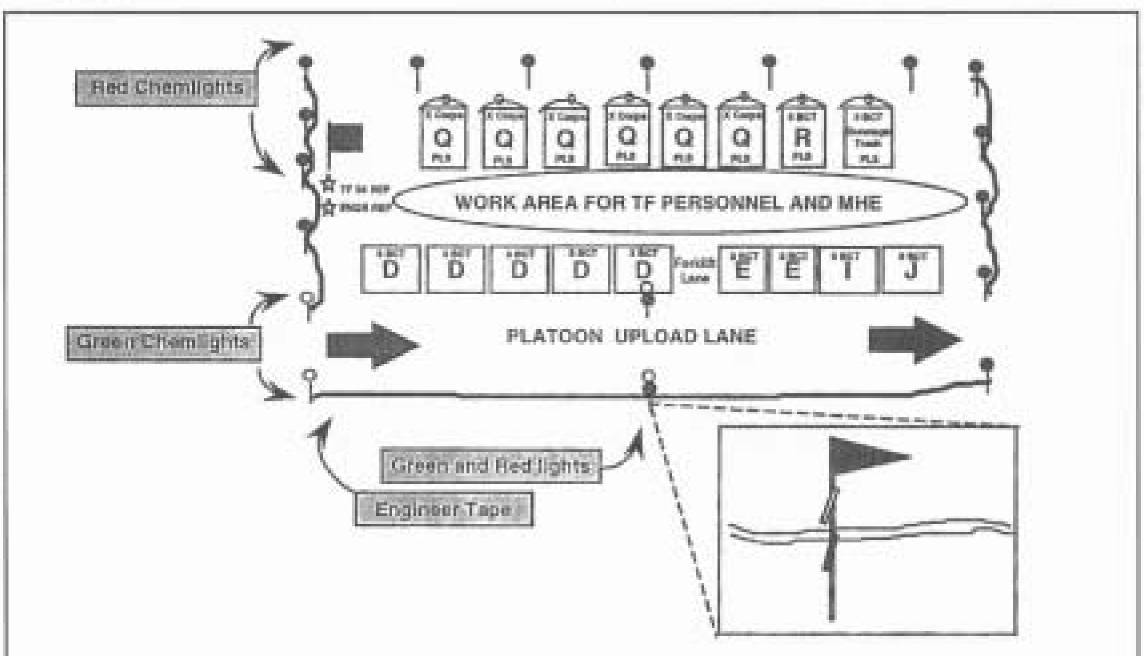


Figure 2

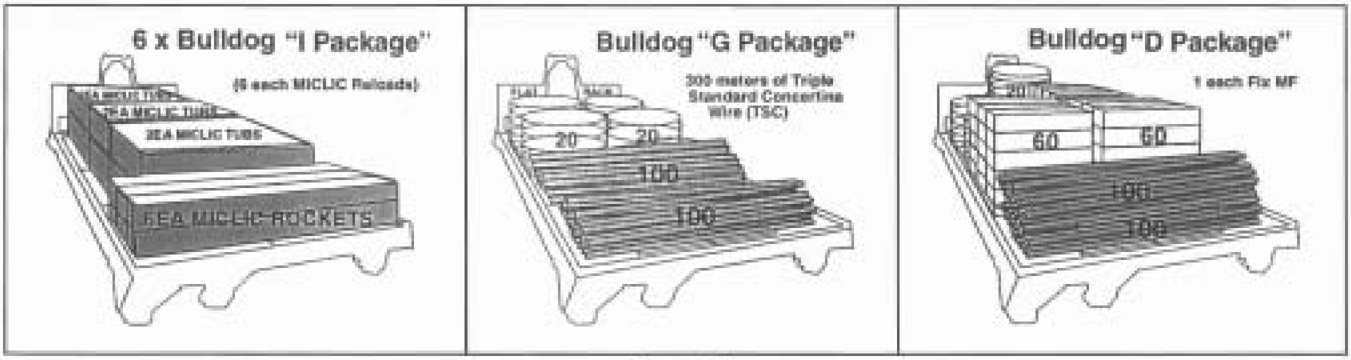


Figure 3

point NCOIC and does not supervise the work detail. He provides technical expertise for the push-package configuration; oversees the handling of mines, fuses, and antihandling devices; and monitors and records the quantities of Class IV/Class V supplies at the site.

AAR Comment. Use the same NCOIC each time, so he will build a good working relationship with the task force S4.

S = Security. The task force S4 and staff, in cooperation with the engineers, selects a Class IV/Class V supply point location that can be easily defended against both mounted and dismounted troops. The S4 develops and enforces the site security plan. The task force provides a security force for the supply point.

AAR Comment. This task often is given only "lip service." The task force must initiate a security plan. Losing the Class IV/Class V supply point to "dismounts" has grave consequences.

Simple to Run

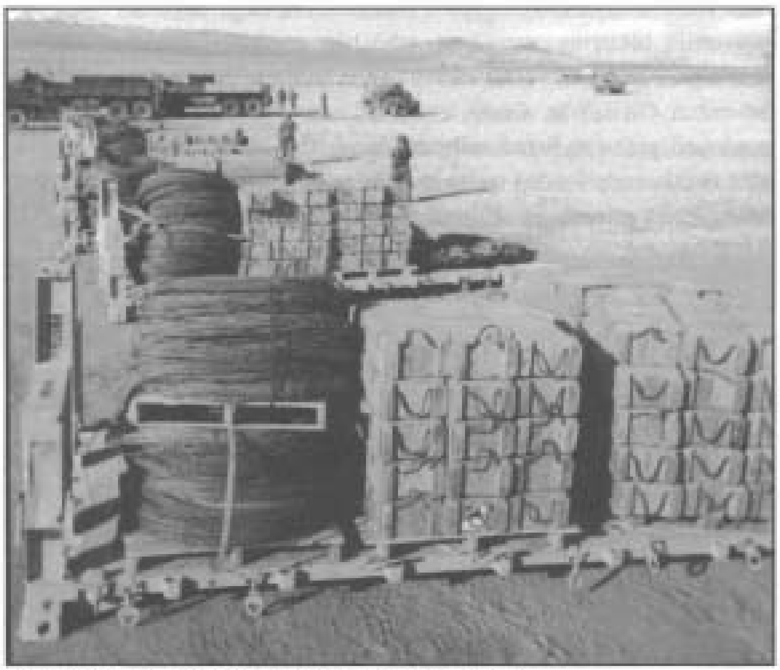
A plan is only good until the line of departure, so keep it as simple as possible. FM 90-7, page 8-9, states that most brigades and regiments in the U.S. Army use push packages to simplify and expedite planning and resourcing of Class IV/Class V supply points. Push packages are the most efficient way to get the right amount of wire and mines to the right spot on the battlefield, especially when you are 72 hours into your failed sleep plan.

The 3BCT takes the push-package concept one step further and provides the task force S4s with a "cookbook" that describes the push packages (Figure 3). Each page shows a picture of the material required for a particular type of obstacle. To facilitate building and transporting, the page also shows how the material is arranged on the palletized load system flatrack. At the National Training Center, this cookbook was extremely helpful in recovering and reconfiguring push packages so they could be used again in the next fight. For example, the task force S4 used the cookbook to provide a picture of the "G Package" to the supply point NCOIC and asked him to build a number of them. In this case, one picture is worth a thousand directives.

Sustain the Fight

The Class IV/Class V supply point plays a key role in sustaining the fight. This fact sometimes is overlooked until the call comes to end the mission, and then it becomes a reaction drill to recover lost barrier material. An easy way to plan recovery operations is to use the four "Rs": retrieve, reconsolidate, reconfigure, and reintroduce. When transitioning from the defense, the implied task for the task force can be: "Conduct battlefield recovery operations using a collective effort to retrieve, reconsolidate, reconfigure, and reintroduce Class IV/Class V supplies into the battle." To recover obstacle effects, reconfigure the packages, and reintroduce them into the fight is essential in conducting sustained defensive operations. The Class IV/Class V supply point should be the cornerstone for this operation, and the task force S4 must be trained in recovery operations.

(Continued on page 50)



Push packages loaded with obstacle material.

The Origins of Military Mines: Part II

By Major William C. Schneck

Part II of this series traces the origins of antivehicle mines and countermine equipment. Though it may seem odd, the explosive antivehicle mine predates the appearance of the tank by more than 50 years! The continuous evolution of these weapons is driven by the defender's need to economize his forces while protecting them from attack. This, in turn, drives the development of the countermine equipment that attackers must have to successfully retain their mobility.

Antivehicle Mines

One of the earliest antivehicle "mines" was described by military engineer Philo of Byzantium around 120 B.C., when he recommended that "in front of the advanced walls (of a city) empty earthenware jars should be buried. These are placed in an upright position with their mouths upward, stopped up with seaweed or imperishable grass, and covered with earth. Troops may then pass over the jars with impunity, (but) the engines and timber towers brought up by the enemy will sink into them."[1] Another early example occurred during the Roman siege of Jerusalem in 70 A.D., when Jewish Zealots dug a tunnel mine under one of the besieger's four massive siege engines (powerful battering rams on wheels), resulting in its destruction and a three-day delay in the battle.[2] During the American Civil War, Confederate soldiers developed and employed pressure-fuzed railroad mines that destroyed at least two heavily loaded trains in Tennessee.[3] To counteract the railroad mines, the Union Army improvised the first mine-clearing roller, a flatcar pushed slowly in front of a locomotive to detonate any mines ahead of it.[4]

A German World War I vintage antitank mine lifted by U.S. combat engineers prior to its destruction. (Photo courtesy of *Military Engineer* magazine)

Antitrack (Pressure-Fuzed) Mines

German pioniere (combat engineers) improvised the first antitank (AT) mines during World War I in response to another innovation in combat engineering—a British-made tank developed in September 1916 by Lieutenant Colonel E. D. Swinton, Royal Engineers (RE). Initially, the Germans buried standard artillery and mortar shells with a sensitive fuze pointed up. They also employed command-detonated mines, which are forerunners of full-width-attack AT mines. Later in World War I, the Germans improvised many types of mines, including a wooden box mine that measured approximately 14 by 16 by 2 inches and weighed about 12 pounds. Twenty 200-gram blocks of explosive were placed in each box, which was normally buried about 10 inches deep. Detonation was initiated by a hand grenade placed inside and against one wall of the box so that the primer passed through the wall. The mines functioned by pressure as tanks passed over them or by command detonation. Electric blasting caps, which first appeared in 1900, greatly facilitated command detonation.[5] During World War I, Germans scattered their AT mines at random or in locally created patterns to reinforce wire obstacles and AT ditches in front of trench lines.[6]

The Germans began to manufacture standard AT mines in 1916 and produced nearly three million before the Armistice of 1918. Regrettably, no information on the characteristics of these factory-produced mines has come to light. German AT mines accounted for a significant portion of allied tank losses, including about 15 percent of U.S. tank casualties, during the battles of St. Mihiel, Catalet-Bony, Selle, and Meuse/Argonne.[7] The British also improvised AT mines during World War I. Two varieties have been identified: one based on a pipe bomb and the other on a bombard shell.[8] In 1929, the Germans introduced the Tellermine 29, the first in a series of modern pressure-fuzed AT mines. This series formed the basis for many of the AT mines used to date, including the U.S. M15.

Table 1. Origin of Mobility Equipment

Equipment	First Prototype	First Production	First Combat Use
Bangalore torpedo	U.K., 1912		U.K., Western Front, WWI
Tank mine roller	U.K., 1918	U.S.S.R.	U.S.S.R.,
Tank mine plow	France	U.K.	U.K, Sword Beach, WWII
Electronic mine detector	France		Germany, Polish Campaign, 1939
Vehicle-mounted electronic mine detector	France, Pre-WWII	U.S.	U.S.
Flail	U.K., 1942	U.K., 1943	U.K., 2d El Alamein, 1942 (24 prototypes were used in this battle.)
Remote-control breaching	France	Germany, 1940	Germany, Sevastopol, 1942
Demolition snake	Canada		U.S., Anzio, May 1944
Projected line charge	U.K., 1944	U.K., 1944	U.K., Calais, September 1944
Mine-resistant wheeled vehicle	U.K., 1941	Sweden, 1940s	U.K., North Africa, 1941
Scatterable mine-clearing system	France, 1980s	Israel	
Full-width mine rake	U.S., 1990	U.S., 1990	U.S., Gulf War, 1991

Antihull (Full-Width-Attack) Mines

The Russian AKS, a tilt-rod-actuated blast AT mine that appeared on the Russian front during World War II, was probably the first true full-width AT mine. However, the Germans developed the first modern full-width-attack mine toward the end of World War II. Called the Hohl-Sprung Mine 4672, it employed a tilt-rod fuze and shaped-charge kill mechanism.[9] Although 59,000 of this mine were produced, there are no reports that it was ever used in combat.[10] Nevertheless, it represented a significant improvement in mine technology. The French probably were first to field a modern full-width-attack mine when the Model 1948 entered service in 1948.

Another important advance in the evolution of the full-width AT mine was the Russian development of influence fuzing, both seismic (VZ-1) and magnetic, during World War II.[11] This combination of a shaped charge with a full-width-attack fuze has proven extremely effective. Its greater coverage enables emplacing units to get the same obstacle effect with significantly fewer mines per kilometer of front. Additionally, this type of mine often produces a K-kill (catastrophic kill), with fatalities to crew members of all vehicles, including tanks and other tracked vehicles. This lethality definitely decreases the willingness of combat vehicle crews to "bull through" a mined area.

Side-Attack Mines. The advent of shoulder-fired AT weapons, beginning with the U.S. bazooka in 1942, led to the development of side-attack AT mines. First employed by the Germans and Soviets during World War II, these mines were based on the Panzerfaust.[12] The early Soviet-made LMG reportedly is still being used by North Korea.[13] This type of mine is difficult to employ due to its large size and because it must be emplaced aboveground.

Wide-Area Mines. The predecessor of the wide-area landmine—one that sends a munition toward its target without human guidance—is the Russian "dog mine" of World War II.[14] Advanced wide-area mines are now emerging in Western Europe and the United States.[15]

Mine-Emplacement Systems

The Italian AR-4 Thermos Bomb (also called Antipersonnel (AP) Bomb Manzolini) was one of the first scatterable mine-laying systems used in combat. Scattered by aircraft, it was used fairly extensively in North Africa from 1940 to 1942).[16] Another early scatterable mine was the German SD-2B Schmetterling (butterfly). It was used effectively against the Poles in September 1939. Both types employed antidisturbance and time-delay fuzing. The Germans also developed a cluster-bomb version of the SD-2 that had airburst or impact fuzing. An aircraft-dropped bomb container could carry 24 Thermos bombs as a submunition. The Schmetterling could be carried as submunitions in the following cluster-bomb containers: AB 23 (23 SD-2s), the AB 250-3 (108 SD-2s), the Mk 500 (6 SD-2s), and the AB 24t (24 SD-2s).[17] In addition to Poland, the Schmetterling was used in France, North Africa, Italy, England, and Russia.[18] It could be dropped by one of 15 Luftwaffe groups equipped with specially modified aircraft (Ju-88s, Do-17s, Me-109s, or Ju-87s).[19] The U.S. Air Force copied this mine, called it the M-83, and used it against Germany and later in Korea[20] and Vietnam.[21] In Germany, Krupp developed (but did not field) the first mechanical mine planter, which was towed behind a Tiger tank.[22] The U.S. Marine Corps developed the first air-scatterable AT mine—the Douglas Model 31 from 1952 to 1958. The first one to enter production (in 1975) appears to be the U.S.-made UH-1 helicopter-mounted M-56 system, which used the M-34 AT mine.[23]

Table 2. Origin of Countermobility Equipment

Mine/Fuze Type	First Prototype	First Production	First Combat Use
Tunnel mining			Assyria, ~1000 BC
Caltrops			Greece, 330 BC
Explosive tunnel mines			Florence, 1403
Self-contained AP mine	China, 1277	China, 1277	China, 1277
Electric command- detonated mine	France, 1858		France, Sevastopol, 1858
Blast AT Mine	Germany, 1917	Germany, 1918	Germany, Western Front, 1917
Bounding AP mine	U.S., 1859	Germany, 1930s	Germany, West Wall, 1939
Chemical mine	U.K.	Germany, WWII	
Flame mine	Confederacy, 1864[1]	U.S.S.R., 1943	U.S.S.R., Kursk, 1943
Mechanical boobytraps	China, 1277	Confederacy, 1864[1]	China, 1277
Side-attack AT mine	Germany, 1943	U.S.S.R., 1943	Germany, Eastern Front, 1943
Full-width-attack AT mine	Germany, 1945	France, 1948	
Fixed-wing aircraft- scattered AP mine	Germany, 1930s	Germany, 1930s	Germany, Polish Campaign, 1939
Fixed-wing aircraft- scattered AT mine	U.S.	U.S., 1960s	U.S., Southeast Asia, 1960s
Helicopter-scattered AP mine	U.S., Vietnam	U.S.S.R., 1970s	U.S.S.R., Afghanistan, 1980s
Helicopter-scattered AT mine	U.S., 1970s	U.S., 1975	USSR, Afghanistan, 1980s
Tube artillery-scattered mines	U.S., 1970s	U.S., 1970s	U.S., Gulf War, 1991
Rocket artillery-scattered mines	U.S.S.R., 1970s		U.S.S.R., Afghanistan, 1980s
Vehicle-scattered mines		U.S., 1970s	
Manpack-scattered mines		U.S., 1990s	
Radio-controlled mines		U.S.S.R., 1941	U.S.S.R., 1942
Tilt-rod fuze		U.S.S.R., 1941	U.S.S.R., 1941
Daisy-chained mines	Finland, 1939		Finland, 1939
Coupled mines	Germany, 1942	Germany, WWII	Germany, North Africa, 1942
Boosted mines	Germany, 1942		Germany, North Africa, 1942
Breakwire fuze		U.S., 1960s	U.S.S.R., Afghanistan
Tripwire fuze	Germany, 1573	Germany, 1939	Germany, 1500s (?)
Railroad mine	Confederacy, 1862[1]	Germany, WWII	Confederacy, Civil War, 1862[1]
Electronic boobytrap		Yugoslavia, 1980s	Yugoslavia, 1990s
Low-metal mine		Finland, 1939	Finland , 1939
Influence fuze		U.S.S.R., WWII	U.S.S.R., WWII
Antihandling devices		Germany, 1930s	Germany, WWII
Mechanical mine planter	Germany, WWII	U.S.S.R., post-WWII	
Blast-hardened mines		Italy, 1980s	Mujahideen, Afghanistan, 1980s
Antihelicopter mine	Viet Cong, Vietnam War		Viet Cong, Vietnam War
Integral electronic antihandling device		Italy, 1980	

[1]Confederate States of America, 1861-65.

Countermines

The original countermines were tunnels dug by besieged defenders to disrupt enemy mining efforts. A countermine was successful when an enemy tunnel was intercepted. Inevitably, a confused, close-quarters fight in the dark followed, as the two sides fought to control the tunnel.[24] One example of this occurred during the siege of Barca about 510 B.C. "The Persians excavated underground tunnels that reached the walls. Among the Barcaeans there was a skilled worker in brass who took a brazen shield and, carrying it round within the wall, applied it here and there at places where he thought the workings might be. Where there were no mines the shield was silent, but at places near mining operations the shield made a vibrating sound. By countermining at these points, the Barcaeans broke into the enemy's works and slew the men they found there."[25]

Explosive Countermines. The first identified use of an explosive countermine was during the siege of Belgrade in 1433, when John Vrano used black powder in a countermine against the Turks.[26] In this application, the intent was to dig close to the enemy's mine gallery and emplace and detonate a charge that would collapse the tunnel and kill the miners. This type of explosive countermine was used up to World War I.[27] During the Thirty Years War in central Europe (1618-1648), some defenders released poisonous antimony gas into tunnels to kill miners.[28]

Manual Breaching. The first deliberate breach of a minefield was by Colonel Serrel's 1st New York Volunteer Engineers at Fort Wagner, South Carolina, in August and September 1863 during the Civil War. Union sappers literally dug their way through the minefield using traditional siege warfare techniques.[29]

Mine Plows, Rakes, and Detectors. In 1918, the French developed the first plow-equipped tank, which was based on a Renault FT-17 tank.[30] However, plow tanks were not used in combat until D-Day in 1944, when the British 79th Armored Division employed a "Bullshorn" plow on a Churchill tank at Sword Beach.[31] Modern versions used by most countries, including the United States, are based on an Israeli design. The highly successful full-width mine rake was first developed and used by the United States during Operation Desert Storm.

The Germans, French, Russians, and Italians entered World War II with metallic mine detectors, but information on the details of their origin is lacking.[32] During the interwar years, the French developed the first vehicle-mounted electronic mine detector on an R-35 tank.[33]

Bangalore Torpedo. Captain McClintock—an engineer officer in the Bengal, Bombay, and Madras Sappers and Miners—invented the bangalore torpedo in 1912. Its purpose was to counter problems caused by the rise of barbed-wire obstacles during the Boer War (1899-1902) and the Russo-Japanese War (1904-1905). The torpedo, which took its name from Bangalore, India, where it was developed, was originally a 5.5-meter length of pipe filled with 27.2 kilograms of dynamite.[34] Early in World War II, the torpedo was found to effectively clear a path through minefields, and it remains a standard item in most armies. In 1944, the United States began experimentation for a supplemental system that would use a bullet-trap rifle grenade or small rocket to deploy a length of detonating cord,[35] but these devices have not been generally accepted. A more likely successor is the U.S. Antipersonnel Obstacle-Breaching System (APOBS), which is based on the Israeli-developed POMINS.[36]

Mine Rollers and Assault Bridges. At the end of World War I, the British developed a tank-mounted mine roller as a countermeasure against German AT mines. Major Martel (RE) explored the possibility of producing mine rollers and assault bridges that could be used by armored vehicles. Martel was assisted by Major Inglis from the Engineer-in-Chief's branch at general headquarters. Inglis, an engineering professor at Cambridge, had designed a prefabricated tubular mobile bridge to carry tanks across a clear span of 100 feet. Three special tank battalions, one commanded by Martel, were formed at Christchurch in Hampshire, England, in 1918. Each battalion had Mk V tanks designed to accept either mine rollers or to push/pull mobile bridges. Although the armistice came before the units were operational, Martel continued trials with the one remaining unit, called the Experimental Bridging Company, which was transitioned to the civilian-controlled Experimental Bridging Establishment in 1925.[37] The mine roller was first used in combat in 1940, when the Russians used it to help breach Finland's Mannerheim Line.[38] The highly successful Russian Mugalev roller, which first saw action in 1942, was developed based on this experience.[39] Most rollers currently used by former Warsaw Pact countries, Israel, and the United States are patterned after the Mugalev roller.[40]

Snake. The demolition "Snake" was first developed by Major MacLean, a Canadian combat engineer from the 11th Field Company, in October 1941. Originally nicknamed the "Worthington Wiggler" after F. F. Worthington, commander of the 1st Canadian Tank Brigade, it was basically an oversized bangalore torpedo. The Snake consisted of sections of 3-inch diameter pipe loaded with explosives, which could be coupled together in lengths up to 400 feet and pushed as a unit across a minefield ahead of a tank. The subsequent detonation would clear a path through the field. The Snake was demonstrated successfully in February and March 1942.[41] Although the U.S. Army was equipped with a small number of them during the campaign in North Africa, the Snake was first used in combat by the U.S. 1st Armored Division on 23 May 1944 during the breakout from the Anzio Beachhead.[42]

Mine-Clearing Line Charge. A British-made, rocket-deployed, flexible line charge called the "Conger" was developed to overcome the shortcomings of the Snake. The Conger was the first modern mine-clearing line charge. Consisting of 330 yards of specially woven 2-inch diameter flexible hose, it was launched across a minefield by a 5-inch rocket. After the hose was deployed, it was filled with 2,500 pounds of a nitroglycerine-based liquid explosive known as 822C. Because it was so dangerous, the Conger was used in combat only once by the British 79th Armored Division during the battle for Calais on 25 September 1944.[43] Modern mine-clearing line charges like the U.S. M58 MICLIC and the British Giant Viper evolved from this device.[44]

Mine-Clearing Flail. Lieutenant Colonel Colman, a South African engineer, got the idea for a mine-clearing flail when he saw a tracked vehicle drive by with a length of wire wrapped around its sprockets. The wire hit the ground hard with each revolution of the sprockets. Colman's idea was developed by Field Marshal Montgomery's 8th Army in the general headquarters workshops in August 1942. Twenty-four of these flails, called "Scorpions," were first used in combat during several British breaching efforts in the Second Battle of El Alamein.[45] Eventually, the British consolidated the flail and many other specialized armored vehicles in the famous 79th Armored Division. Commanded by General Hobart, RE, this division—known as Hobart's Funnies—was probably the most advanced combat engineering organization ever developed.[46] Modern descendants of the Scorpion are in service in England and are the forerunner of the jointly developed German and Israeli Keiler system.[47]

Remote-Controlled Breaching Vehicles. The first prototype, remote-controlled breaching vehicles for cutting wire obstacles were developed in Germany and France during World War I.[48] The Germans were the first to produce and deploy remote-controlled minefield breaching vehicles by using both an expendable charge-carrying vehicle (the "Goliath") and a nonexpendable vehicle (the B-IV) that was intended to drop its charge and withdraw before the charge detonated. Although these vehicles were used with some success at Sevastopol in 1942 and Kursk in 1943, they were generally considered failures.[49]

Sea Mines

The Chinese first employed sea mines in the 14th century. The oldest known European design for a sea mine was presented by Ralph Rabbards to Queen Elizabeth I in 1574.[50] In the West, the first known employment of sea mines occurred in 1777 when Captain David Bushnell, an American Continental Army engineer, attacked British ships on the Delaware River with floating mines. He also made the first submarine attack in the history of warfare and commanded the Company of Sappers and Miners that stormed Redoubt 10 at Yorktown.[51] Robert Fulton and Samuel Colt both experimented with sea mines in the early 1800s but lost interest when their efforts were not well received by any government. The term "torpedo" was first applied to Fulton's submarine engine. Floating mines were used by the Russians during the Crimean War in 1855 and at Canton, China, in 1857-58.[52] Their first significant employment, however, occurred during the American Civil War, where they were responsible for most of the Union ships sunk.[53]

Antiaircraft Mines

This type of mine is still emerging from the technological shadows. The first improvised antihelicopter mines appeared during the Vietnam War and were used by the Viet Cong on potential landing zones.[54] During the Cold War, the Russians developed an antiaircraft mine based on their surface-to-air (SA)-7/14 missile for use by their special-purpose forces (SPETZNAZ) against NATO airbases.[55] In the 1990s, Britain and the United States had developmental programs for producing "smart" antihelicopter mines that could be deployed to engage low-flying helicopters, but these have been cancelled.[56] However, a Russian company is looking for partners to help fund the development and fielding of the "Temp 20," an antihelicopter mine with a lethal range of 200 meters.[57] Some of the technologies being developed for the Ballistic Missile Defense Office could even be considered orbiting space mines.

Conclusion

This series of articles has explored the origins of military mines and the ingenuity of the engineers who drove their development. (See *Engineer*, July 1998, for Part I.) The evolution of these necessary but unglamorous weapons will continue. Antiaircraft/antihelicopter mines and possibly antisatellite "mines" will almost certainly appear in the future. So far, history has shown that whenever a new means of movement appears in the attacker's repertoire, the military engineer responds with a defensive countermeasure.

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(Continued from page 43)

Sell the Idea

No matter how great his ideas, an engineer is worthless to those he supports if he cannot sell himself and those ideas. Unfortunately for engineers, infantry and armor officers make the final call on the brigade SOP. New ideas are a hard sell, especially to those comfortable with the "old ways." Engineers in the 3BCT developed a PowerPoint slide presentation that shows the Class IV/Class V supply flow on the battlefield. This presentation points out to the task force S4s that the supply point is their responsibility and demonstrates with the "WELCOMES" card how easy their job can be. After the 3BCT commander blessed the concept, it was included in the brigade's noncommissioned officer and officer development plans. Then, with a measurable amount of insistence on the part of the engineers, the Class IV/Class V supply flow was exercised during the home station train-up for the National Training Center. After receiving guidance, the task force S4s took ownership of their supply points and ran them quite well. This achieved the brigade commander's intent to free up the engineers and use the brigade's limited assets to push enough material to keep those engineers gainfully employed on the ground.

Maximize Assets

FM 20-32, *Mine/Countermine Operations*, states that "Mine warfare logistics at the task force level can be complex. It requires prudent use of scarce haul and materiel handling equipment and demands positive command and control." With dwindling resources in personnel and equipment across the Engineer Corps, it is paramount to use all the brigade's assets for Class IV/Class V supply point operations. Training maneuver elements in the brigade before they deployed to the National Training Center paid high dividends for the 3BCT—and it would be time well spent during any brigade's train-up. Key tasks for engineers are to simplify doctrine, assign responsibilities, sell the idea, and train maneuver elements to take ownership of the supply point. When a unit can free engineers from processing mines and mass their efforts on mine emplacement, they have cracked the code on Class IV/Class V supply point operations.

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Through the Breach: A Tanker's Perspective

By Captain Jeffrey Erdley

"Operation Desert Storm showed that our World War II vintage minefield breaching and clearing capability, coupled with the lack of demolition expertise, resulted in an inability to technically or tactically breach the modern minefield that we faced."

Operations Desert Shield/Desert Storm Engineer Observations

Quotes such as this may stir emotions of disbelief in U.S. forces, because all of the breaches during Desert Storm were successful. It is important to note, however, that the majority of our forces (except the Marine divisions and a 2d Armored Division brigade) maneuvered far to the west of the main defenses. In every case, the Iraqi resistance was vastly weaker than predicted—a fact that thankfully negated the 80 percent casualty predictions for U.S. breaching forces.

I served as an acting engineer platoon leader with B/23rd Engineers (1st Armored Division) for a Combat Maneuver Training Center, Hohenfels, rotation and conducted well over 100 breaches as a tank platoon leader, executive officer, and acting commander of armor-heavy teams. I have held both tanker and engineer viewpoints through field training in local training areas and combat training centers and formal schooling at Fort Knox and Fort Leonard Wood. Through my experience, one fact has proven itself over and over: the maneuver arms and engineers lack a common understanding of breaching and only work together when forced to conduct a breach.

Breaching Issues

FM 90-13-1, *Combined Arms Breaching Operations*, lays the framework for a common vision, but the principles of this manual are not always followed or understood by units in the field.

FM 71-2, *The Tank and Mechanized Infantry Battalion Task Force*, states, "Combat engineers are located with the breaching force of the battalion to perform hasty breaches. However, time and distance factors may require a hasty breach by maneuver units without direct engineer participation." Likewise, engineers are often thrust forward of both light and mechanized units and are told to reduce obstacles with little more than direct-fire support. The disjointed guidance may be corrected in future versions of FM 71-2, because engineers don't use the term "hasty," and the new FM 90-13-1 will eliminate each distinct operation (deliberate, in-stride, etc.) and designate them all simply as a "breach."

In my experience, engineer and maneuver soldiers when faced with a breach often view each other as adversaries who get in the way of the mission. An important point is that creating a lane through an obstacle is not conducting a breach; it is one small part of the operation. A breach is a combined arms operation involving not just engineers and tankers but every battlefield operating system (BOS) element. Somewhere in the middle of the engineer and armor "high grounds" is an effective way for these branches to work together to breach an obstacle and continue with an attack. This is where task force and brigade combat team rehearsals and training become essential—before units deploy to the field. It is imperative for the unit to develop a cohesive plan for a breaching operation as early as possible and to bring all participating elements together to orchestrate the complex operation. Through refinement, the breaching plan is developed and captured in the unit's standing operating procedure (SOP) as an effective reference for both maneuver and support units.

Current doctrine does not provide insight concerning an effective middle ground for breaching operations. Most armor manuals reserve a few pages to roller and plow operations and simply state that armor units will get support from the engineers for large obstacles. Engineer manuals are also lacking. For example, the obstacle-reduction capability of tanks is viewed as an afterthought, mainly for proofing. Even FM 90-13-1, the doctrinal bible on breaching operations, barely mentions tank obstacle reduction. It states that plows and rollers are mechanical reduction assets but does not explain how to employ them. FM 20-32, *Mine/Countermine Operations*, devotes one page each to the plow and roller. (Lest we forget how important tanks are, it was the introduction of British tanks that opened the wire and trenches in France to help end the stalemate of World War I.) Since there is no effective manual on the tactical employment of either the plow or the roller, tankers must discover the tactics, techniques, and procedures (TTPs) for unit SOPs and operations on their own. To spur ideas and raise awareness, I offer some personal observations on identifying obstacles, ways to maneuver to them, notes on equipment, and breaching techniques that have proved successful in the field.

Obstacle Intelligence

As with any successful combat operation, a successful breach begins with accurate reconnaissance. Through trial and error, 3-67 Armor learned that the most effective method of locating obstacles, bypasses, and potential reduction sites was to put an engineer in a scout vehicle that overwatched named areas of interest and have him gather obstacle intelligence. Armor battalion scouts know the task force or brigade combat team commander's intent and have the "maneuver view" of how to conduct the operation. But no one has more knowledge of obstacle composition, dimensions, and purpose than engineers. When they are in the same vehicle, armor and engineer soldiers form an efficient team to locate obstacles and locate and mark potential bypasses or create lanes not covered by fire. Other reconnaissance assets, such as the brigade reconnaissance troop, unmanned aerial vehicles, scout helicopters, and combat observation lazing teams, may be available depending on the priority of the mission in the overall scheme of operations.

Breach Operation Planning

Even as reconnaissance personnel are being deployed, the commander and staff must start planning for a breach in every offensive course of action. It is safe to assume that our forces will be under both direct and indirect fire, because the enemy uses obstacles to channel and separate forces just as we do. With the speed of breaching operations in mind, the task force or brigade combat team breach force must maneuver toward the front of the formation. If a breach is imminent, their best location is second in the order of march.

Both FM 17-15, *Tank Platoon*, and FM 71-2 state that the roller tank should lead in a breach, because it is designed to detect minefields. This technique may be effective if units cannot visually identify mines or locate them with the tank's thermal sites. The roller tank may also find enemy scatterable mines. With the density of conventional and scatterable mines, however, the roller tank may be well past the leading edge of the minefield before the roller hits a mine and thus determines the minefield's location.

I have not observed this order of march to be effective, because the roller tank is a massive, lumbering beast that is ill-suited to lead a combat formation. Lead tanks should not have mounted equipment, because they must be killers on point that clear the immediate area for the formation and fix enemy vehicles with direct fire. Tanks with plows and rollers should then move behind terrain or at a safe distance to the rear of the lead tanks.

Within a tank company, the modified table of organization and equipment distributes one plow to each

An A/3-67 Armor M1A1 moving to a company assembly area. Note the deliberate orientation of the gun tube away from the roller assembly.

platoon and a roller on another tank in the company. Since tank platoons rarely maneuver on their own and never maneuver alone in a breach, this division of resources is a serious violation of unity of command that is usually corrected through task organization in the field. The most effective breach forces I have seen have had *all* of the reduction assets massed in one platoon. In a few missions, we attempted to attach this platoon under an engineer company commander. However, these attempts had disastrous results because the units did not use guns in the battle. Tanks were treated as engineer vehicles, and the company's killing capability was reduced by one-third.

To be successful, both maneuver and engineer chains of command must remain intact. Although the maneuver commander commands the breach force, the engineer commander may control the reduction element within that force. This organization allows the maneuver commander to concentrate on the security element and the critical task of controlling direct fire at the reduction site.

Mobility Assets

The equipment available for a breach is not limited to tank and engineer armored vehicle-launched bridges (AVLBs), mine-clearing line charges (MICLICs), armored vehicle-launched MICLICs (AVLMs), bangalore torpedoes, and grappling hooks. A successful breach is a combined effort involving engineers; indirect, counterbattery, and smoke missions of field artillery; mortars; aviation fires; infantry support; and sometimes chemical corps smoke. All these systems are excellent in their own way, but this article concentrates on integrating the M1 tank with mine-clearing plows and rollers with engineers.

Armor Equipment

Armor manuals are fairly weak on describing breaching missions. Three breaching methods are discussed in FM 71-2: employing an M1 tank with a plow/roller combination, using an M88 recovery vehicle with its blade down, and simply driving through. FM 17-15 describes the disastrous method of staggering plow tanks to create wider lanes. This method often leads to a live mine in the spoil that explodes on the second tank. FM 17-15 also instructs tank platoon leaders to use the cleared-lanes marking system (CLAMS). I believe that most of these systems were turned in after they proved to be ineffective.

In my opinion, the most effective method of tank obstacle reduction is with the plow tank. It digs below mines and then uses spoil to push them to the sides. Any vehicle that stays within the track of the tank is safe from mines.

Contrary to the belief of some soldiers, a plow does not necessarily slow a tank during movement. The main planning consideration for plow tanks is to keep them away from wadis, streambeds, bridges without the appropriate military load classification, and other restricted terrain that would impede movement. A tank is much longer with a plow attached and cannot drive through steep dips. If a plow digs in, crews must scrape the mud and dirt off immediately. If they don't, the added weight may cause seals to burst on the suspension in the front of the tank.

Roller tanks have some uses but generally are considered to be more trouble than they are worth in the armor community. Several tank manuals suggest leading an attack with a roller tank to find the leading edge of the minefield. However, anyone who has maneuvered with them understands that an attack with a roller point man would have all the momentum of a lethargic snail. Rollers were designed to be carried to the battlefield on a lowboy trailer, and the receiving tank would already have a mounting kit secured to the front slope. The crew only installs rollers on a tank in the attack position before crossing the line of departure, then it maneuvers through the breach as the proof tank and drops the rollers on the far side to be retrieved later. In this mission, and this mission only, a roller is effective. Prolonged use of a roller is suicide to a tank. During one field exercise, a wingman left the roller on a tank for an entire month because the unit lacked support to transport it. It took about nine months to replace or repair all the shocks and seals of the tank's suspension that were destroyed by the extra weight.

There is a major Class IX supply problem with both the plow and the roller. These systems are not reportable and can lose deadline visibility. Neither system is reportable, so we could order all the parts 02 priority, nondeadline. Even with this priority, the average shipping time for plow parts is about nine months and about a year for roller parts. Crews that cannot repair deadlined systems do not train on them. After a short time, no one in the unit is familiar with the equipment and it is ignored. Even item managers could not help us get parts faster because of the lack of emphasis on this vital equipment.

Engineer Equipment

During most of the heavy task force operations I have been involved with, engineers believed that the best breaching equipment was the MICLIC and the AVLM. The prevailing belief among armor personnel when they saw the MICLIC or AVLM being prepared for the point of breach was: "Get the plows ready, the MICLIC won't work." Engineer after-action reports from Desert Storm contain the following conclusions:

"Units placed an overreliance on the MICLIC as the answer to all their breaching problems. This was due to the ignorance of threat mine capabilities, poor MICLIC training at home station, and the general lack of an effective training device or training strategy."

"The MICLIC system suffered from several serious shortcomings. During test firings the system suffered a 50-percent failure rate."

Even when the MICLIC fires successfully, it can only clear a 100-meter-long path in an obstacle. This is excellent for small obstacles, but not for the deep obstacles found in many breaching operations. FM 90-13-1 acknowledges that the MICLIC has a "skip zone," where mines are left untouched. Also, deeply buried mines, nonpressure-fuse mines, and overpressure-resistant mines are very resilient against the MICLIC. A major advantage of tank-mounted systems is that they can keep going through an obstacle without a lengthy firing process. Since engineers cannot accomplish a breach alone, it is essential that they work closely with tankers to perform the operation.

Reduction Techniques

The possible combinations of breaching assets and methods to use them are almost unlimited. The methods I have used most are the MICLIC/plow tank combination and the plow tank/roller combination. But regardless of the method, all breaches must be the task force's or combat team's main effort. Because an attack hinges on the breach mission, every asset—including most of the ammunition, close air support, fire priority, firefinder radar, and smoke platoons—must be concentrated at this decisive point. Using these assets, the commander must build the breach fundamentals of suppress, obscure, secure, and reduce. To accomplish this, he organizes the breaching unit into support, breach, and assault forces. When forming these forces, he must retain unit integrity and the existing chain of command.

Success hinges on keeping those platoons or companies intact under the maneuver commander, with the engineer commander as a right-hand man. When teams are in place and firing on the enemy, the support force commander calls for indirect fires and smoke missions. His mission dictates a good view of the battlefield, which gives him the best overall view to control these fires. Artillery and armor battalion mortars must be used to the fullest for fires and smoke missions. If they fail, tanks can fire volleys of high-explosive antitank rounds in front of enemy positions to create obscuration from soil. When the effects of all these systems peak, then and only then has the force set the conditions for commitment of the breach force. Regardless of the breaching method used, the end state must be the same: The maneuver force must get through a breach quickly to continue the assault and kill the enemy.

MICLIC/Plow Tank Method

After setting the conditions for commitment of the breach force, most engineers I've observed have moved the plow tank in position in front of the obstacle with the MICLIC directly behind it. In this technique, the MICLIC is the reduction asset and the plow is the proofing system. This technique provides some cover for the MICLIC crew while they are exposed to the enemy for the minutes it takes to raise, lock, fire, and detonate a charge. A well-trained tank crew also may help set up the engineers for success on the MICLIC launch by halting at the correct stand-off distance for launching and then positioning the tank perpendicular to the obstacle. After the explosion, the tank is in position to plow through the obstacle while the enemy is still disorganized from the detonation. While the MICLIC crew is getting ready to fire, the tank crew can drop the plow and verify that it is locked down. Once the rocket is fired, the obstacle is quickly reduced.

From a tanker's perspective this technique works, but it includes actions that could lead to failure for the breach force. It is critical that the attacker place a large volume of fire on the defender during the entire mission. However, with the plow tank directly in front of the breach, where our obscuration smoke and burning enemy vehicles may obscure the enemy's view, his main gun is effectively taken out of the fight. When the enemy sees the tank and MICLIC at the point of breach, he has a large target (two vehicles end to end) to aim at for several minutes. This is when everyone learns if the suppressive fire was effective or not. During this time, enemy forces can destroy the attacker's best tools for getting through the breach and deny the commander the best place to enter the lane. Even if the plow tank crew survives the enemy fire, a 25-year-old friendly vehicle with a misfire rate of about 50 percent is about to fire almost a ton of high explosives over their heads.

Immediately after the MICLIC fires, the plow tank begins to move through what is left of the wire and mines. The tank must go on a straight path, because it cannot turn without risking damage to the plow tines. The turret should be traversed to the left, so that any mine blast to the front does not damage the gun tube. If the turret is traversed to the right, the tank commander is farther back and has problems seeing the front to determine the far edge of the obstacle. Some crews install a makeshift wire-cutting device in the center of the blades. This allows them to cut and push away the wire, so it won't be dragged along. The wire won't stop the tank, but it could damage the plow by cutting the nylon lifting straps or getting caught in the track.

Armor and engineer doctrine on plow tank employment present the extremes of plow performance, while the best answer lies somewhere in between. Many armor and joint doctrinal publications state that the crew can drop the plow blade as little as 10 meters in front of the obstacle and then plow up to 10 miles per hour (see FM 71-2). (The M1's speedometer is in kilometers per hour.) The tank platoon Army Training and Evaluation Program lists no standards. Engineer manuals bring the blade drop point back to 100 meters with a speed below 10 kilometers per hour (see FM 20-32). Both specifications are partly right and partly wrong.

The only way to be sure the depth setting and plow speed are effective is to conduct a rehearsal. By plowing two or three practice lanes in the area of operations with conditions similar to those at the obstacle, the commander can determine the best depth and speed to dig out mines and produce sufficient spoil to push them to the sides. The blade drop point and speed also can be refined during a rehearsal. It is best to drop the blade before beginning to move to avoid possible damage to the plow tines. After the plow creates a lane, the roller follows the same path through the obstacle to detonate any remaining mines. The roller should travel at the same speed as the plow, with the gun tube to the left, and then exit the lane to the right in a hasty defensive position. In theory, each roller can withstand two mine hits and continue to effectively proof the lane. Regardless of the method used, several systems must work together to breach, proof, and mark lanes.

A plow can dig down to 8, 10, or 12 inches. The depth must be set before the mission begins and is based on ground conditions (the softer the soil, the deeper the setting). The depth is critical, as is installation of the plow's moldboards, which force spoil farther to the sides of the tank and create a wider lane while preventing mines from falling back into the lane. After the tank commander is sure that the plows have plowed beyond the far edge of the obstacle, the tank must briefly stop, back up, and raise the plow. This only takes a few seconds. Then the plow tank should move to the left of the breach lane and remain in a suppressive fire position. Because the plow control cables run through the driver's right vision block, he should drive to the left so he can see where he is going. Meanwhile, the gunner traverses and looks for targets.

Although the lane is now well established, it is not complete until it is marked. The MICLIC and the path dug by the plow are very distinctive, so the immediate concern is to mark the exact entrance and exit. VS-17 panels are excellent markers at each end. We used the red side on the right and orange on the left. The exit point is the most critical under fire, because many combat vehicles turn off too early in training and run into the minefield. At night, plastic water bottles filled with chemical light fluid enhance the VS-17s. We used markers called "tippy toms" to mark the left handrail of the lane because engineers can throw them out as they move through, but they usually are not very useful after the path is dug. Any initial method that clearly marks the entrance, exit, and path of the lane is satisfactory but should be continually improved for follow-on units (see FM 90-13-1, Appendix E).

Plow/Roller Tank Method

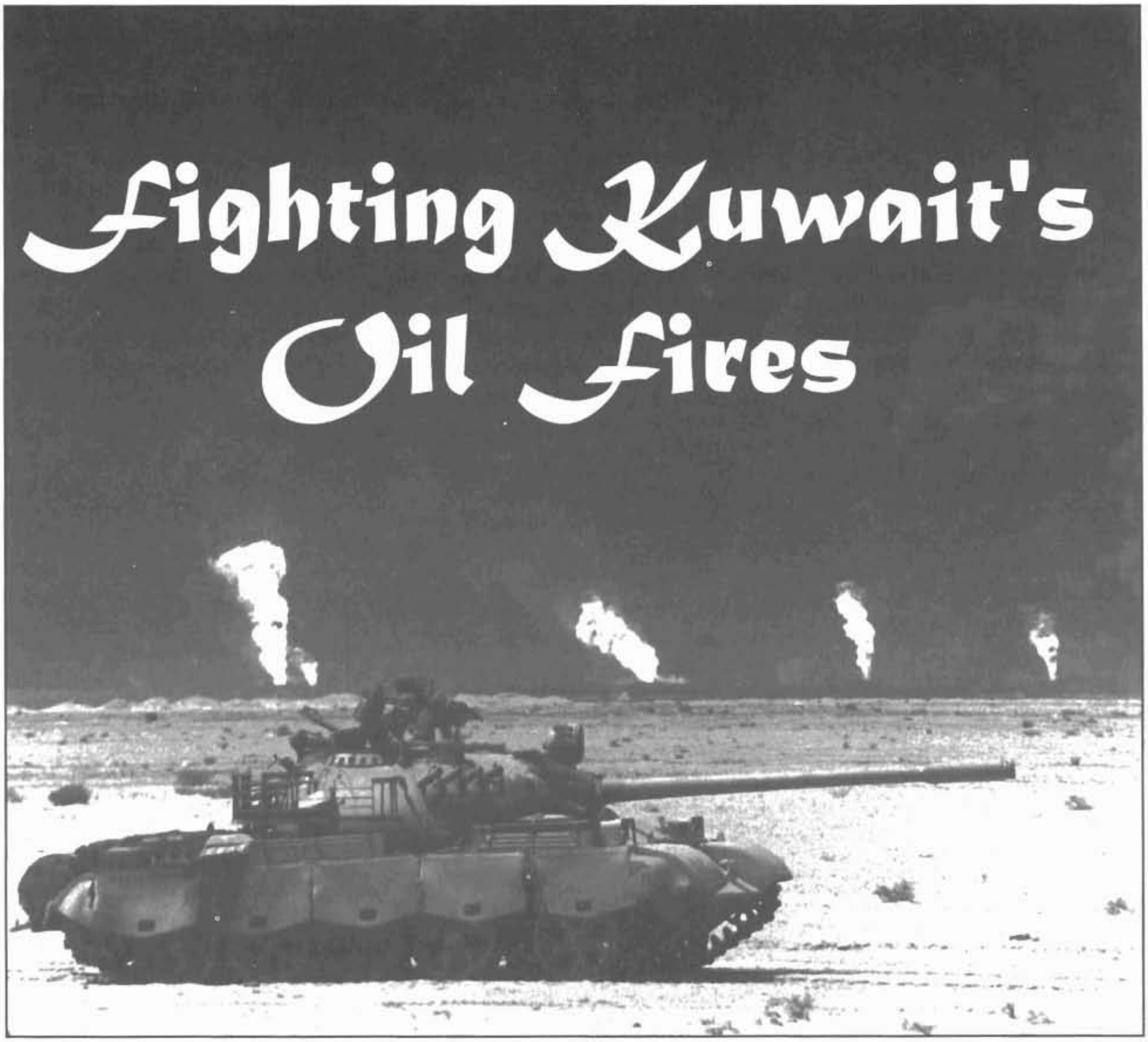
When tank units train to reduce obstacles without a MICLIC or AVLM, they use only a plow and roller. They follow the basic tenants of breaching as with the MICLIC/plow combination, but this method uses the plow to reduce and the roller to proof. Without a roller, tank units are forced to drive a "Hollywood" tank through the obstacle first to proof the lane. It is a grim job, but if the tank doesn't hit a mine, then the lane is proofed. Regardless of which reduction/proofing combination the commander uses, the plowing portion is almost identical to the process described for the MICLIC/plow combination. The only difference is in how the plow tank begins its mission. When terrain allows, a plow tank is most effective if it remains behind an intervisibility line while conditions are set for the breach. The commander can talk directly to the tank commander and position him directly in front of the desired breach point, so that when he orders the plow forward it quickly drives straight to it. This is another instance where doctrine falls apart. Determining the blade drop point and tank speed may seem simple, but they drastically affect the quality of the lane.

Synopsis

In heavy-force breaching operations, the maneuver commander must synchronize every available BOS to set the conditions for a successful breach and continued attack. No one system or branch can accomplish this mission without direct involvement and assistance from others. A major problem facing the combined arms team today is a lack of understanding of the common doctrine in FM 90-13-1 on how to execute this mission. The primary soldiers in a breach are tankers and engineers, but our schools teach different execution methods. Then, when we come together in the field to plan and execute a mission, the officers disagree on exactly what to do.

To eliminate this confusion, we must develop more effective combined arms doctrine and TTPs for obstacle reduction. If we begin by locking a group of tanker sergeants and captains in a room with their sapper counterparts, they may be able to find some common ground before the next balloon goes up. Common techniques will allow tankers and engineers to complement each other in a combined arms breach and be reinforced by every available BOS. Through combined TTP development, refinement, implementation, and training, we can set the conditions for a successful combined effort of all BOS elements on the battlefield. As individuals, or individual units, we can do many great things. Acting together as a cohesive team with common doctrine, we can accomplish anything—even an operation as demanding as a breach.

Captain Erdley is working on a master's degree in engineering management at the University of Missouri-Rolla. He has served as a tank platoon leader, executive officer, battalion maintenance officer, and S1 for 3-67 Armor in 2d Armored Division and 4th Infantry Division (Mechanized). He is a graduate of the Airborne, Air Assault, Armor Officers Basic, and Engineer Officers Advanced Courses. CPT Erdley is a 1994 Distinguished Military Graduate of Lehigh University, Bethlehem, Pennsylvania.



Fighting Kuwait's Oil Fires

By Janet A. McDonnell

During the Gulf War, the U.S. Army supported what was by all accounts the largest oil-fire-fighting campaign in history. Overall responsibility for fire-fighting operations rested with the Kuwaiti government and its Ministry of Oil. Kuwaiti leaders decided early on that the Kuwait Oil Company would manage and direct all fire-fighting operations.

Before the Iraqi invasion (in August 1990), Kuwait had roughly 1,300 producing wells in its primary oil fields. Approximately 75 of them were high-pressure wells in the important Burgan field that produced from 20,000 to 50,000 barrels of oil a day. Kuwait had a production quota of 1.5 million barrels per day, set by the Organization of Petroleum Exporting Countries (OPEC), though it could produce much more.

As Iraqi soldiers withdrew from Kuwait, they blew up more than 600 oil wells, resulting in the loss of an estimated 5 to 6 million barrels per day. Roughly 520 of the wells, or 85 percent, burned at temperatures as high as 2,000 degrees Fahrenheit. The rest gushed thousands of barrels of crude oil into large, dark, lifeless "lakes" that were up to six feet deep. Onlookers hundreds of feet away could feel the intense heat and hear the roar of the burning wells, similar to the sound of a jet engine. Thick smoke shrouded the fields. To further complicate matters, unexploded ordnance and Iraqi land mines littered the oil fields. The country's three refineries—Shuaiba, Mina Abdulla, and Mina al Ahmadi—were also damaged.

The Kuwait Oil Company directed the early planning for the fire fighting in Washington. The Kuwaitis requested U.S. Army civil affairs support in the planning effort. Members of the Kuwait Task Force (a small group of reserve officers from the 352nd Civil Affairs Command) helped the Kuwaitis gather information about the well fires, plan logistics support, and develop an emergency plan of action. The Kuwait Oil

Company hired O'Brien, Goins and Simpson as the executive agent to coordinate fire-fighting activities. It signed contracts with Red Adair Company, Boots and Coots, and Wild Well Control, Inc., all skilled Texas-based, world-renowned firms; and with Safety Boss of Calgary, a well-qualified Canadian firm. The Kuwait Oil Company eventually hired Bechtel to reconstruct the oil infrastructure and to provide food, housing, and other support to the firefighters, but Bechtel had no direct role in putting out the fires.

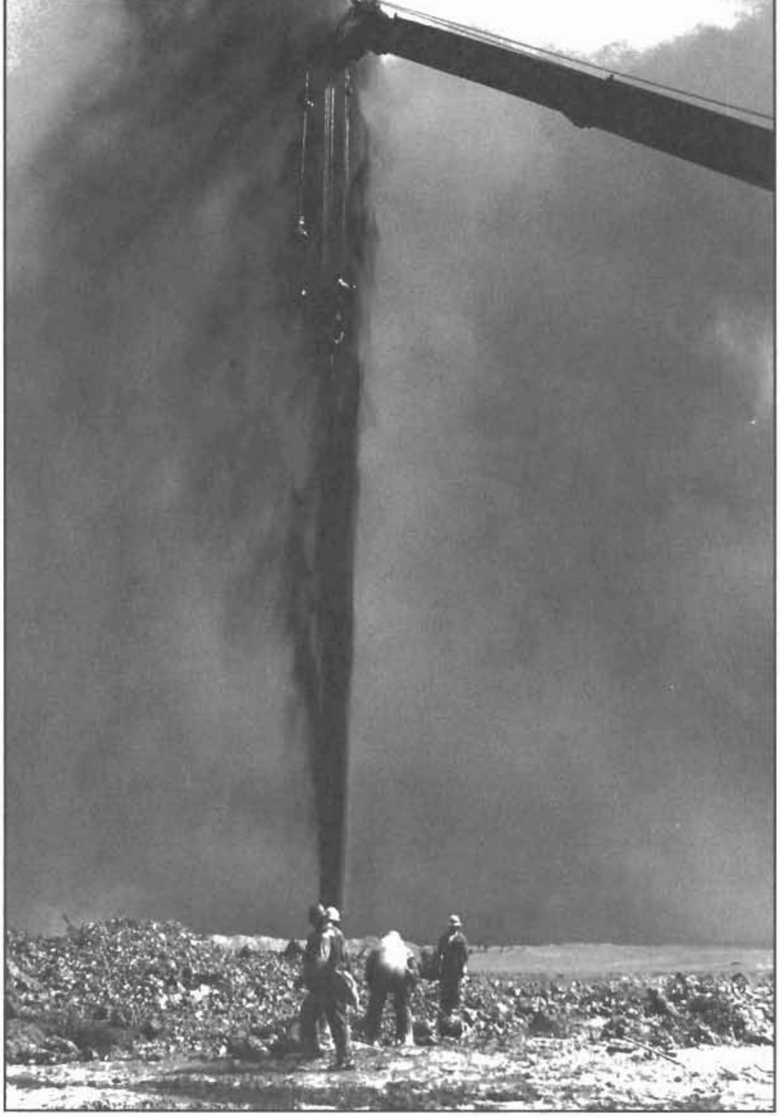
It took the Kuwaitis four months to award the first fire-fighting contract, and they hired firefighters before hiring a contractor to support them. A severe shortage of heavy equipment, such as bulldozers, backhoes, and trucks, hampered the fire-fighting effort. Because of theft and Iraqi destruction, virtually everything needed to support the operation had to be imported. The challenges of feeding, housing, and equipping a workforce that eventually grew into the thousands were staggering.

Firefighters arrived to survey the damage, assess their personnel requirements, and determine where they could stage their equipment. The first experts from Red Adair, Boots and Coots, and other companies arrived in Kuwait City on 4 March and toured the burning oil fields by helicopter. They estimated that extinguishing the fires and repairing the wells could take two years.

Initially, the contractors could not bring in workers because they had no way to feed or house them. The companies also had trouble getting the necessary equipment. The Kuwaitis initially were reluctant to invest the tens of millions of dollars needed for equipment, even though the fires consumed roughly $100 million worth of oil each day.

Members of the Kuwait Task Force provided immediate logistics and communications support to the fire-fighting teams. They also provided ground and air transportation to assess damage in the burning fields. Civil affairs troops coordinated the use of C-5A aircraft to bring in heavy fire-fighting equipment from Texas and to provide firefighters with food, water, lodging, and helicopter and truck transportation. This gave the Kuwaiti government enough time to bring Bechtel personnel on-site to take over the support operations. The Kuwait Task Force also provided explosive ordnance disposal support and training and coordinated engineer support until Kuwaiti equipment arrived. Army explosive ordnance disposal specialists steered the firefighters safely through unexploded ordnance to the wellheads and checked the wellheads for explosives.

Kuwait Task Force members, Major Tom Wilson, a procurement specialist with Hunt Oil Company in civilian life, and Lieutenant Colonel Phil Huber, focused on fire issues. Task force members coordinated between the firefighters and Ambassador Edward Gnehm. They also coordinated between contractors looking for work and Bechtel or the Kuwait Oil Company.



An estimated 5 to 6 million barrels of oil a day were lost.

Because of the shortage of equipment and firefighters, the work got off to a painfully slow start. The Kuwait Oil Company initially used nine teams that represented the four fire-fighting companies. Fire-fighting equipment began arriving in Kuwait on military aircraft throughout March, and on 7 April a Boots and Coots team used liquid nitrogen and water to extinguish the first oil-well fire. Fighting the wellhead infernos was dangerous and difficult. The firefighters worked in intense heat, amid blowing sand and smoke, and their brightly colored jumpsuits quickly became coated with an oily mist.

In April, Kuwait's oil minister, Dr. Rashid Al-Amiri, announced that the national oil company would bring in fire-fighting teams from several different companies, breaking up the American and Canadian monopoly. With only 25 well fires extinguished, he wanted to

Firefighters cap an oil well in Kuwait in August 1991.

quicken the pace. The Kuwaiti government later brought in teams from three additional U.S. companies as well as British, German, French, Russian, Chinese, and Iranian firms. Ultimately, however, teams from the original American and Canadian firms put out most of the fires. Meanwhile, firms and individuals from around the world continued to inundate U.S. and Kuwaiti officials with proposals for extinguishing the fires.

The slow pace of the fire fighting worried U.S. officials. In April, the Office of the Principal Deputy Undersecretary of Defense for Strategy and Plans hosted a meeting for representatives of the Army, Navy, Air Force, and Department of Energy to address this issue. The Deputy Assistant Secretary of Energy for Export Assistance, George Helland, warned that the Bush administration would come under attack if it did not act quickly to put out the oil fires. The participants decided to forward all proposals for extinguishing the fires to the Undersecretary of Energy. He would screen the proposals before forwarding them to David Tarbell, the Director of International Economic and Energy Affairs, in the Office of the Principal Deputy Undersecretary of Defense for Strategy and Plans. The participants, however, made no attempt to define the problem. They failed to develop any specific format or guidance for drafting proposals and failed to develop any initiatives to get support from high levels in the Pentagon or the Bush administration. These were important oversights.

After Task Force Freedom ceased operations, the Army continued to support the fire-fighting effort through the Defense Reconstruction Assistance Office. Neither the Kuwaiti government nor any of the commercial firms could quickly bring in needed supplies and heavy equipment. As a result, with little legal or funding authority, the Military Airlift Command found itself flying the cargo on U.S. Air Force C-5A transports. The Defense Reconstruction Assistance Office later helped broker more than $13 million in transportation expenses between the Military Airlift Command and the Kuwaiti government. Other Defense Department agencies provided support through satellite imagery photographs, airfield repair, and environmental surveys.

Major General Patrick Kelly, Commander of the Defense Reconstruction Assistance Office in Kuwait, and his staff monitored the work, gathered information, and kept the U.S. Ambassador to Kuwait, Edward W. Gnehm, informed. Gnehm had no environmental specialists on his staff, so he relied on Kelly's environmental officer, Lieutenant Colonel Christopher Werle, to advise him and coordinate environmental issues. Where appropriate, Kelly's staff helped coordinate the delivery of heavy equipment on C-5A transports, the tracking of oil fires and spillage with Landsat imagery, and the stabilization of work sites with airfield matting. Werle, who performed much of the day-to-day coordination with the fire-fighting organizations, developed a particularly good rapport with the firefighters and their support crews. Kelly and his staff considered all activities related to the environment and the oil-well fires to be "embassy business" and took no action without the ambassador's approval.

The Army also provided combat engineer vehicles (CEVs). These vehicles are tanks with turret-mounted demolition guns and hydraulically operated debris blades. They give engineers in forward combat areas a versatile means of clearing rubble and filling tank ditches. More than 80 Kuwaiti oil fires were encircled by huge, hardened mounds of coke (solids produced when unburned oil mixed with sand), which had to be removed before the firefighters could work. Firefighters used dynamite and backhoes to remove the searing mounds, but the process was hazardous and slow. Werle developed a plan to use existing CEVs to fire rounds of high explosive plastic at mounds to break them up so the firefighters could remove the debris. This plan, he argued, would speed the capping effort and save the Kuwaiti government $300,000 per well. Moreover, it would provide unique training for the CEV crews and positive Army public relations. The Kuwait Oil Company covered the costs of using the CEV crews and equipment.

On 31 July, the Kuwaiti government and Bechtel conducted a very successful experiment: firing the large-caliber gun on a CEV to remove coke mounds from wellheads. Rounds from the vehicle shattered four out of five of the coke-mound targets. Soldiers cleared two wells using this method. Soon after the initial experiment, however, the focus of the fire-fighting effort shifted to Burgan, Kuwait's densest oil field. Officials concluded that using the CEVs there would be too dangerous because the wells were so close together.

As the oil fires continued to burn, the U.S. Army and other agencies became increasingly concerned about the short- and long-term health risks of the smoke and other emissions. In March 1991, an interagency team headed by the Environmental Protection Agency collected samples at several sites in Kuwait, Saudi Arabia, and elsewhere in the Middle East. They attempted to ascertain the presence of potentially harmful air pollutants, specifically carbon monoxide, sulfur dioxide, and hydrogen sulfide gases and particulates—tiny particles that lodge in the lungs. The team found each of these gases but not in concentrations that exceeded current standards. The Environmental Protection Agency subsequently concluded that no imminent health risk existed.

Some experts questioned the validity of the agency's study because it included only samples the team could collect within 20 minutes, rather than samples collected over 18 to 24 hours. The team found an abnormally high level of particulates. "Soldiers may become concerned because they find soot in their nostrils," they conceded, but the smoke was "only an irritant and a nuisance." For the long term, though, scientists needed to know more about the composition of the smoke to determine the potential health hazards. Meanwhile, at the request of the Deputy Assistant Secretary of Defense for Environment, a special health-risk assessment team from the Army Environmental Hygiene Agency conducted a 60-day study. The agency coordinated its effort with the Environmental Protection Agency's interagency assessment team to exchange information and prevent duplication of effort.

At the request of President George Bush, the administrator of the Environmental Protection Agency, William K. Reilly, traveled to Kuwait in June to assess environmental damage from the Iraqi invasion. "The horrors endured by the people of Kuwait and the unprecedented level of intentional environmental destruction," Reilly reported, "remind us all that there is still evil in the world." He praised the "environmental sensitivity" of the soldiers he met. "One of the untold stories," he added, "is the dazzling performance of the Army Corps, which essentially jump-started the infrastructure of a county." The military, he informed Secretary of Defense Richard Cheney, had greatly assisted scientists working in Saudi Arabia and Kuwait and those responsible for sewage treatment and pollution control. Upon his return, Reilly reported that the environmental damage was not as great as predicted. He cited the interagency team's finding that the levels of sulfur and heavy metals in the air were not abnormally high. Environmental groups, however, questioned those findings.

On 2 June, Kuwait resumed oil production in an offshore field, averaging 130,000 barrels a day. Later that month, it began producing 30,000 barrels a day onshore. On 25 July, Kuwait announced that for the first time since the Iraqi invasion it would resume exporting crude oil, though only on a small scale. Half of the oil fires had been extinguished. Firefighters were snuffing out more than six fires a day. By November 1991, all of Kuwait's oil wells had been capped. On 6 November, the emir attended a ceremonial capping in the Burgan field of the final oil well. The Kuwaitis, delighted to see the end of this tragic and costly episode, celebrated the event as a national holiday.

Kuwait lost more than 1 billion barrels of oil (or 1 percent of its sole natural resource) as a result of the Gulf War, but its huge reserves escaped lasting damage. The country still retained 10 percent of the world's crude oil reserves. With assistance from the U.S. Army and the dedicated, skilled private contractors, the Kuwaiti government had extinguished the oil fires and recapped the wells in record time.

Note: The above article is from a new book, "*After Desert Storm: The U.S. Army and the Reconstruction of Kuwait,*" by Janet A. McDonnell. The book, a joint publication by the U.S. Army Corps of Engineers and the U.S. Army Center of Military History, is scheduled for distribution in the spring of 1999. To obtain a copy, write to: U.S. Army Corps of Engineers Publications Depot, 2803 52nd Avenue, Hyattesville, Maryland 20781-1102.

Records of references used in the article are available in the research collections of the Office of History, U.S. Army Corps of Engineers, 7701 Telegraph Road, Alexandria, Virginia 22315-3865.

All photographs by Jonas N. Jordan, U.S. Army Corps of Engineers, Savannah District.

Janet A. McDonnell, chief historian at the Defense Logistics Agency, previously served as senior historian with the U.S. Army Corps of Engineers. She holds a Ph.D from Marquette University.

ENGINEER UPDATE

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

Maneuver Support Center (MANSCEN)

MANSCEN Update. New facility construction is more than 80 percent complete, and some new buildings and ranges have been turned over to the Fort Leonard Wood installation. The Chemical Defense Training Facility will undergo surety training and inspections during the 2nd quarter of FY99.

Schoolhouse organizations are reorganizing to the MANSCEN structure, with adjustments to office space scheduled for completion by May 1999. Most Engineer School personnel will keep their current telephone numbers after they move. Job vacancy lists have been published by Fort Leonard Wood's Civilian Personnel Advisory Center (CPAC), and the selection of personnel to vacancies is ongoing. The Garrison Command Reception Plan is initiating sponsorship and reception activities. POC is Mark Premont, -6134.

Engineer Personnel Proponency Office (EPPO)

DA Pam 600-3. The Chief of Staff, Army, approved the new DA Pam 600-3, *Commissioned Officer Development and Career Management*, on 4 August 1998. It is scheduled for publication on the U.S. Army Publication and Printing Agency (USAPPA) homepage (http://www-usappc.hoffman.army.mil) in November. Distribution of paper copies is scheduled for December.

The Engineer Chapter in DA Pam 600-3 experienced one significant change during the staffing and approval process. Based on a decision by the Combined Arms Center (CAC) commander, the Engineer Training Support Battalion's Executive Officer (XO) and Operations Officer (S3) positions are no longer considered branch-qualifying for engineer majors. POC is MAJ Dave Hartley, -4087.

Department of Training and Doctrine Development (DOTD)

Field Manual Update. FM 5-116, *Engineer Operations: Echelons Above Corps*, and FM 5-415, *Fire-Fighting Operations*, are at the Army Training Support Center awaiting printing. FM 5-116 is a revision of the 1989 edition, and FM 5-415 is a new publication. These manuals are posted to the Engineer School's Publications Page at: http://www.wood.army.mil/PUBS/pubs.htm.

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

- FM 5-34, *Engineer Field Data*
- FM 5-436, *Paving and Surfacing Operations*
- FM 5-434, *Earthmoving Operations*
- FM 5-472, *Materials Testing*
- FM 90-13-1, *Combined Arms Breaching Operations*
- FM 20-3, *Camouflage*

POC is Sandra Gibson, -4100.

Directorate of Combat Developments (DCD)

Tool Kit Upgrades. Prototypes for the revised Masonry-Concrete Tool Kit (LIN W44923), Electrician Set #1 Tool Kit (LIN W36977), Pipefitter's 1/8" to 2" Pipe Tool Kit (LIN W49033), and Pipefitter's 2-1/2" to 4" Pipe Tool Kit (LIN W48622) were reviewed by subject matter experts at Fort Leonard Wood in October. The tool kits were showcased at the Soldier Review at Fort Benning, Georgia, and are available for viewing at intraservice school sites at Sheppard Air Force Base, Texas, and Gulfport, Mississippi. These upgrades follow the upgrade of the carpenter tool set. The new kits will provide soldiers in the General Engineering Career Management Field with industry-standard tools and high-technology devices comparable to those used in the commercial construction industry. Although the focus remains on construction in a theater of operations, these sets will enable soldiers to complete new construction projects and perform maintenance on existing structures across the spectrum of conflict. POC is Alan Schlie, -6191.

Lead the Way

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

Tell It Like It Is

Much has been written about the Department of the Army's enlisted centralized promotion selection board process and how soldiers can successfully compete. While the process is familiar to all of us, after-action reports written by the Armor/Engineer Panel reveal some disturbing trends. A review of these trends follows.

1. Many noncommissioned officers (NCOs) do not spend enough time in key leadership positions – specifically as squad leaders for promotion to sergeant first class, as platoon sergeants for promotion to master sergeant, or as first sergeants for promotion to sergeant major and appointment to command sergeant major. No other positions can substitute for these key and challenging leadership experiences. It is critical that NCOs serve in these positions for a minimum of 18 months, but more time is better, and it is best to serve in several different squads, platoons, or companies. *Nothing* takes the place of sufficient leadership experience. Also, NCOs should not spend too much time in tables of distribution and allowances (TDA) positions and should avoid back-to-back TDA assignments. A proper balance of TDA and tables of organization and equipment (TOE) experience is best. Every NCO should also perform well in one of the following positions: drill sergeant, recruiting, Active Component/Reserve Component (AC/RC) duty, equal opportunity duty, Inspector General duty, Reserve Officer Training Corps duty, or as an observer/controller at a combat training center.

2. Many engineer Noncommissioned Officer Efficiency Reports (NCOERs) do not properly state the ratees' performance and potential. "Excellent" blocks *must* be fully substantiated with well-written bullet comments. Raters and senior raters must do a better job of quantifying and qualifying the performance and potential of the NCOs they evaluate and avoid personal opinions. For example, instead of "Best squad leader I have ever seen" write "Best squad leader in my platoon." Instead of "Led from the front" write "Improved the squad's average PT score by 25 percent." Instead of "Physically fit" state "Scored 275 on the Army Physical Fitness Test." State facts about the ratee's ability to train his soldiers, maintain his equipment, and care for his soldiers. Senior raters must be specific about the NCO's potential. For example, write "Must select for promotion to master sergeant" or "Promote ahead of peers."

Raters must evaluate subordinates thoroughly and fairly. Everyone is good, but a few are "best." If the senior rater does not identify the best squad leader in his platoon or the best first sergeant in his battalion, someone else will make that decision based on what they think was intended in the NCOER. Be specific—write "Best squad leader in my platoon" or "Best first sergeant in my battalion." Tell it like it is. Senior raters must inform Army leaders about the truly great NCOs. There is room to promote only the best so don't allow the promotion board to second-guess you. They may not make the right decision.

3. Some NCOs forget the importance of military schooling. We know that the NCOES schools are a must for promotion. Remember that the Battle Staff course, the First Sergeants' course, and the Defense Equal Opportunity Management Institute are important for NCOs who serve as an operations or intelligence sergeant, a first sergeant, or in an equal opportunity position. The Airborne, Master Parachutist, Air Assault, Master Fitness, and Sapper Leader Courses are important for those serving in a unit and position requiring that knowledge.

4. Civilian education also is important. It improves NCOs' written and oral communications skills and develops their intellect. In today's Army it is not acceptable for an NCO to stop at a general education development or high-school diploma. NCOs must progress further to successfully compete with their peers. All NCOs have time during their careers to acquire civilian training. Be a self-starter! Your post education center will help you select a program that meets your needs.

5. Some NCOs have photos in their DA files that are more than 5 years old. Army Regulation 640-30 states that a new photo is required every 5 years or when the photo no longer represents your appearance. The regulation allows certain members of the chain of command to order a soldier to get a new DA photo, so it is a chain-of-command issue. It is a good idea to get a new photo every time you are promoted. That practice sends a signal to board members that you care about your records and career. Take a buddy along when you are photographed to ensure that your uniform fits properly and looks good and that all awards and decorations are placed correctly.

6. Many NCOs fail to thoroughly review their records and DA microfiche before the promotion board meets. NCOs must review the microfiche to ensure that all documents on it are theirs and that it includes all documents favorable to them. All of your NCOERs, college transcripts, orders for awards, letters and certificates of appreciation, and favorable documents allowed by the regulation should be on the microfiche. Thoroughly check your DA Forms 2A and 2-1 for accuracy and neatness. Ensure that these forms are complete and that they represent you correctly. The degree of interest you show in your record will pay big dividends at promotion time.

Leaders at all levels should ensure that all their subordinates who compete for promotion have reviewed their records and that their records and photos are up to date. It is the right thing to do.

Additional information on promotions is found in the Engineer Center Command Sergeants Major home page (http://www.wood.army.mil/ECCSM/index.htm) or the Engineer Personnel Proponent Office home page (http://www.wood.army.mil/EPPO/eppo_hp.htm). The proponent guidance document that is sent to the promotion board's Armor/Engineer Panel is posted on the home page along with the review and analysis memorandum, which is the board's AAR. Use this information to help you and your subordinates at promotion time. I wish you good luck.

ARMY VALUES

RESPECT

"Without a feeling of respect, what is there to distinguish man from beast?"
Confucius, ANALECTS - 6th Century B.C.

18th Engineer Brigade Construction, Operation Provide Comfort

Following Operation Desert Storm, soldiers from the 18th Engineer Brigade were called upon to provide humanitarian assistance to the Kurdish people of northern Iraq in Operation Provide Comfort. An important consideration for constructing facilities was that they be appropriate to the Kurdish lifestyle. Cultural and religious considerations were more important than any "engineering efficiency." This was true for all construction even for sanitary facilities. The engineers of the 18th knew as others before them that respect for the culture of the people was often the key ingredient to success in nation building, civic action, or humanitarian relief. Almost 30 years before Operation Provide Comfort, an engineer in Southeast Asia noted that the key to success in foreign assistance was to establish bonds of trust and respect between the engineers and those they sought to help.

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