Engineer

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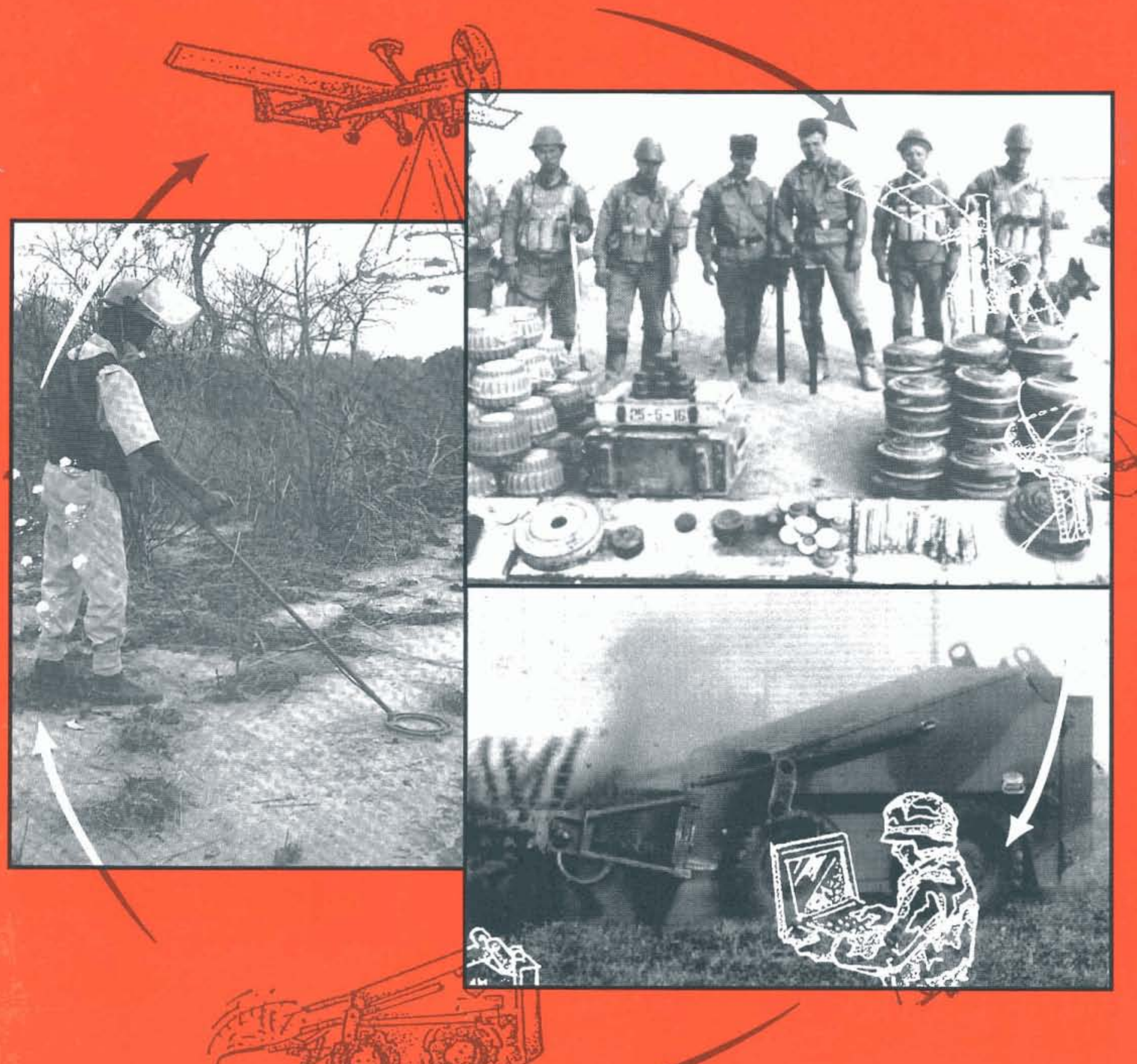

COUNTERMINE

Headquarters, Department of the Army

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CLEAR THE WAY

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

Land mines cause about 26,000 casualties worldwide every year. Although most of these casualties are the result of the indiscriminate and irresponsible use of mines, they have caused antipersonnel (AP) mines to be severely stigmatized by the international community. As a leader of the "responsible" international community, the United States has chosen to pursue the regulation of AP mines. In setting a standard that we hope others will follow, the President announced a significant change in U.S. policy for AP mines on 16 May 1996. The Army and the engineer community were involved with the Joint Chiefs of Staff in developing the new policy and will continue to be key players in discussions regarding the expanded policy. This new policy affects the way combat engineers will "shape" battlefields in the future. Several articles in this magazine address the countermine challenge. I will discuss the impacts of this policy on the way engineers will train and fight at all levels of conflict.

The "U.S. Anti-Personnel Landmine Policy" announced by the President in May 1996 states:

- The U.S. will aggressively pursue an international agreement to ban the use, stockpiling, production, and transfer of AP land mines.
- The U.S. views the security situation on the Korean Peninsula as a unique case and in the negotiation of this agreement will protect our right to use AP mines there until alternatives become available or the risk of aggression has been removed.
- Effective immediately, the U.S. will unilaterally undertake not to use, and to place in inactive stockpile status with the intent to demilitarize by the end of 1999, all nonself-destructing AP mines not needed to train personnel engaged in demining and countermine operations, and to defend the United States and its allies from armed aggression that crosses the Korean Demilitarized Zone.

This far-reaching policy eliminates the use of M14 blast AP mines and M16 bounding fragmentation mines outside the Republic of Korea. It does not affect our use of self-destructing mines or command-detonated weapons (M18 claymore). The loss of nonself-destructing mines requires that we rewrite doctrine on the emplacement of both tactical and protective minefields. Engineer School personnel are revising the doctrine in FM 20-32, *Mine/Countermine Operations,* to reflect these changes. The regional commanders in chief (CINC) have been directed to remove nonself-destructing AP land mines from all unit basic loads (except in Korea) and to modify existing war plans to account for the loss of nonself-destructing AP mines. Currently there is no replacement for these mines, although alternative technologies and "nonlethal" weapons are being explored (see article, page 11).

We are reviewing and changing our training strategies accordingly. Because there will be no live M16 AP mine training by units outside of Korea, the authorizations for live-mine training in DA Pam 350-38, *Standards in Weapons Training* (STRAC manual) are being eliminated except for units in Korea. The Engineer School will continue to train initial entry soldiers on inert mines.

As part of the change in land-mine policy, we have been directed to examine ways engineers can help expand demining efforts. Demining is defined as the complete removal of *all* mines and unexploded ordnance from an area after a conflict. It is typically done without the benefit of any existing minefield record. Traditionally, special operations forces (SOF) have conducted most demining train-the-trainer missions. The policy stating that U.S. soldiers will not enter a known, live minefield will not change.

The U.S. goal in demining is to develop a long-term, self-sustaining, indigenous demining program based on training provided by U.S. forces to a foreign government. The U.S. training program includes mine awareness campaigns, setting up national demining headquarters, detection techniques, and demolitions used to destroy mines. U.S. Army engineers may participate in demining operations but probably not in a pure engineer unit. Army engineers generally will participate as part of a combined team of SOF, engineers, and explosive ordnance disposal (EOD), psychological operations, and civil affairs personnel in a train-the-trainer mode.

The Engineer School has been asked to investigate the feasibility of establishing a humanitarian demining operation (HDO) training facility at Fort Leonard Wood. Our Countermine Training Support Center is conducting this study due to their ties to the special operations and EOD communities. If approved and funded, we anticipate that this center will become the nucleus of the HDO training facility. The engineer community must ensure that the military use of AP mines is effectively presented in future political and legislative initiatives.

We will keep you informed about the new mine doctrine, training-policy issues, and demining studies. Engineers must work within this policy and remain a trained force ready to fight our nation's battles.

Engineer

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Front Cover: Countermine technology supports the global effort to detect and neutalize mines and UXO. Photos, clockwise: Mozambique deminer, Afghan soldiers with recovered mines, and U.S. soldiers with miniflail in Bosnia.

Back Cover: *Battle of Palo Alto. Artwork courtesy Library of Congress.*

FEATURES

DEPARTMENTS

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The hazards of operations in a mined environment—an M2 Bradley after striking a TMA-3 antitank mine.

Countermine: It's More Than In-Stride and Deliberate Breaches

By Colonel Robert Greenwalt and Major Brigid Ockrassa

Engineers do countermine. It's a key part of the mobility mission, and we know how to do it. Field Manual 90-13-1, *Combined Arms Breaching Operations*, tells the entire Army how to do it. Our equipment may not be very good, but it works and we train the mission all the time, particularly at the combat training centers. So what's the big deal?

Hold on to your Kevlar! The world has changed. Breaching through defended obstacles to allow maneuver forces to close with the enemy is no longer the only game in town.

Since the Cold War ended and peace broke out, the world has discovered that it is littered with mines—about 100 million mines! The United Nations (UN) and our allies are actively engaged in dealing with them. Somalia reinforced the fact that single mines buried in a main supply route can stop traffic—and that many people can bury single mines in a road. Bosnia showed that widespread minefields can stop operations cold, even when no one is actively mining. Mines are ubiquitous and, under the scrutiny of CNN cameras, may impact any military operation. Their impact must be neutralized. The engineer force must move beyond simply breaching minefields.

Lessons From Bosnia

Bosnia is a model of countermine operations in a "peace" environment. Residual mines in that country are a threat to all members of the Implementation Force (IFOR). U.S. actions there have included extensive mine-awareness training as well as extremely controlled troop movements and operations to avoid mine encounters. Engineers working with the former warring factions have mapped and recorded minefield locations and proofed and cleared areas for use by U.S forces.

The IFOR's role in mine-clearing operations highlights the dangers and frustrations of clearing operations. Details of the demining activities made headlines similar to those produced for the Sava bridging mission. Faithful CNN watchers learned the incredibly low-tech, labor-intensive methods we use to clear minefields—and they became outraged. Although the media hype on the countermine mission in Bosnia has crested, it left a lasting impression. It motivated the American public and Congress to demand better solutions. As is typically American, standards are high and patience is

A United Nations peacekeeper uses a bayonet to probe a minefield along the road to the enclave of Gorazade, just outside Sarajevo in 1995.

low—but the resolve to "fix" the countermine problem has energized the world.

President Clinton, along with Ambassador Albright (the U.S. Ambassador to the UN) and Senator Leahy, have deep concerns about the worldwide disaster caused by residual land mines. In addition to working toward an international ban on antipersonnel (AP) mines, they want to remove residual AP mines that threaten innocents daily. In the policy announced on 16 May 1996, President Clinton directed the Department of Defense to increase its support to humanitarian demining operations.

Once again, engineers find themselves on the cutting edge of a defense issue of national importance: trying to solve the countermine problem. As new types of mines, fuzes, explosives, and emplacement techniques are discovered, the task becomes increasingly difficult. However, we aren't in this situation alone. The assets of the nation and the world have mobilized and, in a very real sense, U.S. Army engineers are at the hub of this activity.

As a result, your job as an Army engineer will assume a new countermine dimension.

What's the Problem?

"If we can put a man on the moon, why can't we find mines?" This question was asked in congressional committee hearings. If only we could make the ground transparent! It's easy to find the moon because we can see it. The keystone in the countermine arch is detection, and it is extremely difficult. Mines come in a wide variety of shapes, sizes, and materials. The ground is an almost infinite set of soils, moisture, vegetation, and clutter (and much of the clutter is the same shape, size, and material as the mines). Weather plays a significant role. And the enemy tries to fool us. No single technology solves the mine problem—and so far, no combination does either.

In a high-speed maneuver scenario, engineers don't look for individual mines. Instead, we treat the ground with something like a MICLIC, or use plows or rollers to remove enough mines to pass through, and move on. Less-than-perfect technologies are good enough for this scenario. Unfortunately, as the Army moves beyond a high-speed maneuver focus, engineers must move beyond breaching into areas where technological weakness has significant impact.

Countermine consists of two basic tasks: find the mine, and neutralize it. If we know exactly where a mine is, neutralization is relatively simple. If we don't know where it is or don't know how many mines we may have missed, neutralization is far more difficult. The best detection technology available today has only a 70-percent probability of detecting plastic AP mines. We cannot adequately detect mines along routes at speeds that allow convoy operations. All mine detectors produce too many false alarms (each of which must be treated as if it were a mine). Instead of precise detection, engineers sometimes use breaching techniques to treat an entire area—but those techniques aren't 100-percent effective either. Breaching techniques are extremely destructive and cannot be used in areas where they may damage property or structures.

To put it bluntly, the technology isn't there yet!

Who's Working the Problem?

Before addressing the categories of "players," we acknowledge that there is a long-standing group of professionals in each. The following information focuses on recent changes, activities, and increases to the "team roster."

The Army

When U.S. forces deployed into Bosnia, the U.S. Army Engineer School immediately took steps to send additional countermine equipment to them. We fielded low-risk items that showed definite operational potential, working with the countermine technology base at the Communications-Electronics Command, Night Vision Laboratory Countermine Directorate, at Fort Belvoir. That effort soon was absorbed by the Army Countermine Task Force, which provided additional quick "Band-Aid" type enhancements for countermine shortfalls. It broke through much of the traditional acquisition bureaucracy to get limited quantities of needed products into the hands of our soldiers. A follow-on task for the Army Countermine Task Force is to determine an ideal mix of countermine equipment to support contingency operations.

Joint Services

The entire military community has gained a sincere appreciation for the effects of mines. This was made extremely clear during Operation Desert Storm, in Somalia, and now in Bosnia. As the following examples show, many groups within the joint structure are addressing parts of the countermine issue.

The U.S. military services work together on the battlefield, and we require joint doctrine to support them. Joint Publication 3-15, *Barriers, Obstacles and Mines*, currently is under revision, and the new version will update the countermine doctrine.

One tangible result of the President's policy statement is the recently formed joint unexploded ordnance (UXO) and countermine working integrated product team (WIPT). This team is tasked to coordinate user requirements and development work across all services. The WIPT defines five categories of users:

- Combat countermine
- UXO site remediation
- UXO disposal
- Humanitarian demining
- Explosive ordnance disposal active range clearance

The WIPT showcases the vastness of the problem. An Engineer School representative is the subgroup chairman, and he articulates the joint services' combat countermine requirements. A follow-on task for the WIPT is to compare the requirements of all five groups, eliminate redundancy, and streamline technical solution sets.

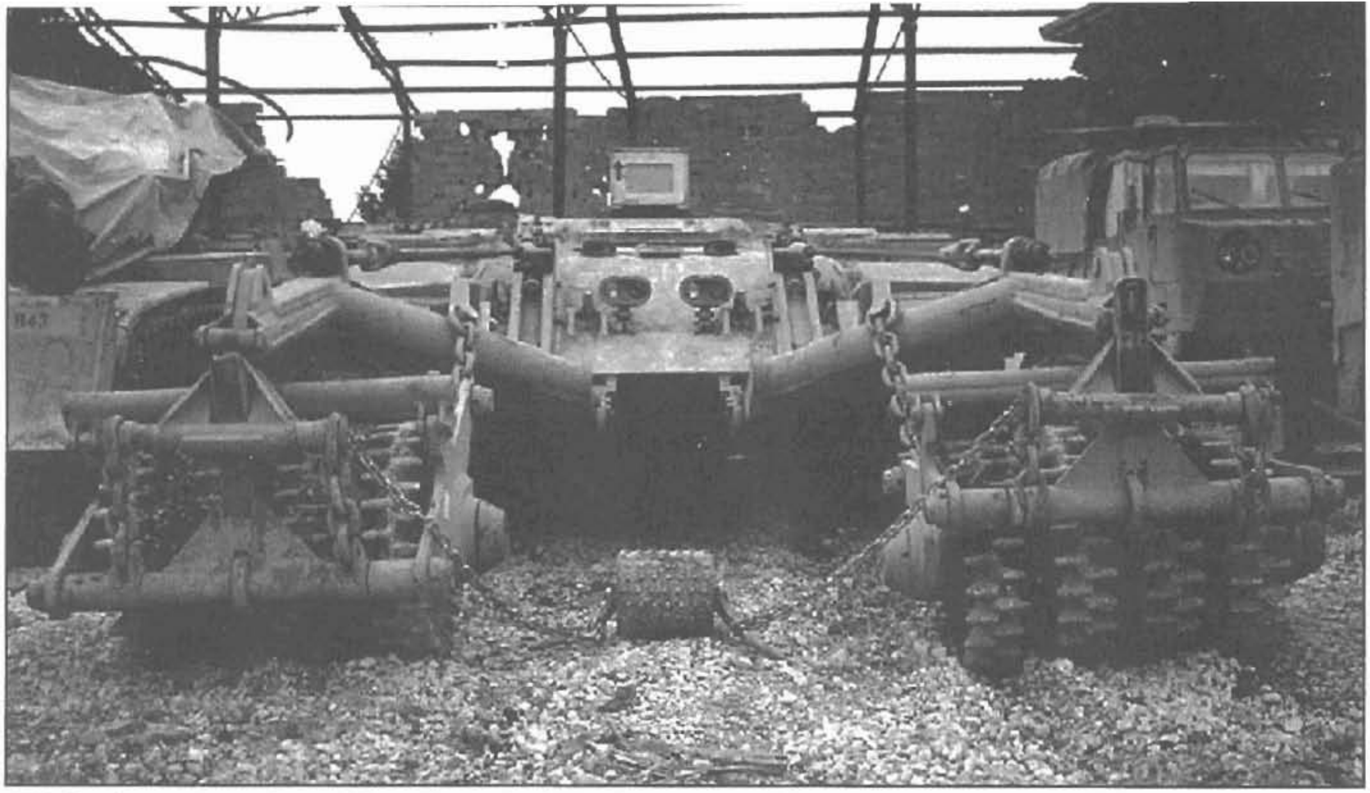
The Defense Science Board focuses a brain trust of outstanding scientists, retired senior military, and captains of industry on defense matters. They are exploring the challenges of UXO remediation. To ensure that recommended products meet user needs, they established a working liaison with the Engineer School. Board members consider mixes of technologies, such as ground-penetrating radar, remotely operated systems, and nuclear quadripole resonance.

The Defense Advanced Research Project Agency and its advisors in industry and academia, the Defense Science Resource Counsel, and the JASONs address the mine-detection challenge by attempting to artificially replicate the chemical detection process that takes place in a dog's nose.

To promote education and training regarding the mine issue, the Naval Post-Graduate School is hosting a week-long seminar in November 1996 that will showcase working solutions.

Federal Agencies/Private Industry

This is the hardest category to describe because it is so diverse. Unlike most military technological challenges, solutions to the countermine problem have vast federal and



M60 Panther countermine vehicle with track-width mine rollers and improved dogbone assembly.

commercial applications—vast *lucrative* possibilities. Demining is big business. Although profit is a strong motivator, motivations include everything from money to moral responsibility and to simple mission satisfaction.

Among the federal agencies with operational interests in UXO and countermine issues are the Departments of Defense, Energy, Interior, and State; the Federal Aviation Administration; and the Environmental Protection Agency. National laboratories, including those at Livermore, Los Alamos, Oak Ridge, Sandia, and the Savannah River, are pushing the technological envelope to find workable solutions. Potential solutions range far afield—including, for example, genetically engineered bacteria that produce a protein that glows in the presence of explosives. (Don't laugh, it works!). If technology can ensure reliable detection of explosive material, the antiterrorism applications alone would be incredible. Additional missions, less glamorous but necessary, include cleaning hundreds of ranges affected by the Base Realignment and Closure (BRAC) initiative.

Participating private and commercial institutions include numerous defense, environmental, medical, and security contractors. Academic participants include the University of Missouri at Rolla, Duke University, and Ohio State University. Promising developments at these institutions may result in school grants. As their developments produce iterative improvements, everybody wins. Academia is exploring some innovative ideas that may evolve into great successes.

International Organizations

Several international organizations dedicate significant energy to the UXO/ countermine/demining challenge. The cornerstone organization is the United Nations. The UN has sponsored and financed demining operations worldwide and set the standard for performance and international demining contracts.

A coalition formed by America, Britain, Canada, and Australia (ABCA) has a Countermine Special Working Group that shares ideas, doctrine, and techniques. A countermine subgroup of the U.S./U.K. Staff Talks meets biannually to share data and techniques. The U.S. and Canada share test data and ideas. As a result of the open dialogue and extensive experience of coalition members, participants' understanding of countermine concepts has increased significantly.

The South African Defense Force, which has more than 20 years of active countermine activities, willingly shares its approach to the problem. Their military has adopted an aggressive program to make all military vehicles safe from mines. This program, coupled with unique mine-detection and mine-clearing equipment and a mine-hunting program that includes bounties for mines, has rendered land mines of little value to insurgents in South Africa.

Clearly a strong sense of cooperation permeates the international community. This cross-fertilization is reaping great benefits.

What's the Army Doing?

The Army is gaining a clear understanding of the countermine challenge. A deployed force that conducts operations in a mine-threatened environment is faced with one of two distinct problems: In a combat operation, the force must be capable of free maneuver (maneuver-oriented countermine, where risk is traded for speed). In an operation less than combat, it must ensure there are no mine casualties (a force-protection orientation, where speed is traded for risk). These problems require different solution sets, and neither is satisfied simply by placing an engineer with an AN/PSS-12 mine detector on the ground.

A significant outcome of Operation Joint Endeavor is the shattered perception that countermine is exclusively an engineer mission. All forces in Bosnia are encountering mines and must "deal" with them tactically. The need for the entire Army to perform missions in a mined environment has expanded the player list to include everyone. This is a mission for the entire force!

TRADOC has chartered a Countermine Integrated Concept Team to develop a holistic concept across all branches, all battlefield operating systems, and all DTLOMS (doctrine, training, leader development, organization, materiel, and soldiers). On the basis of this concept, the team will determine what future operational capabilities must be developed across all DTLOMS and will test them under Battle Lab auspices to determine which should be funded and fielded.

All Army branches must identify how they will operate in a mined environment. They must determine which countermine tasks are so time sensitive that the unit should accomplish them directly, and which require a call for help.

The Army must institutionalize mine-awareness training, as it has NBC training. This includes training for—

- Soldiers—initial entry, annual, and predeployment training.
- Leaders—basic and advanced officer and NCO courses
- Units—the Army Training and Evaluation Program, combat training centers, and field exercises.

The President's policy set the stage for Department of Defense engineers to start planning support to special operations forces in humanitarian demining missions. The current concept has the Army in the lead.

What Happens to the Engineer Role?

While its too early to tell, it appears that the engineers' role will significantly expand. We understand the need for an extensive mine database in Bosnia and the need for a formal "Mine Action Center" when mines are the major threat to an operation. We require an improved reconnaissance capability. The requirement to keep routes open through sweeping and clearing operations is returning to our mission essential task list (METL). Engineers have other new tasks: answer 911-type calls when units get in trouble, extract wounded, clear mission-critical areas, and resume operations. Additional tasks engineers are almost assured to acquire include assisting with humanitarian demining through reconnaissance, recording, mapping, training, and proofing for quality control.

To assist with these traditional and additional missions, we are on the verge of fielding some exciting technologies for engineers:

- The Airborne Standoff Minefield Detection System (ASTAMIDS) is due for fielding in 2002, but an early version mounted on a Blackhawk helicopter is almost ready—and an engineer may ride in the back to watch the screen.
- The first prototype ground-penetrating radars that attach to an AN/PSS-12 mine detector were tested this fall. A few may be purchased for use in contingency operations.
- A mine database system that links powerful computers, stores data, and overprints maps to field GPS survey computers will be ready within months. (See article, page 14).

New engineer equipment employed in Bosnia includes remote-controlled tank rollers and miniflails. Mine protective boots used there may become standard engineer field footwear (they work and are extremely comfortable). The Army is purchasing special mine-hardened vehicles for engineer squads working main supply routes and an interim vehicle-mounted mine-detection system. The Engineer School, working with the Army Countermine Task Force and the Deputy Chief of Staff for Operations, is assembling a set of contingency equipment to augment normal unit equipment for the next countermine operation.

The Countermine Training Support Center, recently established at the Engineer School, is developing new tactics, techniques, and procedures for all mine mission areas. This organization will provide mobile training teams to take new technologies to units that deploy to contingency operations.

Better countermine technologies are coming, and they are coming faster than anyone could have predicted even a year ago. In the interim, Army engineers can expect changes in doctrine; in tactics, techniques and procedures; and in organizations. Keep using your mission focus, your Essayons spirit, and the creativity of your soldiers to attack and defeat this problem. Last but not least, send your good ideas to the Engineer School. Together we can win the countermine battle.

Colonel Greenwalt is the director, Directorate of Combat Developments, U.S. Army Engineer School. Previous assignments include chief, Nuclear Division, and weapon's effects officer, U.S. Army Nuclear and Chemical Agency; and chief, Tactics, Training, and Doctrine Division, U.S. Army Engineer School. COL Greenwalt holds a master's degree in National Security and Strategic Studies from the Naval War College.

Major Ockrassa is an action officer in the Director of Combat Developments at the U.S. Army Engineer School. She serves on the Army Countermine Task Force, the Countermine Integrated Concepts Team and the UXO Requirements Subgroup of the Integrated Products Team.

Mine Detection Sensors

By Jim Smith

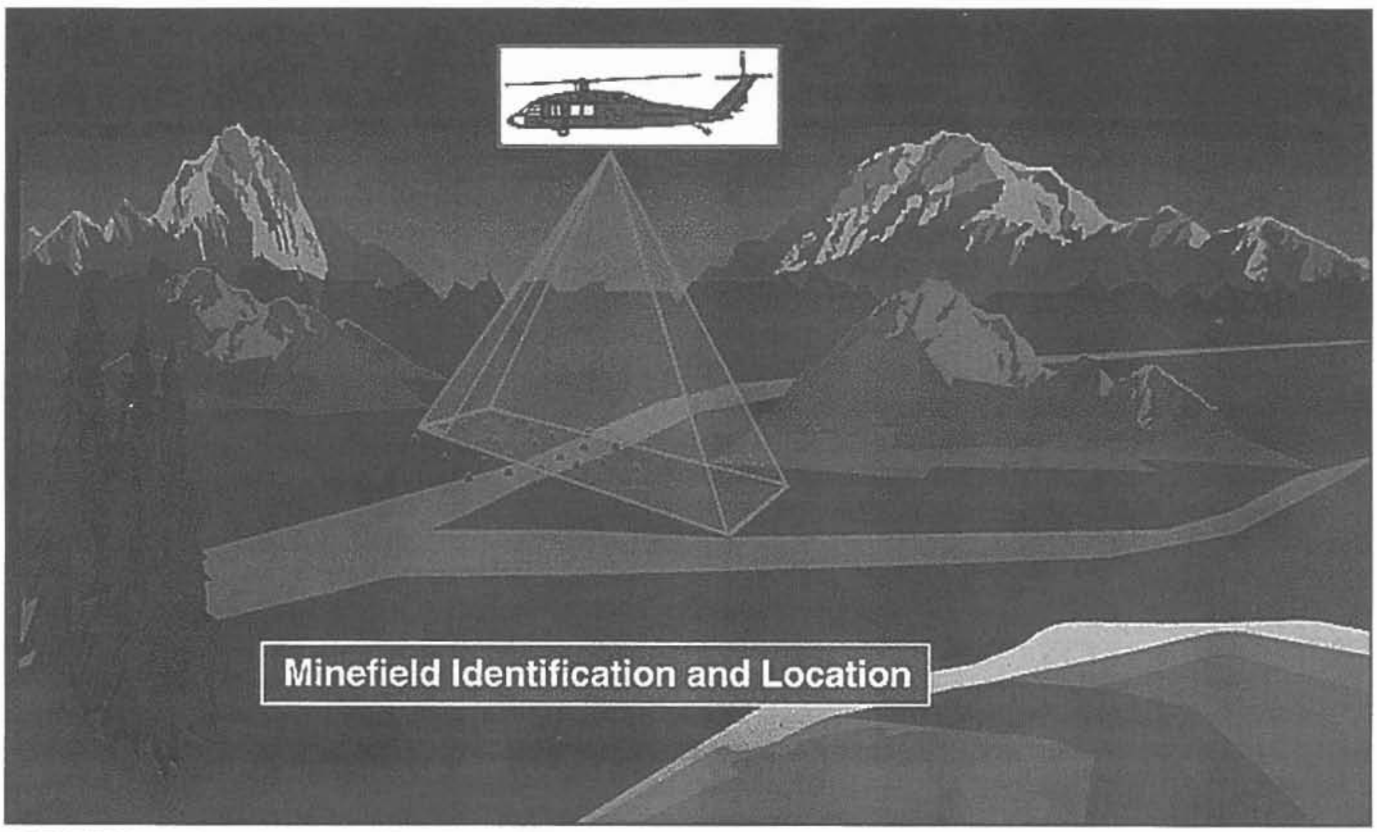
Over the past century, land mines became an inexpensive, effective means to stop enemy movements and demoralize personnel. Deployed and stockpiled, they number in the hundreds of millions. They will continue to pose a threat to soldiers and civilians alike for generations. To combat their threat, countermine efforts have pursued numerous mine-detection approaches. One result is the fielded handheld AN/PSS-12 metal mine detector. The "silver bullet" solution to mine detection has eluded our efforts.

Why is it so difficult to find an object buried just inches underground? One reason is that Mother Nature provides an endless number of roadblocks in the way of environmental factors that change hourly. Also, mine manufacturers produce an almost infinite variety of mine features such as size, shape, and composition. Their only commonality is the intent to thwart effective mine detection. Technological approaches often fail to meet all of the combat developer's requirements. Often, the solutions are too big, too heavy, or too slow to meet requirements. Finally, countermine program funding is usually too low and fluctuates with demands for other military equipment.

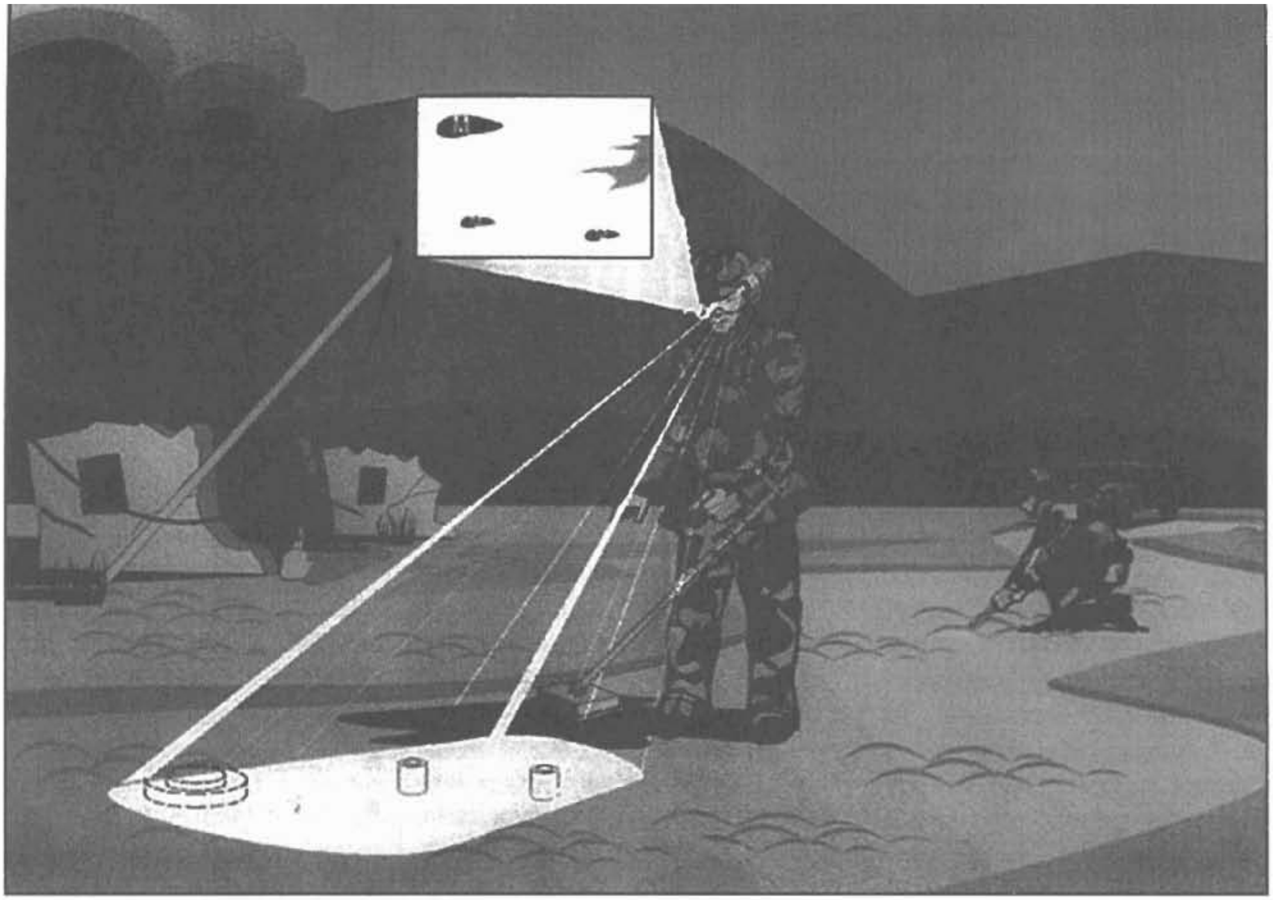
The Defense Science Board of 1987 suggested three technologies with potential to meet the mine detection challenge:

- Metallic detector sensors.
- Ground-penetrating radar (GPR).
- Infrared (IR) sensors.

All three technologies are useful in mine detection, but they have latent limitations that impact the mission. One common point is that none of them is



ASTAMIDS consists of sensors (IR or IR and laser) mounted on either fixed or rotary-wing aircraft and helicopters. Data processing (minefield detection) will occur onboard a helicopter or in a ground control station.



HSTAMIDS is a multisensor handheld mine detector that will replace the AN/PSS-12. The "standoff" sensor is a FLIR. A metal detector and GPR sensors are mounted on a wand similar to the AN/PSS-12.

specifically a mine detector. They are anomaly detectors, because they look for metal, ground density, or thermal anomalies. By judicious use of equipment coupled with visual cues, an experienced mine sweeper can find many (if not most) mines under varying soil, weather, vegetation, and topographic conditions. Of course, there is no perfection in this world, so some mines may be missed. The challenge is to know when and how to use the various sensors for the best results.

Other technologies are emerging from industry, universities, and the government. These will be evaluated for technical potential as well as operational utility, and we will need lessons learned about them. We can assume that each will have some strengths and some weaknesses. Many are so new that it will take years to prove their capabilities.

Our mine-detection capability will improve when the Army fields three emerging Standoff Minefield Detection Systems (STAMIDS). They are—

- Airborne STAMIDS (unmanned aerial vehicle (UAV) or helicopter-mounted) is scheduled for fielding in FY02.
- Handheld STAMIDS (the replacement for the AN/PSS-12) is scheduled for fielding in FY03.
- Ground STAMIDS (vehicle-mounted) is scheduled for fielding in FY06.

A brief description of the sensor technologies used in these systems and how they are fuzed together follows.

Metallic Detector Sensors

The theory is simple. Although there are different metal-detection technologies (such as balanced bridge and metallic induction), the basic concept remains the same: As the detector head moves over a metallic mass, the detector senses a change in the magnetic field under it. This initiates an audible signal (and often a visual signal for reduced noise operations), which alerts the operator. By moving the detector head forward/back and left/right, the location can be narrowed to within a few inches. Mine and "coin" detectors share many characteristics, but the capabilities of coin detectors pale by comparison. Today's advanced mine detectors find minuscule metal traces, are hardened for rough field use, and some can be used underwater.

To some extent, metallic detectors are our most dependable workhorses. They are not subject to error from soil moisture and other weather-induced variables. If all mines possessed enough metallic content, metal detectors would be adequate as stand-alone sensors. Unfortunately, mine construction is veering from large, metallic bodies to small, nonmetallic mines. Lightening and reducing mine size decreases the cost, weight, and manpower needed to transport and employ the mines. Gluing metal onto nonmetallic mines is one answer, but it is expensive and labor intensive. In addition, there is no way to control the mine producers and users to ensure that all mines receive the metal tab. We foresee more nonmetallic mines in the future, because they defeat metallic sensors.

The AN/PSS-12 evolved out of an effort to find low metallic content mines. In use by many NATO and U.N. forces, it proved itself in Operation Desert Storm, Somalia, Haiti, and in Bosnia. Along with its improved maintainability, cheap operation, and interoperability among friendly forces, the AN/PSS-12 detects minuscule metal amounts. However, it has two major shortfalls that are common with all handheld mine detectors:

- It is "look down" only (it must be within inches of mines to detect them).
- It cannot find totally nonmetallic mines.

Finding mines from outside their lethality distance is a critical detection survivability objective.

Ground-Penetrating Radar

The GPR sensor is typical of all radars. It includes two antennae: one to broadcast an active signal through the ground and another to receive the reflected signal that bounces off whatever is in the ground. These bounced-back echoes are plotted to trace the surface texture of the target. Homogeneous soil sends back a flat image, but add a mine and the picture changes. The mine body, buried in the same homogeneous soil, disrupts the soil density. It reflects an active signal which, in certain radar designs, can actually trace the mine surface much like a topographic map.

One radar developed by the Lawrence-Livermore Laboratory may penetrate the mine housing, search for component planar arrays, and possibly identify the mine by its characteristic planar structure—essentially its fingerprint. This is the high end of advanced radars. To date, it is unproven and requires a detailed mine-construction database.

GPRs are limited by distance from the ground surface and do not work well in conditions of high soil moisture. They work best with aspect angles of "near nadir" (+/- 5 degrees from the vertical); performance drops off as the angle off

GSTAMIDS is a multisensor vehicle-mounted mine detector. It is in concept exploration with development scheduled to begin in FY98. This concept drawing shows GSTAMIDS mounted on a teleoperated HMMWV. The actual system will be different.

the vertical increases. As such, almost all GPRs can be characterized as "look-down" detectors. This requires the sensor to pass over the mine to detect it. Look-down sensors may accidentally trip the mines, thereby detecting the mine by losing the sensor. Also they are slow because every inch of the mined area must be "viewed." A few emerging "look ahead" GPRs promise increased standoff and detector/crew survivability.

Infrared Sensor

Military forward looking infrared (FLIR) sensors search for thermal anomalies. A FLIR can find an active heat source quite easily. A main battle tank silhouetted against vegetation or clear sky is easily detected, but it is more difficult to differentiate between passive thermal targets. Passive targets are those that receive heat from another source (typically solar loading for mine detection). The ability of an object to radiate its heat is impacted by many factors, including size, construction material, and soil moisture. A metal mine radiates heat at a different rate than a plastic mine beside it, as does the soil on which it rests and vegetation and water nearby. This enables a FLIR to "photograph" a scene from its passive, radiated electromagnetic energy.

On the surface, it appears that a FLIR may make an admirable mine-detection sensor, especially since IR is a true "look ahead" sensor. A camera enables the user to take photos from a distance; this is the same concept—just a different slice of the electromagnetic spectrum. Visible light is 0.4-0.7 millimicrons, short-wave IR is 0.7-1.2 millimicrons, medium-wave IR is 3-5 millimicrons; and long-wave IR is 8-12 millimicrons. Most mine-detection sensors are in the medium- and long-wave IR portions of the spectrum. The 3-5 range works in most areas and reduces the number of false alarms because of its narrower sensitivity. The 8-12 range is more sensitive, but it has a higher false-alarm rate.

IR has technical limitations. It requires solar loading to develop passive heat signature. As the sun moves throughout the day, shadows from trees, buildings, and other solid objects move. This changes the amount of solar loading available to a mined area. Cloudy days lower or eliminate solar loading. Precipitation reduces the dielectric at the soil/mine interface. Any object (such as a rock, beer can, or lost wheel cap) buried in a given soil type has its own thermal signature. Additionally, IR sensors can't "see" through solid objects (such as foliage); they require optical access to mines or at least to the soil over mines.

As the sun rises, mines and their environment soak up solar heat at different rates. During the morning, cold mines show well against the warmer soil. During the evening, warm mines show well against rapidly cooling soil. At full night and around noon, mines and their background environments are at roughly the same temperatures; hence, no thermal signatures.

The FLIR is essentially blind at certain hours, but has excellent vision at other times. Having the flexibility to use the sensors only when they work well makes IR an excellent tool. Unfortunately, soldiers must conduct operations throughout the day and under all weather conditions. The trick is to use IR when it is most effective and plan mine-detection operations around its best target of utility.

Sensor Fusion

There is one important option in using the three sensors discussed in this article: We can take each sensor's output, combine the best features of each, and process them using a mature algorithm. By processing data from each sensor into an integrated whole, we keep their strengths and filter out their weaknesses. At times, the processor must ignore one sensor and use the remaining two. This sounds easy, but developing complex processors and efficient algorithms is as difficult as developing complex sensor technologies. A few commercial companies entered the market during the early 1990s, and today we have high-speed processors that can handle the huge data influx from the sensors. Companies with in-depth countermine experience are working diligently to improve their sensor fusion algorithms. Algorithm development remains the long pole in the tent for mine detection.

Conclusion

Mine detection is a complex, difficult task we are working to solve. The challenge to materiel developers is tremendous. Combat developers (in this case the Engineer School) often establish stringent operational requirements. Our intent is to provide a family of robust mine detectors that will safeguard the force. Combat and materiel developers are working together to achieve this goal.

Jim Smith is a countermine combat developments materiel analyst at the Engineer School. He has 32 years of military/retired service with nine years of countermine experience. Mr. Smith holds a bachelor's degree in earth science.

Alternatives to Antipersonnel Mines

By Captain Bryan Green

On 16 May 1996, the President announced a new policy that establishes guidelines for the use of antipersonnel (AP) land mines by U.S. forces. (See "Clear the Way," inside the front cover.) The following information describes actions taken by the U.S. Army Engineer School in a vanguard effort to prepare for the 1999 moratorium on mine warfare.

Photo courtesy Sandia National Laboratories

Sticky Foam

Countermobility Mission Needs

For military forces to meet combat mission requirements and stay within the policy limits, they will require nonlethal AP munitions that support the countermobility mission. These munitions must fulfill the intent of AP obstacles against both combatants and nonbelligerents, provide less-than-lethal effects, and preserve the lives of innocent parties.

Munitions that can discriminate between noncombatants and belligerents, such as claymore mines and other man-in-the-loop (command-detonated) systems, are not considered AP mines under the new policy. However, they are discussed as an AP mine alternative in this article.

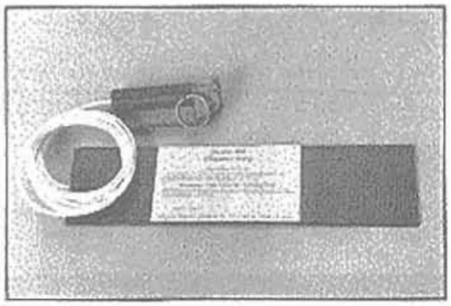
Constraints

When implemented as prescribed, nonlethal munitions must incapacitate, distract, or contain both nonbelligerents and military forces. While directly affecting personnel and vehicles, they must provide the equivalent physical and psychological deterrents as existing lethal mines but leave no permanent damage or intentional disability. Nonlethal AP munitions also must interface with existing military vehicles and systems, operate in all types of weather, and be environmentally safe.

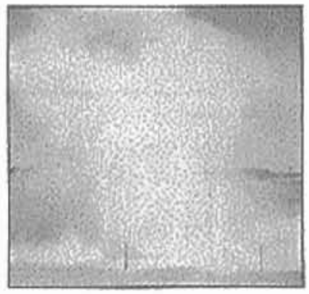
Before describing new technologies that may replace conventional AP mines, we must define what these AP mines do. Review of mine-warfare doctrine and conventional uses leads to four basic capabilities:

- Protect other mines (antitank) or obstacles from dismounted forces.
- Provide an economy of force by effectively denying terrain; they

Flash/Bang-Type Munitions

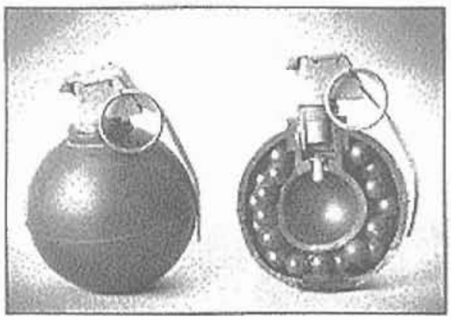


M460 Thunderstrip Stun Munition



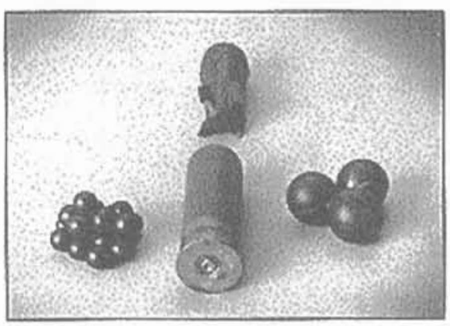
Bursting Smoke Grenade

M359 Bursting Obscurant Smoke Grenade

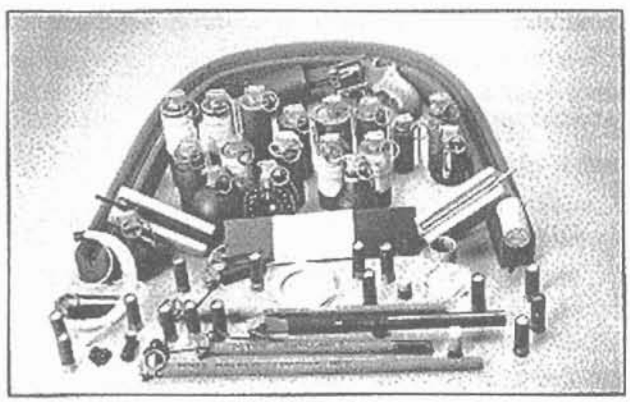


M452 Slingball Stun Grenade

Multiflash Diversion/Distraction Grenades



Rubber Bullet "Slingshot" Ammunition



SPLLAT Munitions

Soft-Projectile Munitions

Various nonlethal antipersonnel munitions that may be used

equate to an additional soldier or sentry on the battlefield.

- Act as a protective obstacle to defeat the enemy's final assault on a position.
- Act as a psychological deterrent.

Any successful AP mine replacement or group of replacements must achieve these four functions. All man-in-the-loop munitions meet these criteria. Command-detonated claymores, for example, allow soldiers to discriminate targets and distinguish between belligerents and noncombatants before detonation. However, many nonlethal options fail to meet the psychological deterrent criteria.

Alternatives

Based on these guidelines, the Army and the Engineer Corps are pursuing alternative nonlethal man-in-the-loop and tunable (selective-energy/progressive-penalty) munitions.

The countermobility remote-control system (CIRCE) is one man-in-the-loop initiative. It is a teleoperated system of fiber-optic monitors that relays information back to the controller. It allows the operator to decide whether to fire or not. The CIRCE controls conventional mines and effectively makes them command-detonated.

Possible alternative nonlethal munitions

System	Capability
Tasar	Shoots low-voltage darts that incapacitate the target.
Sticky-foam mine	Covers the target with encapsulating foam.
Sting net	Shoots nets that are charged with low-voltage electricity and cover a 50-meter area.
Microwave energy	Beams from a field generator and slowly heats the skin. It gets hotter as the target approaches the source. If the target progresses too far, the heat produces a casualty.
Soft-projectile kinetic-energy munition (Nonlethal claymore mine)	Shoots rubber balls, beanbags, or baton rounds instead of steel pellets.
Water slug munition (tunable munition)	Fires supercharged slugs of water in the autonomous mode or turns to an explosive charge when command-detonated.
Texas boot	Locks or attaches to the foot, immobilizing or limiting mobility.
Embrittling/galvanizing agent (a spray chemical or powder)	Corrodes material or fibers or causes mechanical parts to fuse together.
Radio-frequency-kill munition	Causes a nonnuclear electromagnetic pulse that destroys computers and electronic circuits, effectively stopping vehicles and forcing equipment to be operated manually.
Tessler coil	Creates a harmonic wave that produces a tremor within a 100-meter radius.

Another man-in-the-loop system is the intelligent minefield (IMF). This prototype system will ultimately develop into both an artificial intelligence and a man-in-the-loop automated combat-security outpost. The outpost will employ an array of lethal, nonlethal, and tunable munitions. The IMF probably will control a suite of sensors that can cue fires and command and control elements.

Tunable munitions are systems that incorporate nonlethal technology. Selective-energy munitions remain autonomous while in the nonlethal mode, preventing casualties or damage to noncombatants. They can be placed in a lethal mode when there is a man in the loop.

Progressive-penalty munitions provide another option. They are designed to temporarily incapacitate both soldiers and noncombatants. These tunable munitions start with a nonlethal response but progress to an ultimately fatal penalty for continued perseverance in a particular direction.

Some nonlethal systems that the Engineer School is considering for future use are shown in the table above. These are just a few of the alternatives currently being pursued.

We welcome new ideas for AP mine replacements. To offer suggestions, call Captain Bryan Green at the Maneuver Support Battle Lab, DSN 676-7355 or commercial (573) 563-0131, extension 3-7355.

40-millimeter baton/beanbag/sponge round

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Building a Minefield Database System

By Major Edward B. Taylor

The deployment of U.S. forces to Bosnia highlighted an engineer information operations shortcoming. The 1st Armored Division (1AD) Engineer Brigade identified a void in our ability to develop and maintain mine-threat information in an immature theater. Their challenges include fulfilling doctrinal responsibilities as the custodian of the "dirty" battlefield, developing mine-threat information to ensure force protection, and incorporating a solution into existing command and control (C2) platforms that support the maneuver commanders. These commanders require detailed information about minefields and other obstacles during and after hostilities. So how do we track thousands of minefields now? How can we improve the way we track them in the future?

The 1AD Engineer Brigade determined that computer technologies were the appropriate tools to track mines. However, current table of organization and equipment (TO&E) units lack the computer equipment and expertise to build and manage complex databases. Due to their tenacity and resourcefulness, engineer soldiers in Bosnia are successfully managing this information with an ad hoc organization and database. But their solution is theater specific.

Considering the experience of these engineer soldiers, we must begin now to prepare for the "next Bosnia." We must capitalize on the experiences and recommendations of the 1AD Engineer Brigade to develop a useful set of database tools and a supporting organizational structure.

The Night Vision and Electronic Sensors Directorate (NVESD) of the Communications and Electronics Command and the Engineer School have developed a program to build a comprehensive database system. Between December 1995 and August 1996, their strategy slowly emerged.

Strategy

The NVESD and the Engineer School agreed on a three-phased approach to solve the mine-tracking problem (see table below). In the near term, we sent a quick fix to the engineers in Bosnia—commercial computers, printers, and software to give soldiers there an improved capability. However, this "Bosnia Band-Aid" is not the solution for the future.

The near future (1 to 5 years) requires an interim system that bridges the gap between Bosnia and Force XXI (Figure 1). It will combine lessons learned from Bosnia with currently known Force XXI requirements. This data will define the operational requirements to create a contingency system for near-term future operations.

Lessons learned from the interim system and related events will provide the framework for the design of the objective system for Force XXI. Both Task Force XXI and the Joint Countermine Advance Concept Technology Demonstration (JCM-ACTD) are likely sources of additional or refined requirements.

The remainder of this article describes the interim system.

Phases of building a minefield database system

Phase	System	Target	Characteristics
Near term	Bosnia Band-Aid	Quick fix	■ Commercial hardware/software ■ Paper maps ■ Current capabilities plus enhancements
Near future	Interim system	Post-Bosnia missions	■ Windows and UNIX systems mixed ■ Bosnia minefield database program
Far future	Objective system	Force XXI	■ Army common hardware/software ■ Digitized Army

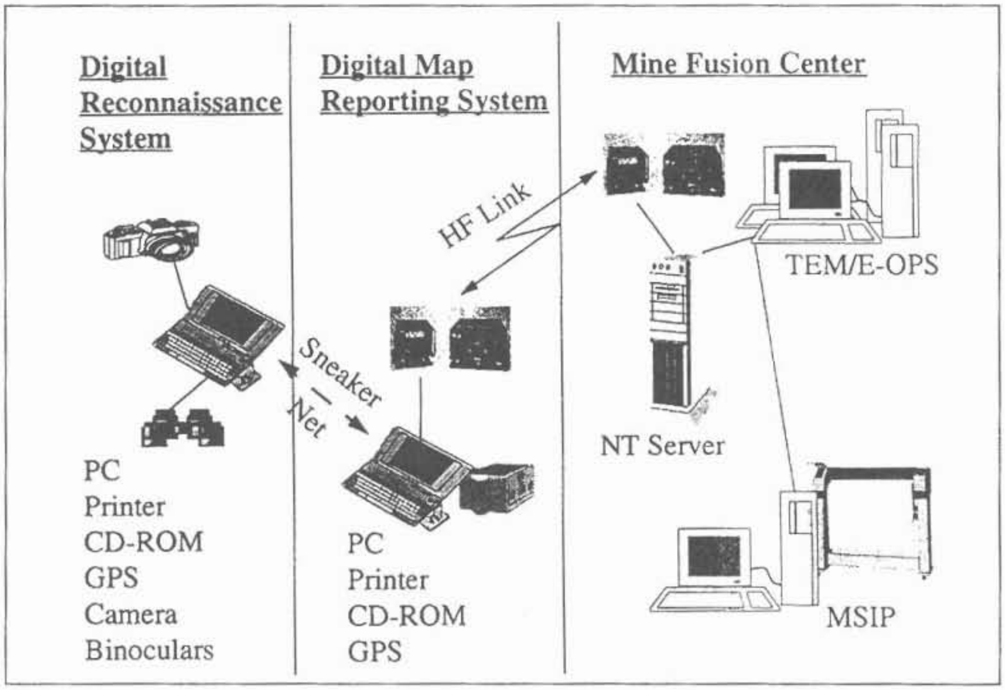


Figure 1. The interim minefield-database system

Mine Fusion Center

The organization charged with collecting and disseminating minefield information in Bosnia is the Mine Fusion Center, which resides at the engineer brigade level. Other United Nations and NATO organizations in theater use the term *Mine Action Center.* In the JCM-ACTD, which is scheduled to begin in the summer of 1997, a similar organization called the *Mine Warfare Center* is under consideration. Regardless of the name, the unit that gets the next Bosnia-type mission should have a minefield information system ready and waiting, with an organization such as these centers provide to operate it. Figure 1 shows the components of the developing system. In addition to the devices discussed below, each system contains both a color and a black-and-white printer, a CD-ROM recorder, and a scanner.

TEM/E-OPS

The Terrain Evaluation Module/ Engineer-Obstacle Planner System (TEM/E-OPS), the central database, maintains minefield information and provides it to other systems. The program developer is the Waterways Experiment Station (WES), a Corps of Engineers Laboratory.

TEM/E-OPS is a prototype of the Tactical Engineer Command and Control System (TECCS) (Figure 2, page 16). Eventually, it will merge into the Maneuver Control System (MCS) as the engineer piece of that system. TEM/E-OPS is a combination of terrain-visualization capabilities and engineer decision-support applications for planning and tracking battlefield operations related to mobility and survivability. It currently runs on a Common Hardware and Software II (CHS II) workstation, which is a Sun workstation that runs a UNIX operating system. Each workstation contains two TEM/E-OPS to provide 100-percent redundancy.

TEM/E-OPS is being enhanced to provide capabilities required by the minefield database program. These enhancements include:

- A database modified to include portions of NATO STANAG 2430, *Engineer Reports and Returns*, and three STANAG minefield-related messages.
- A user interface to modify database entries and attributes.
- Ability to plot minefields with appropriate symbols.
- Ability to export data to the All Source Analysis System (ASAS) and the Multispectral Imagery Processor (MSIP).

Multispectral Imagery Processor

The MSIP will use minefield-database information received from the TEM/E-OPS to produce special digital or paper maps, overlays, or other products that assist battlefield visualization. The Topographic Engineering Center, another Corps of Engineers laboratory, assembles the MSIP.

The MSIP provides an interim capability to generate and print image maps from commercial and national imagery and to perform some terrain analysis of the imagery. MSIP hardware consists of the Common Hardware and Software I (CHS I) workstation. It has several storage devices and one Hewlett-Packard DesignJet 650C large-format printer (it can operate up to three such printers).

The software on the MSIP is Earth Resources Data Analysis System's

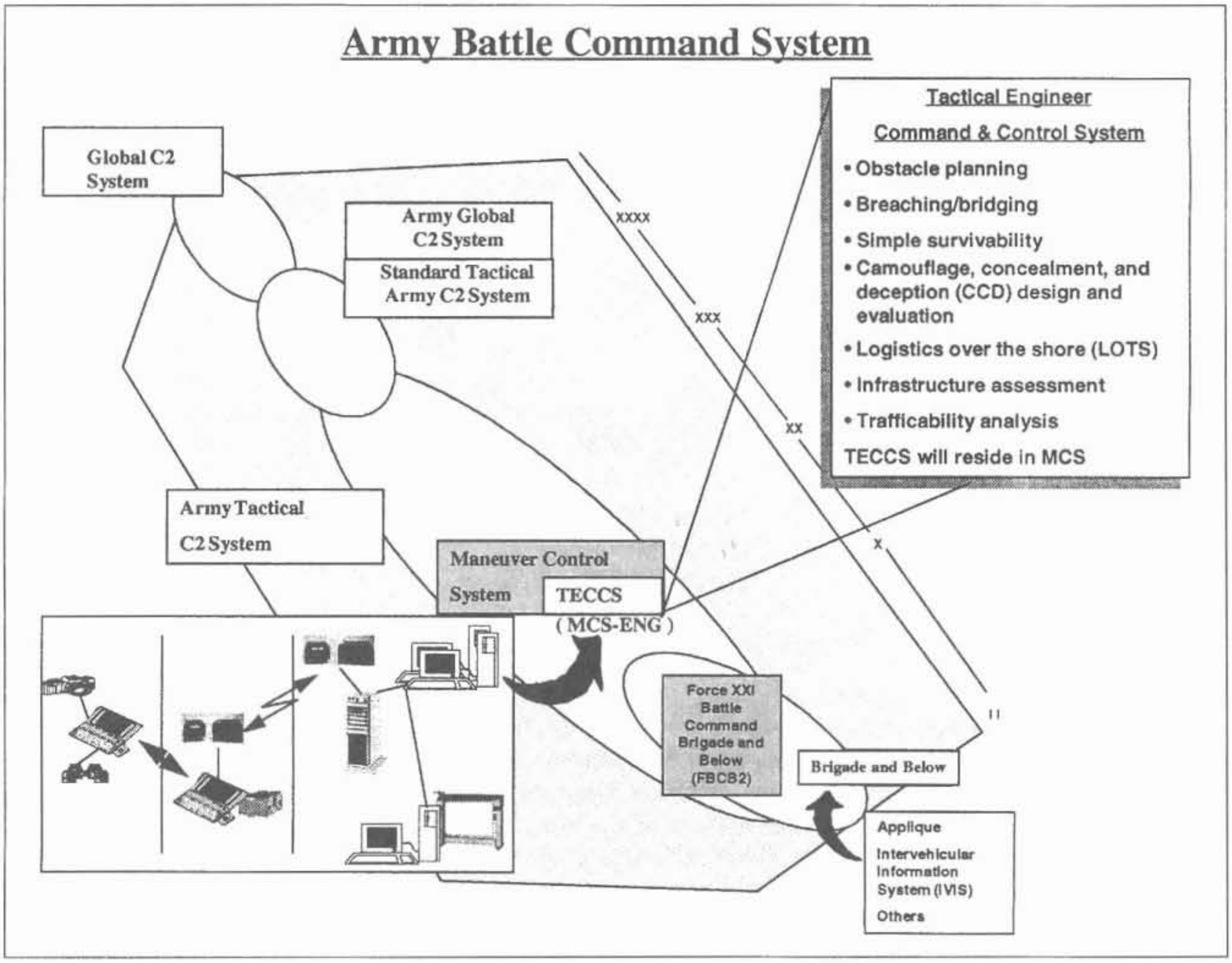


Figure 2. The interim system will merge into the Maneuver Control System as a part of the ABCS

(ERDAS) Imagine, which can—

- Process commercial and national digital imagery.
- Rectify and add grid lines.
- Add thematic layers, intelligence, and environmental conditions overlays.
- Retrieve and use Defense Mapping Agency standard digital databases.

Windows New Technology (NT) Server

Windows NT is an advanced version of the Windows operating system. The Mine Fusion Center's Windows NT server is a temporary storage location for incoming information. The server stores data until it is reviewed, verified, and recorded in the TEM/E-OPS.

The NT server hosts a scanner and a CD-ROM recorder, which allow the Mine Fusion Center to scan minefield records into the database and produce CD-ROMs for bulk distribution to supported units. The NT server also hosts an electronic bulletin board system (possibly Wildcat Navigator) to provide a digital wireless e-mail link between the engineer battalions and the Mine Action Center.

High Frequency (HF) Radio

The NT server has a Joint Internet Controller (JINC) that readily connects with tactical ultra-high-frequency (UHF) radios (such as SINCGARS [single-channel, ground-to-air radio system]) or HF radios. This connection allows the transmission of digital minefield reports or updated minefield information between the engineer battalions and the Mine Action Center.

Digital Map Reporting System

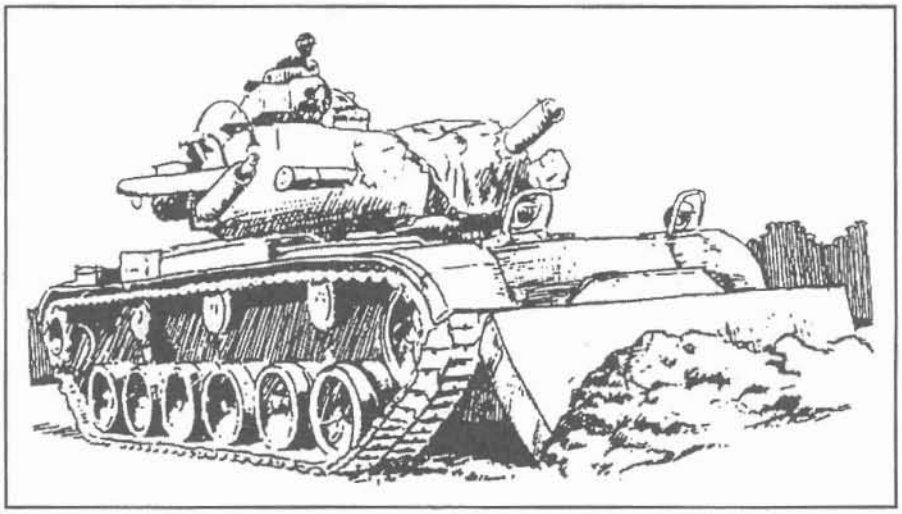
Operators of the Digital Map Reporting System (DMRS) combine information collected by Digital Reconnaissance System (DRS)-equipped reconnaissance units for transmission to the Mine Fusion Center (Figure 1). The DMRS is used at battalion level. It enables commanders to view data collected by their subordinates before it is transmitted to the Mine Fusion Center. Software being written for the DMRS will allow the battalion to receive minefield data from the Mine Fusion Center and display it on digital maps.

(Continued on page 61)

Death of the Combat Engineer Vehicle

By Command Sergeant Major Timothy B. Chadwick

It is official, the Army has declared that the combat engineer vehicle (CEV) will cease to exist throughout the Army inventory. When I heard the news, many emotions ran through me in a split second. I felt relieved of the burden of trying to maintain a piece of equipment based on a chassis system that the rest of the Army had retired. The second feeling was that of disgust—that the leadership of our Army finally agreed with us engineers about how painful maintenance of this system had become.



Several days passed before the last and probably most important emotion hit me head-on. Evidently it took that long to fully digest the impact of the loss of the CEV, without a replacement identified. I can only call this emotion fear. That's right, fear—that we are getting rid of a piece of equipment based on our inability to maintain it and not on an evaluation of its tactical requirement. My fear centers around engineer soldiers of the future and their need for a standoff demolition capability that only the CEV or a like vehicle can provide.

I am fully aware of the Army's research into a 120-mm gun round that will replace or closely resemble the capabilities of the 165-mm CEV round. Can that be done? You bet it can, but my concern doesn't center around the round itself. Why did we look at keeping the gun tube of the CEV so short? I believe that we recognized the need of a turret system for use in tight spaces, such as cities. That tactical possibility exists today and will continue to exist in the future. I tried to remember how many times I personally saw tanks in urban areas with their gun tubes restricted or even stuck through building walls. I soon realized there were far too many times to count. So, how do we solve this problem in the future? I say that the solution must center around a turret system that resembles the one on the CEV.

I fully realize and agree that the current CEV is too difficult to maintain at the necessary operational readiness rate of our leaner Army. My primary concern remains that mechanical and monetary nightmares overrode our tactical need. Will we need the CEV in the future? You bet we will! I only hope that someone realizes it before a bloody nose forces its replacement.

So ends our love-and-hate relationship with the CEV. To all of the soldiers who manned the CEV, past and present, a hearty "well done!" is in order. You employed and maintained the system to the best of your abilities, and for that you deserve great credit. To the soldiers who employed the CEV in combat, I ask that you voice your opinions about the need for a standoff demolition capability. Let's not wait for the need to arise in combat before we tell the leadership about our concerns. Soldiers' lives may rest with this lost capability. We must provoke a thorough evaluation of this possible need.

Again, farewell to the single piece of equipment I hated and loved the most of all others during my career.

CSM Timothy Chadwick currently serves as the command sergeant major of the 299th Combat Engineer Battalion (Mechanized), Fort Hood, Texas. He has served in every leadership position available to combat engineers. Previous assignments include three tours with the 7th Combat Engineer Battalion (Mechanized), Fort Polk, Louisiana; two tours in Germany, with the 82nd Combat Engineer Battalion and the 547th Combat Engineer Battalion (Corps) (Mech); and two tours with the 17th Combat Engineer Battalion (Mechanized), Fort Hood, Texas.

Photo-Essay From Operation Joint Endeavor—Part II

By Major Andrew Goetz

Engineers and engineer units must be able to accomplish a wide range of missions, regardless of modified tables of organization and equipment (MTOE). As an engineer observer with Combined Arms Assessment Team (CAAT) II, Center for Army Lessons Learned (CALL) in Bosnia, I found this lesson reinforced most of all. Our current division engineer brigade structure, however, is not designed to accomplish the wide range of general engineering missions asked of it in Bosnia. A large section of this essay addresses my thoughts on the shortfalls of our current structure in the heavy division. I think it's worthwhile to talk about these shortfalls even as we move toward Force XXI. We must identify the capabilities we need. Only then can we design a unit that ensures success in both the high-intensity conflicts for which we must be ready and the Joint Endeavor-type missions that we will surely continue to have.

Base Camp Living Conditions

Much of the base camp construction was complete by the time I arrived in March 1996, and most soldiers were living in relative comfort, with hot showers in almost every camp. The following information shows some of the techniques used to house soldiers in Bosnia.

Brown & Root had the contract for base camp maintenance and upgrades, while engineer soldiers continue to work the force protection mission. The two missions are closely linked and require good coordination at all levels.

Task Force Eagle established a "mayor" in each base camp to serve as the camp administrator. The mayor provides transient housing, coordinates with Brown & Root, and resolves base camp issues as they arise.

Few of the camps are built from the Army Facilities Component Systems standard designs for initial or temporary construction. Most are somewhere in between these two standards and include hardback tents, Force Provider modules, container express (CONEX) camps (often called United Nations container camps), and existing facilities adapted for our use.

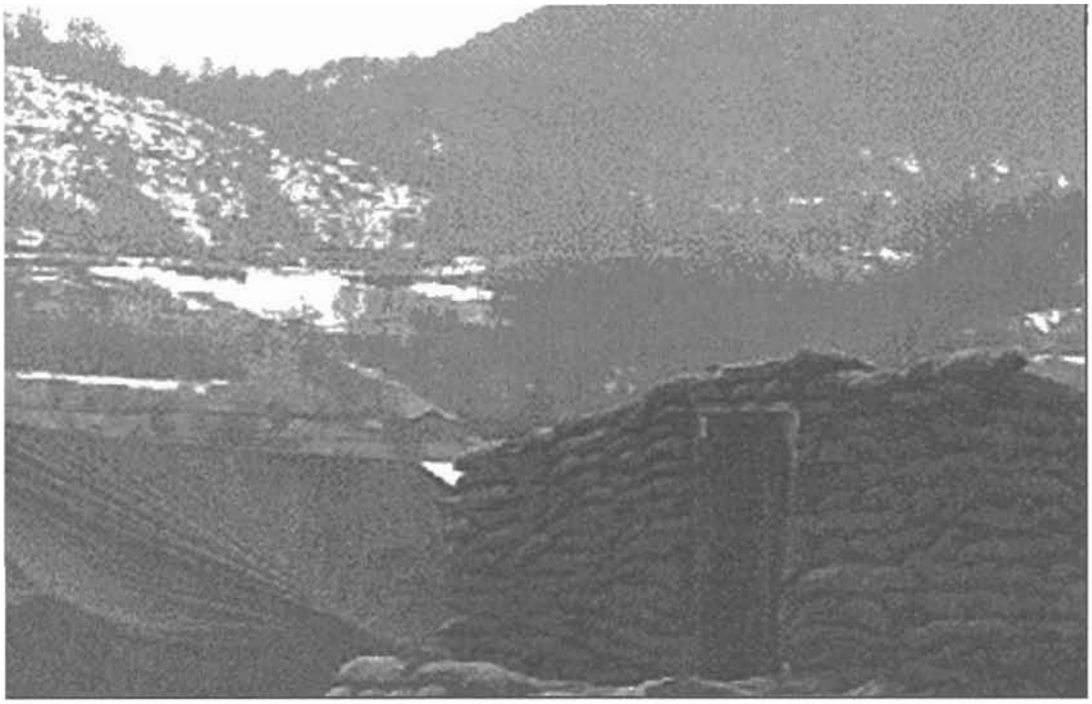
(Photo, left)

Tent City 1 in Tuzla Main, the Task Force Eagle headquarters, is the most traditional type of base camp in Bosnia. The dwellings are hardback, general purpose, medium tents with wood floors, sides, and frames. Boardwalks in most camps keep soldiers out of the mud. Task Force Eagle instituted a self-help program, which provides some materials for soldiers to build shelves, load-bearing equipment racks, and other quality-of-life improvements.

The daily ration cycle is A-MRE-A (hot meal; meal, ready-to-eat; hot meal). Most base camps supplement the lunch MRE with soup, bread, and salad or occasionally serve a hot meal. Mess halls are frequently run by or in conjunction with contractors. At Tuzla Main, the mess hall is run by contractors and is in an old Yugoslavian Army mess hall.

(Photo, right)

This photo shows the difficult conditions under which many of the base camps are built. The tracked vehicle is from the 40th Engineer Battalion. The buildings in the background are typical of those in the zone of separation. They are either destroyed or stripped of useful items, including window and door frames.



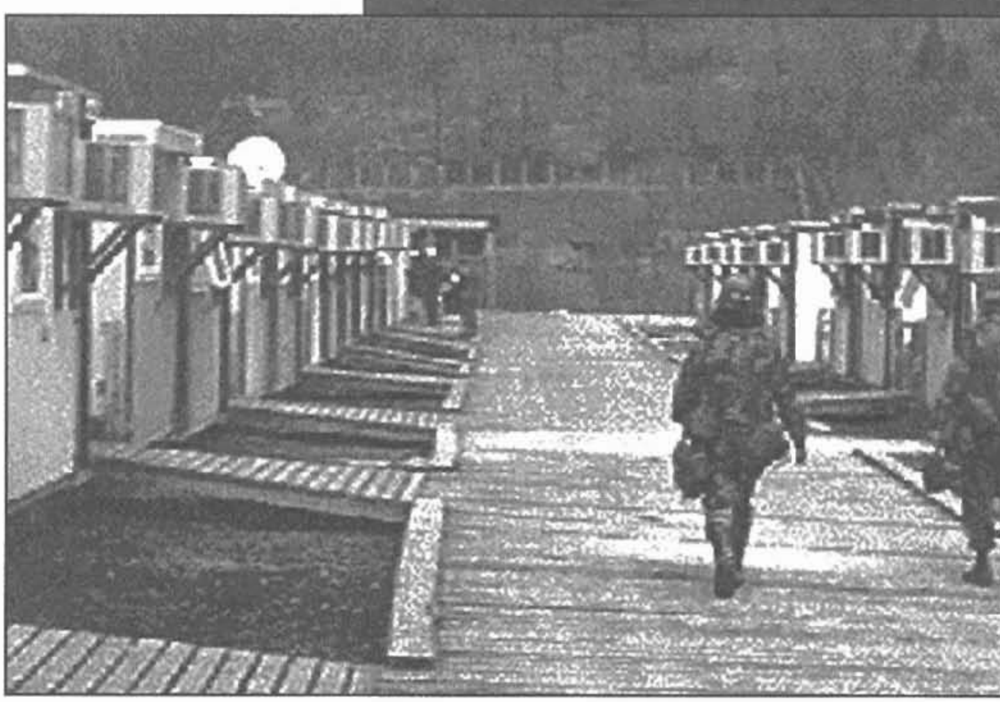
(Photo, left)

This bunker is at Lisa Base, headquarters of the 2d Brigade Combat Team. The bunker is a standard design developed by the engineer brigade. It must pass brigade safety and construction standards inspections before it is certified as complete.

(Photo, right)

This is Steel Castle, home of the division engineers and division artillery. The engineer flag flies at the 94th Engineer Battalion (C)(H). Steel Castle is a Force Provider camp. Each Force Provider module can support 550 soldiers and is comfortable, with electricity, heat, and air conditioning.

Steel Castle is built on a dirt airfield that is extremely muddy. Gravel has been laid for all of the roads, between rows of tents, and in parking areas. Drainage for this base camp, as for other base camps and the entire area of responsibility, is a major concern for engineer units.



(Photo, left)

The 2d Brigade Combat Team camp is made from military-owned demountable containers (MILVANs) with windows, doors, air conditioning, and heat. The containers are also equipped with beds, sheets, blankets, and towels—just like a hotel. This was the most comfortable camp I stayed in.

(Photo, right)

This view of a container base camp in the 2d Brigade sector shows elevated CONEXes and boardwalks. Off the boardwalks, the mud is two feet deep in places and probably was deeper early in the spring. A similar CONEX camp design links the containers into barracks.

Construction Effort

The primary engineer mission during my stay in Bosnia was construction. Mine-clearing operations in the zone of separation were important, but the construction effort clearly drove the engineer train. In Task Force Eagle, the division engineer brigade was responsible for construction. The 130th Engineer Brigade was on the other side of the Sava River, not in Task Force Eagle's area of responsibility. Division engineers also managed the Class IV construction materials.

To complete their construction mission, the division engineer brigade obtained construction management sections from the 130th, the 94th Engineer Battalion, and the 535th and the 362d Combat Support Equipment (CSE) Companies. Division engineers originally asked for a group headquarters to help manage these corps assets, but that request was not approved.

The construction management section provided planning, management, and quality assurance for the division engineers, and the 94th furnished design work. Both units had the Theater Construction Management System, but problems with the hardware were not resolved during my stay.

(Photo, left)

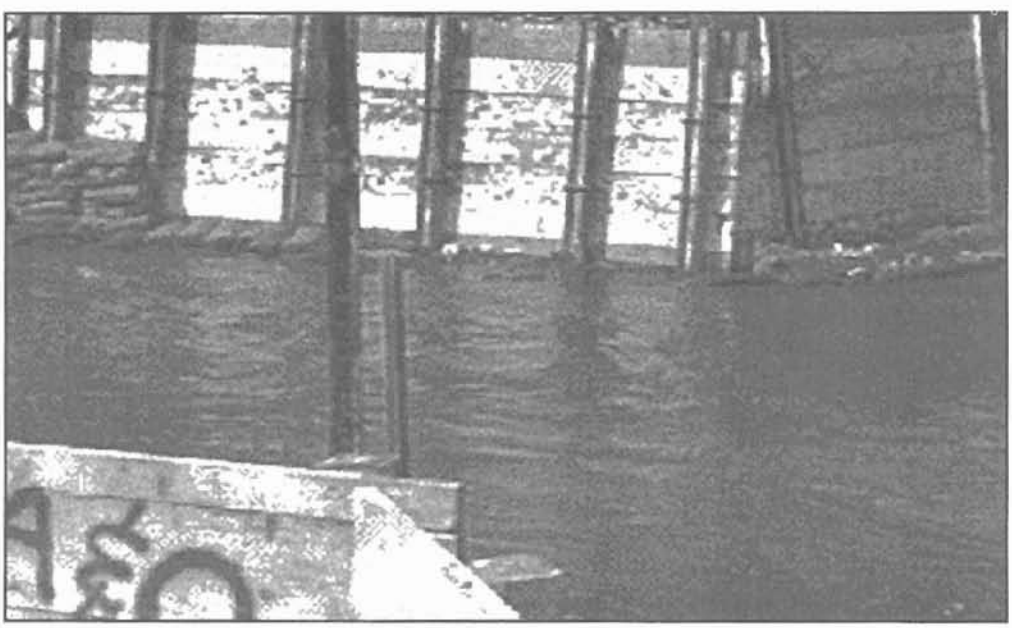
Constructing parking lots and roads keeps every horizontal asset in country busy. Soil conditions throughout the area of responsibility are terrible, and laying gravel on the muddy subgrade does not solve the problem. Mud percolates through the gravel and causes the structures to fail. The solution is to use geotextile fabrics before laying down the gravel. Since geotextiles are not available through the military system, Task Force Eagle purchased large quantities commercially. We should get these geotextiles a national stock number and maintain them in the supply system.

(Photo, left)

Bosnia's extremely weak infrastructure was neglected during the war, and we have weakened it further. Main supply route maintenance is a major concern throughout the country. The 94th did some paving operations, as shown above and in the next photo. Soldiers in Task Force Eagle filled potholes with gravel, cold patch, and hot asphalt. Much of this work was done under contract and was paid for by either NATO or Task Force Eagle, depending on the route and location.

(Photo, below)

The division engineer battalions are deeply involved with construction. In addition to building bunkers, two-man fighting positions and erecting hardback tents, combat engineers completed projects like the bridge abutment shown here. This abutment is for an armored vehicle-launched bridge (AVLB) on the entrance road to a base camp. The 362d Combat Support Equipment Company provided the heavy equipment, and the Assault and Obstacle Platoon, B Company, 40th Engineers, did the rest. This is a fairly significant project for an engineer battalion with the current force structure.



(Photo, left)

This is another view of the AVLB abutment. Sandbags will eventually cover the structure on the river side to protect it from erosion.

Current Engineer Battalion Strengths and Shortfalls

Operation Joint Endeavor highlights both strengths and weaknesses of the current division engineer brigade structure. The benefits having an engineer brigade commander and staff at the division level and battalion commanders and staffs supporting maneuver brigades cannot be overemphasized. The ability of brigades to receive diverse engineer units and to synchronize their efforts in support of the division is a force multiplier that cannot be replaced by an ad hoc or nonorganic headquarters. The habitual relationship between engineer battalion headquarters and maneuver brigades in Bosnia enhanced staff integration of the brigade combat team. It also allowed engineer company commanders and especially platoon leaders to focus on mission execution. The result is accomplishment of the diverse missions described in this article. The basic structure of the divisional engineer brigade is an excellent starting point for the engineer organization of Force XXI.

Despite the soundness of the basic structure, Operation Joint Endeavor highlights several deficiencies in the organization, equipment, and training of battalions configured under the engineer restructure initiative (ERI). My intent here is not to try and turn back the clock in our structure, change the primary focus from warfighting to peacekeeping, or propose a wish list that our resources cannot support. I understand the manpower and fiscal limitations we must work with. I believe, however, that we must identify our current shortfalls in order to design the best engineer structure for Force XXI.

Operation Joint Endeavor is the first true operational test of the ERI concept. It represents our most likely future operations—peace enforcement (with or without forced entry) into a theater with a poor infrastructure and a focus on force protection. From an engineer perspective, Joint Endeavor is not very different from Operation Desert Shield: entry into a theater without pre-existing U.S. facilities, no immediate combat operations, great demands for force protection, and significant construction requirements.

The primary mission of a division engineer brigade is to provide the force with mobility and countermobility support. I believe that, with some minor changes, division engineers can maintain that capability and provide critical survivability and sustainment support as well.

Maintenance

The maintenance organization in the divisional engineer battalion is not robust enough to support dispersed companies during extended operations. The small contact team attached to the companies from the battalion motor pool is usually headed by an E5 soldier. This noncommissioned officer lacks the maintenance management experience and training required to run company maintenance operations. Maintenance support problems are compounded by the low-density, unique equipment in the engineer company. Class IX requisitions and direct-support jobs for dispersed companies cannot be easily supported by one engineer unit-level logistics system (ULLS) computer. If the company goes through the task force for supplies (which is not doctrinally correct for direct support), then the engineer battalion loses sight of the maintenance status of the company. Maintenance for the small emplacement excavator (SEE) and the armored combat earthmover (ACE) was especially challenging during Operation Joint Endeavor. The two key maintenance leaders in the motor pool—the maintenance technician and the motor sergeant—are both wheeled-vehicle maintenance experts. This doesn't make sense because the pacing items are all tracked vehicles.

Shortfalls	Fixes
■ The E5 soldier in the maintenance contact team lacks maintenance management experience.	■ Add enough E6 slots for each company contact team.
■ One ULLS computer cannot support the companies in a direct-support role.	■ Add three ULLS computers and clerks to operate them.
■ The ratio of one 62B mechanic to 45 pieces of equipment is insufficient.	■ Add 62B mechanics.
■ The maintenance technician and motor sergeant are both trained to maintain wheeled rather than tracked vehicles.	■ Change one maintenance technician to an engineer vehicle maintenance technician.

Construction Management

During Operation Joint Endeavor, division engineers were tasked to manage all in-theater construction, which they accomplished with a construction management section obtained from the 130th Engineer Brigade. Task Force Eagle created the "Base Camp Coordinating Agency" to help manage requirements and priorities for base camp construction.

The construction challenges of Operation Joint Endeavor highlighted our need to develop a frame of mind that recognizes that both "combat" and "construction" engineers must be able to manage construction. This concept should be stressed in the Engineer Officer Basic Course and reinforced in the Advanced Course. In addition, the Combat Training Centers should include this concept in their training.

At the conclusion of Operation Joint Endeavor, the Engineer School should take a hard look at the division engineer brigade staff. Based on input from the 1st Engineer Brigade, they should determine if the staff is robust enough to manage the wide range of operations expected of it.

Shortfalls	Fixes
■ No significant construction management capability exists in the division engineer brigades or in the battalions.	■ Stress construction management in both the Engineer Officer Basic and Advanced Courses.
■ The division engineers obtained a construction management section from the 130th Engineer Brigade. ■ The battalions appointed either a captain or a lieutenant as their construction officer.	■ Determine if the division engineer brigade staff needs to be more robust.

Haul Capability

The current engineer battalion structure does not have the haul capacity to self-deploy on a contingency mission to an austere theater or to conduct extended operations. The motor pool cannot break its prescribed load list (PLL) into separate trucks to send to dispersed companies. This capability is a key requirement for low-density equipment for which the task force does not carry PLL. The motor pool has extremely limited Class IV haul capability in a theater where the demand for Class IV material drives much of the engineer mission.

Shortfalls	Fixes
■ Engineers cannot transport all MTOE and tables of distribution and allowances (TDA) materiel. ■ Engineers cannot transport Class IV unit basic load (UBL).	■ Add six dump trucks to the engineer battalion's support platoon.
■ The motor pool cannot haul its PLL and tool room or disperse PLL to the companies.	■ Add two 5-ton cargo trucks to the support platoon for use by the battalion motor pool.

Earth-Moving Assets

Because soil conditions are poor in Bosnia-Herzegovina, earth-moving assets are in great demand. The only asset organic to the division engineers is the ACE. It does many things well, but it cannot move dirt like a D7 Dozer. The division engineers have no equipment to haul gravel and sand. Earth-moving and fill materials were both in demand early in the deployment.

Demands on corps construction units were heavy throughout the first several months. The units could not provide all of the support required by the maneuver brigades. If engineer battalions had earth-moving and fill capabilities, they could provide much more support to the maneuver brigades. As it is, the battalions have little to offer from their organic assets.

Shortfalls	Fixes
■ Division engineers lack construction earth-moving capability. ■ Corps construction units could not fill the immediate earth-moving needs of maneuver units upon forced entry.	■ Replace two ACEs with D7 Dozers and lowboys in each engineer line company. If this is not possible, add at least three D7 Dozers to the battalion support platoon.
■ Division engineers have no dump trucks to move even limited amounts of fill.	■ Add four to six dump trucks to the battalion support platoon.

Carpentry Skills

In Bosnia, 12B engineers built protective bunkers and wood fighting positions, repaired buildings, and erected hardback tents, all requiring carpentry tasks that are rarely practiced in currently structured engineer battalions. Maintaining basic competence in these skills is not difficult, and engineers in Bosnia relearned the skills quickly. The main hindrance was a lack of power tools. While I do not promote bringing back the old pioneer tool trailer, I do promote putting some key power tools in a platoon carpenter's box.

Shortfalls	Fixes
■ Some deploying units did not train on carpentry skills needed in Bosnia.	■ Recognize that carpentry remains a 12B mission, even in currently structured battalions. ■ Use self-help and post projects to maintain a minimum level of carpentry skills in the unit.
■ Carpentry boxes had essentially been banded and stored. ■ Lack of power tools diminished the 12B construction capability.	■ Field a platoon carpenter's box with two skill saws, two power drills, and two electric nail guns.

Class IV Management

As is frequently the case, engineers in Operation Joint Endeavor were given the mission of managing Class IV construction materials. This was a major logistical planning and management challenge as well as a material-handling and transportation challenge. As part of the Class IV management mission, engineer companies assumed responsibility for running the Class IV storage yards. While engineer battalions have one forklift, which is usually old and difficult to maintain, engineer companies have no material-handling equipment. Engineers had to borrow the equipment needed to manage stockpiles of lumber, wire, and geotextiles. Since they were the primary users of Class IV materials, transportation of the materials also fell to them. As currently structured, battalions are light in haul assets just as they are in material-handling equipment.

Shortfalls	Fixes
■ Engineers were responsible for Class IV management.	■ Assume that engineers have the Class IV construction material mission. ■ Fill the division engineer brigade S4 or assistant S4 slot with a multifunctional logistics officer.
■ Units lacked sufficient material-handling equipment.	■ Field one SEE forklift attachment to each engineer company. ■ Replace and/or maintain the battalion forklift.
■ Units lacked sufficient haul capability to move Class IV materials.	■ Increase the haul capacity of the current engineer battalions.

Conclusion

I realize that we don't have the resources to do all the "fixes" in the accompanying charts. However, the capabilities that those fixes represent are ones that we must consider as we move toward Force XXI. As our missions diversify, we must break the recent trend of limiting the division engineer brigade to offensive operations. As our missions become more diverse, our capabilities must keep pace. When the maneuver commander needs engineer work, be it breaching a minefield or building a base camp, he expects his engineers to be able to do it. We must ensure that he can.

Major Goetz is attending the Command and General Staff College at Fort Leavenworth. Previous assignments include construction branch chief, U.S. Army Engineer School, Fort Leonard Wood, Missouri; company commander, 82d Engineer Battalion during Desert Storm; maintenance detachment commander, 3rd Engineer Brigade, 3rd Infantry Division; and military observer to the U.N. mission in the western Sahara.

Letters to the Editor

The Engineer School: Providing Lessons Learned to the Force

I would like to respond to your discussion of mine awareness training for units deploying to Operation Joint Endeavor (*Engineer*, August 1996, page 12).

The mine awareness training conducted for units deploying to Operation Joint Endeavor before January 1996 was developed independently by both the engineer observer/controller (O/C) teams at the Combat Maneuver Training Center (CMTC) and by the 130th Engineer Brigade. The 16th Engineer Battalion's training plan (developed with assistance from the Engineer School) was used to train many of the corps assets and some of the divisional combat service support units at Graf and at the home station. However, the majority of the maneuver and combat support units in the brigade combat teams were trained using the CMTC mine-awareness program.

The mine-awareness training that has been and is currently required for all individual replacements and new units deploying to Operation Joint Endeavor was developed by the engineer O/Cs at CMTC. Well over 14,000 soldiers have been trained since we started Individual Replacement Training (IRT) at CMTC in December 1995. In September 1996, we trained an IRT Mobile Training Team (officers and NCOs from the 130th Engineer Brigade) that deployed to Fort Hood, Texas, to train more than 500 engineers from the 62d Engineer Battalion. That training ran from 1-10 October.

The two programs are similar in content and are generally based on information in FM 20-32, *Mine/Countermine Operations*, FM 90-13-1, *Combined Arms Breaching Operations*, and the *Engineer Contingency Handbook*. The CMTC version also incorporates lessons learned from the Canadian and British armies and others. Since the deployment, we continue to update the instruction with lessons learned from Task Force Eagle, observations from O/C trips down range, and other sources.

The following NCOs from the Grizzly Task Force O/Cs were instrumental in developing and executing mine-awareness training at CMTC: SFC James Scher, MSG Herman Wells, and SFC Carlton Young. They did a great job with a difficult subject, and according to the feedback of the soldiers we trained it was "... the best training we ever had...." and "...a real eye opener..."

CPT Scott C. Johnson
Engineer Company O/C, Grizzly 15
Combat Maneuver Training Center

For Your Information:

The CMTC Individual Replacement Training is a three-day program that includes country orientation, media awareness, rules of engagement, negotiations, environmental threats, convoy operations, mine awareness, countermine, situational awareness (checkpoint operations), and force-protection classes. For each class, we also detonate a live M15 mine under a military vehicle to show the effects of a mine strike. Classes usually have about 120 students.

The Air Force has a one-day class at Ramstein, Germany, that selected individuals attend. I know they cover mine awareness, but I have never seen the program of instruction or talked to anyone who attended the class.

Author's reply:

I did not intend to slight CMTC's great efforts in training the force in mine awareness. Their success is demonstrated in the low casualty rates that Task Force Eagle has sustained from mines. My point was only to illustrate that when necessary the Engineer School is capable of supporting the field directly with subject matter experts. The school never sought to supplant the efforts of CMTC, only to assist with the training "surge" that is a normal part of any contingency operation deployment.

MAJ David Brinkley

Maintaining the MICLIC

The article entitled "Maintaining the MICLIC" in the August 1996 issue of *Engineer* was very informative and gave us insight into practices and problems associated with the use of the system in the field. This office is responsible for managing the system, to include the end item, and for supply, maintenance, and publications for all Army applications. Input such as yours can be very beneficial to us.

On page 45, the article specified using a ratchet strap to secure the launcher rail with the rocket to the launcher. We agree with the information in the paragraph except for the use of the ratchet strap. This could easily cause the rail to be distorted, thereby causing a problem with the launch process.

If the crew thinks it is necessary, tie the launcher to the front of the line charge container rail with four interconnected bungee straps. Pages 2-74 and 2-75 of the draft TM 9-1375-215-13&P give detailed instructions. (Please note that the revised TM has been changed from a -14&P to a -13&P manual).

In response to another inquiry, this office prepared a point paper regarding several other problems mentioned in your article.

Thank you for placing this office on the *Engineer* mailing list. In the future, closer coordination with our offices may be of mutual benefit.

Denise Springmeier
Chief, M60/FOV, Mines
Armor Product Center

Author's reply:

We are pleased that Ms. Springmeier had an opportunity to read the article and that many of the issues brought up in the article are incorporated into the new TM that will be published in the near future. Although we do not disagree with using bungee straps instead of cargo straps, I will say that in the past two years the National Training Center (NTC) has not had a problem associated with using cargo straps (the NTC launches up to four MICLICs per month). This article was written as part of the NTC's attempt to reverse identified trends with this equipment. We appreciate the fact that Engineer *was able to get this information quickly to the force and that it also was seen by the people responsible for managing the MICLIC system.*

CPT Joe Birchmeier

Leading the Way Together:
New Doctrine for Joint Engineer Operations

By Lieutenant Colonel John P. Paczkowski

Much has been written in this magazine and elsewhere concerning the need for better doctrine governing joint engineer operations. I am pleased to report that we have made considerable progress in this regard during the past 12 months. With input obtained from a broad cross section of the joint engineering community, we have reached consensus among the flag officers responsible for engineering in the Army, Air Force, Navy and Marine Corps. More significantly, the Director for Logistics (J4) of the Joint Chiefs of Staff (JCS) has endorsed the need and will be the principal sponsor of the effort to move proposed changes through the doctrine-development mill.

We are on the threshold of an intensive effort to craft new doctrine for joint engineer operations. Therefore, it is important that military and civilian engineers at all levels of each service understand the forces driving these changes and the direction in which the new doctrine is heading. We can argue details within our own community, but we must all "sing from the same hymnbook" as we actively promote these ideas to the commanders we serve and our counterparts in other combat and service support functions.

The following paragraphs describe the joint service team's efforts to define the need and set the wheels in motion for development of the new doctrine. That information is followed by key portions of the white paper prepared by the team. The white paper defines the terms of reference for the service, Unified Command, and Joint Staff engineers involved in moving the issue forward.

Background

In February 1993, the Joint Staff J4 commissioned the joint Engineer Interoperability Working Group (EIWG), which is composed of senior engineers from each of the four service headquarters. An outgrowth of experience acquired in the roles and missions review, the EIWG is an ongoing forum to identify and initiate actions that address issues pertaining to interservice coordination and interoperability. An early priority of the working group was the perceived need for better JCS guidance on the conduct of joint and combined engineer operations.

In September 1993, the EIWG prepared a draft standing operating procedure (SOP) for contingency engineering staffs as a way to bridge the gap in joint doctrine. Unfortunately, the draft was not well received by reviewers. It was seen as being too prescriptive, "in the weeds" regarding staff organization and procedures, and did not adequately address the lack of overarching engineer doctrine. Given this reaction and the pressure of other business, the doctrine initiative was put on hold. The EIWG revived it in June 1995 when, as a working group member, the director of the Navy's Seabee Programs Office (OPNAV-N446) requested assistance from the Naval Reserve Contingency Engineering Programs (NRCEP).

Making It Happen

The NRCEP began organizing an EIWG subgroup for joint engineer doctrine in September 1995. Although it had no fixed organization and membership varied with time, the subgroup eventually included about 40 military and civilian engineers, who represented a cross section of the community. Members included both active duty and reserve personnel from staffs of the commanders in chief (CINC) of the regional commands, major component and service headquarters, doctrine centers, and engineer schools. With limited ability to meet due to distance and travel costs, the subgroup functioned as a "virtual" team with most interaction occurring via e-mail and fax. The subgroup's work was accomplished in five phases.

Phase I - Organization and Research - Potential "stakeholders" were contacted in September and October 1995 to invite their participation in the effort. Background information concerning the issue along with the names of people who might provide valuable input were solicited. Initial service and CINC positions regarding the need for doctrine were assessed, and potential "hot button" issues were identified. Command directives, articles, white papers, after-action reports, and lessons learned were collected, reviewed, and circulated to team members.

"We are on the threshold of an intensive effort to craft new doctrine for joint engineer operations."

Phase II - Defining the Problem - Based on data gathered in Phase I, the subgroup planned a meeting to define the joint doctrine issue and determine a shared strategy for succeeding steps. The two-day session was conducted in December 1995 at the headquarters of the Naval Facilities Engineering Command in Alexandria, Virginia. A key product was an outline for a white paper that would become the primary vehicle for gaining interservice agreement and communicating the issue to a broad audience.

Phase III - Building Consensus - The work of the subgroup, including the initial draft of the white paper, was presented at the Joint Engineer Conference in Norfolk, Virginia, in February 1996. The presentation generated considerable discussion on the need for joint doctrine and culminated in several well-attended breakout sessions. These sessions dealt with doctrine and related issues, such as training for joint engineer operations, joint engineer planning systems and procedures, and environmental management.

Phase IV - Winning Executive Commitment - With input gained from the conference, the subgroup revised the white paper and issued the final copy in mid-May 1996. This paper formed the basis of a briefing on joint engineer doctrine and training issues to the Engineer Interoperability Review Board in late July. Chaired by the Joint Staff J4, the Review Board provides executive oversight for the EIWG; it includes flag officers from each service with engineering responsibilities.

At the conclusion of the July briefing, the Review Board unanimously agreed to advance a proposal for new doctrine to the J7 (Operational Plans and Interoperability Directorate), with the J4 electing to be the sponsor. The Army, through the Engineer School, accepted the task of shepherding the proposal though the JCS review process. The Navy, through the Naval Facilities Engineering Command, agreed to formulate a proposal for broad-based education in joint engineer operations, as recommended in the white paper.

Phase V - Gaining Joint Staff Approval - In late August, the J4 transmitted the proposal for new doctrine to the J7. This action also added the proposal to the agenda for the biannual Joint Doctrine Working Party (JDWP), held on 22-23 October. Coordinated by the Joint Warfighting Center at Fort Monroe, Virginia, the JDWP includes representatives from the service headquarters and the CINCs, who review proposals for changes to joint doctrine.

Prior to hosting the JDWP, the Joint Warfighting Center conducted a front-end analysis to assess justification for the proposed changes and recommend actions to be taken by the JDWP. The front-end analysis, completed on 3 October, recommended that new joint engineer doctrine be developed. Following extensive lobbying by members of the subgroup, the J4's engineer staff presented the doctrine proposal on 22 October.

Based on the presentation by the J4 engineer staff and the favorable recommendations presented by the Joint Warfighting Center, as reflected in its front-end analysis, the JDWP recommended development of new overarching joint engineer doctrine. In addition, the JDWP endorsed placing this publication in the "3" (operations) series. This important decision recognizes the broad span of engineer functions in support of operations. As such, it begins to resolve problems that often result from type-casting engineering as primarily a logistics function at the joint force level.

Next Steps

With JDWP approval in hand, the J7 will soon issue a directive assigning the Army as lead agent and TRADOC as the primary review authority (PRA). As PRA, TRADOC will coordinate the joint service doctrine-development effort, with the Army Engineer School in direct support.

With TRADOC and the Army Engineer School poised to take the lead, the work of the EIWG subgroup on joint engineer doctrine is complete. However, the EIWG and the Review Board will continue to monitor progress until a new publication is fielded, probably within the next 18 to 24 months. I encourage you, particularly those of you with experience in joint and combined operations, to step forward and "lead the way" by contributing to this endeavor as it gains momentum over the coming months.

Lieutenant Colonel Paczkowski, a contingency engineering planner assigned to the Installations and Logistics Branch, Headquarters U.S. Marine Corps, is the Marine Corps liaison to the staff of the Director, Naval Reserve Contingency Engineering Programs. He previously served as a Marine advisor to the Reserve Naval Construction Force and as the force engineer, Fleet Marine Force Europe. Lt Col Paczkowski chaired the EIWG subgroup on joint engineer doctrine and is primary author of the subgroup's white paper. He holds a master's degree in management engineering from New Jersey Institute of Technology.

The Need for Joint Engineer Doctrine:

Excerpts from a white paper by the joint engineer community

Edited by Lieutenant Colonel John P. Paczkowski

The absence of a well-developed program of joint doctrine for contingency engineering threatens the effective employment of forces and needlessly increases the costs and risks inherent in joint and multinational operations.

The Issue

Diminishing resources, reduced force structure, and an increasingly complex geopolitical environment have placed demands on the U.S. military to improve the effectiveness of joint and combined operations. In response, the Joint Staff, Unified Commands, Component Commands and service planners are revising joint and service publications, operations plans, standing operating procedures (SOP), and training programs to reflect these realities. Unfortunately, development of comprehensive joint contingency engineer doctrine and its integration with other joint and service doctrine have not kept pace with these reforms.

The fundamental role of engineering in support of joint and combined operations is not receiving a level of attention and focus consistent with its importance. As a consequence, the full potential of engineering as a critical element of operational maneuver is not fully exploited and sometimes is taken for granted by senior combatant commanders. Consideration of key engineer functions critical to mission success is often absent from senior-level decisionmaking. This absence sometimes hampers engineer staff actions and inhibits effective planning, task organization, and the synchronized employment of engineer resources by joint or combined forces.

Genesis of Contingency Engineering

In the early 1980s, European Command (EUCOM) concluded that an all-out confrontation with the Warsaw Pact would cause keen competition within the joint force for engineer resources and that a mechanism for interservice coordination and setting priorities would be needed. Accordingly, they designated the dominant service in each EUCOM region as Regional Wartime Construction Manager (RWCM), with responsibility for coordinating all U.S. military construction in that region. By CINC directive, each RWCM was to augment its engineer staff with representatives from other services as needed to meet its responsibilities.

As the Cold War came to a close, the U.S. military turned its attention to limited intensity conflicts and military operations other than war (MOOTW). The phrase *wartime construction management* was replaced with *contingency engineering management* to reflect the broader role of military engineering from peacetime contingency to war. The U.S. Central Command (CENTCOM) employed contingency engineering management during the Persian Gulf War. Lessons learned from that conflict and lesser contingencies since then led to contingency engineering initiatives by the other regional CINCs. Today, contingency engineering is viewed within the engineer community as the overarching concept for coordinating joint engineer operations. However, these concepts are not yet fully developed or incorporated into doctrine.

The Critical Role of Engineering

When its full range of capabilities are employed, military engineering can be a significant force multiplier for the combatant commander. It aids overall success by shaping to best advantage a variety of conditions under which military operations must be conducted. In particular, the contingency engineering concept ensures that maximum benefit is obtained from the engineer assets available.

Military engineering provides support to the intelligence and operational planning efforts by analyzing the effects of terrain, hydrology, and infrastructure, and identifying potential targets. It speeds force flow by assessing shortfalls and improving needed facilities, including air and sea ports of debarkation, force-beddown sites, and lines of communication. Military engineering also provides associated facility operation and maintenance and fire-fighting capability. It facilitates operational maneuver and force protection by providing bridging, expeditionary airfields, facility war-damage repair, explosive-ordnance disposal, barriers, and defensive fortifications. Military engineering also plays essential roles in disaster recovery and humanitarian relief operations, environmental compliance and mitigation, and chemical and biological wide-area decontamination.

The importance of military engineering spans the continuum from the strategic to the operational to the tactical levels of war, and the focus of the engineer effort varies accordingly. The CINCs are primarily concerned with the overall deployment of forces in the context of theater war plans. Thus, engineering at the strategic level tends to focus on major facilities, theater-wide construction management policy, and the allocation of scarce engineer resources. At the other end of the spectrum, tactical-level engineering is centered on expeditionary or combat-related activities, primarily of a service concern. Between these two is the operational level (i.e., subunified commands and joint or combined task forces), where campaigns are planned and fought. At this level, there must be balanced emphasis on both deliberate and combat engineer activities.

"To fully exploit military engineering at the operational level, the joint or combined force commander must recognize it as an essential aspect of his scheme of maneuver in an overall campaign plan involving naval, air, and land forces..."

To fully exploit military engineering at the operational level, the joint or combined force commander must recognize it as an essential aspect of his scheme of maneuver in an overall campaign plan involving naval, air, and land forces, as appropriate. The object of operational maneuver is to orchestrate movements and engagements to seize, exploit, retain, or deny freedom of action to support the achievement of a common set of objectives. Freedom of action allows the efficient concentration of military capability when, where, and how it is needed; it applies to operations in both peacetime and war. At the operational level, freedom of action can be achieved only through careful planning and seamless execution of deliberate and combat engineer functions in a well-synchronized and, where necessary, integrated effort.

Sufficient engineer resources to satisfy all requirements probably will not be available in all contingencies. Also, the nature of engineer priorities changes as a contingency evolves from reception, staging, and onward movement to force protection, operational maneuver, and ultimately, termination of operations and withdrawal. Resource limitations and the associated challenge of matching requirements with the right capability at the right place and time make it essential that the full range and versatility of all engineer assets be exploited.

Maximizing the use of resources to meet the needs encountered at each stage of an operation will often depend on the flexible use and, when necessary, task organization of troop construction, civilian contractor, and host-nation capabilities as integrated elements of a total contingency engineering effort. Given the unique requirements of a particular contingency, it will also require a well-trained joint engineer staff that is appropriately positioned to most effectively influence the full range of engineer functions.

Deficiencies in Current Joint Doctrine

Despite its importance to the overall success of joint operations and general acceptance of contingency engineering as the overarching concept for coordination of the joint engineer effort by the regional CINCs, there is no clearly defined program of engineer doctrine in the joint publication hierarchy.

What doctrine exists is incomplete and, at times, contradictory.

Joint Publication 4-04, *Joint Doctrine for Civil Engineering Support*, is assumed to be the "capstone" manual and, thus, the primary source of guiding doctrine on joint engineer matters for combatant commanders and their staffs. Though perhaps sufficient as general guidance for engineer management at the CINC level, it falls short of being adequate overarching doctrine across the full spectrum of joint operations. In particular, it fails to present principles underpinning the nature of engineer support for operational maneuver at the joint or combined task-force level and does not address gaps and inconsistencies elsewhere in joint doctrine. Finally, it does not reflect lessons learned from recent operations to the extent that they relate to engineer force organization, staff placement, and operations planning.

Consequently, each regional CINC is pursuing his own approach to contingency engineering, and implementation varies widely. Several major service commands, both active and reserve, have incorporated unique versions of the concept into their SOPs, training, and support relationships. Most recently, both the Army and the Navy have initiated comprehensive efforts to revise their service doctrine to reflect their views of contingency engineering considerations. USACOM, in its expanded role as joint force trainer, has independently established a training program for contingency engineering staff. These efforts are positive in that they serve to develop and promote application of the contingency engineering concept, but they are not coordinated with one another and lack a common base in joint doctrine.

The inadequacy of Joint Publication 4-04 as overarching doctrine becomes clearer when viewed in light of the key elements of military engineering it does not fully cover but that are considered significant enough to be addressed in other joint publications, typically in the operations or "3" series. They include, but are not limited to, Joint Publication 3-10, *JTTP for Rear Area Operations*, and Joint Publication 3-10.1, *JTTP for Base Defense*, which address aspects of survivability and sustainment support engineering. Also significant is Joint Publication 3-15, *Barriers, Obstacles, and Mine Warfare*, which deals with achieving operational advantage through mobility and countermobility engineering.

There are also significant gaps in joint guidance concerning areas such as topographic engineering, engineer intelligence, common design standards, real-estate acquisition, environmental mitigation, disaster recovery, wide-area decontamination, and engineer support for deep operations and targeting (i.e., employment of FASCAM and future intelligent wide-area munitions).

Logistics Paradigm and the Engineer Staff

Perhaps the most significant impediment to full and effective use of engineer resources in any contingency arises from the traditional view that, aside from the most basic combat-related tasks, engineering is predominantly a logistics function that is primarily concerned with the construction of facilities in support of the sustainment effort. The only joint guidance available, Joint Publication 4-04, reflects this view and is replete with references to "civil engineering" and "facilities," but noticeably silent with regard to the engineer functions of mobility, countermobility, survivability, and topographic engineering as these relate to support of combat operations. This logistics paradigm is reflected in the staff organizations of major combatant and service commands, where engineering typically is a J4 function.

Four of the five regional CINCs have placed engineering under the J4 and have developed internal policies for contingency engineering based on this approach. The J4 model may be workable at the strategic or CINC levels, particularly in peacetime when the focus is on deliberate planning and facilities development. However, recent experience indicates this approach does not always work during contingencies. This is particularly true at the joint task- force level. Given the nature of current guidance, joint force commanders have a tendency to view the engineer function in its strategic (sustainment engineering) or tactical (combat engineering) extremes. They often fail to recognize or fully capitalize on the advantages of a total engineer effort that is integrated as an essential part of their operational scheme of maneuver. Thus, joint task-force staffs are often organized accordingly.

At the joint task-force level, when subordinate to the J4, the staff engineer is not well positioned to coordinate or monitor the total contingency engineering effort in support of operational maneuver. The engineer's visibility in operational planning and decision making is significantly curtailed; interaction with and advice to other staff functions is unnecessarily limited; and independence and the ability to exercise initiative are diminished. The result tends to be engineer support for the joint force shaped solely through the eyes of the logistician, whose primary focus is on just one key aspect of the joint campaign: force sustainment. Placement within the J4 staff increases the likelihood that the full value of engineering will not be realized and that key engineer-related issues may not surface to the joint or combined force commander in time for resolution.

Neither Joint Publication 0-2, *Unified Action Armed Forces*, nor Publication 5-00.2, *Joint Task Force Planning and Procedures*, specifies staff placement of the engineer in the joint force structure. While Joint Publication 0-2 assigns supervision of engineer functions to the J4, Joint Publication 5-00.2 is contradictory on joint staff responsibility for engineering. It states that J3 responsibilities include mine warfare; reconnaissance; rear-area protection and security; disaster relief; and mobility, countermobility, and survivability operations, all of which are heavily engineer-related. However, it also states that J4 responsibilities include engineer reconnaissance and intelligence, bridge and river crossings, barrier operations, general construction, and base development and maintenance. Aside from base development and maintenance, each of the other responsibilities assigned to the J4 is more operational than logistics in nature and overlaps considerably with those of the J3.

Although neither Joint Publication 0-2 nor Joint Publication 5-00.2 specifies placement of engineers, both publications reinforce the joint force commander's prerogative to organize the staffs as necessary to accomplish the mission. In the few recent instances where the joint force staff engineers were placed outside the logistics organization (i.e., as special staff), the wisdom of affording the engineer greater independence was ultimately validated.

"Fundamental to the nature of joint operations is the need to tailor force packages and command structures to suit the situation at hand."

Joint Training

Fundamental to the nature of joint operations is the need to tailor force packages and command structures to suit the situation at hand. Although the joint force engineer staff initially may be built around the headquarters element of the dominant component command, this staff typically is augmented with individuals drawn from other components and agencies. Since the makeup and level of competence of the engineer staff is critical to the ultimate effectiveness of the total engineer effort, it is important that these individuals have a common basis for interacting as a team. Gaps and inconsistencies in current joint doctrine and the lack of joint engineer staff training programs make this requirement difficult to achieve.

To a greater or lesser degree, regional CINCs and major component commands have established directives and SOPs to provide local guidance on contingency engineering operations, but approaches vary widely. It is apparent that these differences are not only due to the unique characteristics of a given area of responsibility (AOR) but how, in the absence of adequate guiding doctrine, alternative views on the concept of contingency engineering have evolved over time. The lack of some appropriate level of uniformity in the application of these principles serves to confuse staff augmentees and may result in conflict between the way a major component command and a regional CINC plan to conduct their operations.

The lack of relevant doctrine and the limited number of personnel experienced in joint contingency engineering operations, combined with the usual staff turbulence, causes a situation where the same lessons are relearned over and over. Opportunities to train service personnel in contingency engineering concepts are few. Engineers typically are not permitted a strong presence in joint exercises, and engineer issues are most often assumed away by operational commanders. Although some major reserve organizations have the mission and capability to train and provide engineer staff augmentation (i.e., the Army Reserve's engineer commands and the Reserve Naval Construction Force Support Command), these organizations will not be the first to provide personnel to go "down range." A larger pool of active duty engineers from each service must be trained in contingency engineering techniques. However, this assumes a common base in joint doctrine and interservice compromise on engineer staff practices.

In its role as joint trainer for assigned CONUS-based forces and joint task force staffs, USACOM has developed and implemented a program of instruction (POI) for *Engineer Support to Joint Task Forces*. In addition, the Army's Battle Command Training Program (BCTP) concept is being adapted to exercise joint task force commanders and staffs. This "JBCTP" focuses on joint staff practices, planning, and doctrine as well as tactics, techniques, and procedures. The USACOM POI and the engineer component of the JBCTP are important steps forward in providing platforms for joint contingency engineer training. However, these initiatives have been largely shaped from the perspective of the organizations that developed them. They do not reflect input from other combatant CINCs or the major service commands with direct experience in contingency engineering operations. Developed in the absence of clear joint guidance as their foundation, these initiatives run the risk of becoming joint doctrine by default.

Conclusion

In an era of reduced force size and limitations on strategic lift, it cannot be assumed that a joint or combined force will have enough engineer resources when and where they are required in a contingency. Therefore, it will be essential to get the most out of the resources available. The future development of joint engineer doctrine should do everything possible to support this need.

Existing joint doctrine is incomplete and fragmented. This, along with the view that engineering is primarily a logistics function with an emphasis on force sustainment, has hampered the efficiency of the total engineer effort in support of operational maneuver. These factors pose important implications for the successful planning and execution of future joint and combined operations. Steps must be taken now to systematically improve joint doctrine, engineer planning systems, and staff training programs to flexibly meet the needs of current and future contingencies.

Recommendations

1. Publish more effective guidance for joint engineer operations; fully develop the concept of contingency engineering to reflect its evolving practice in the field.

a) Revise Joint Publication 4-04, *Joint Doctrine for Civil Engineering Support,* as an interim measure and develop a new publication to serve as overarching engineer doctrine.

b) Ensure coverage of the full span of engineer functions—mobility, countermobility, survivability, topography, and sustainment—in support of operations.

c) Define the broad role of the engineer in deliberate and crisis action planning and execution, to include support for the intelligence, operations, and logistics efforts.

2. Propose principles and options to guide joint commanders in staff organization and placement, and emphasize early involvement, freedom of action, and ongoing visibility.

a) Propose revisions to other publications to ensure that references to engineering throughout the doctrine hierarchy are consistent with the concepts outlined in new, overarching doctrine.

b) Revise Joint Publication 0-2, *Unified Action Armed Forces*, to elaborate on the importance of exercising flexibility in the position of the staff engineer in accordance with the needs of a given contingency.

c) Revise both Joint Publications 0-2 and 5-00.2, *Joint Task Force Planning and Procedures*, to resolve the ambiguity and/or potential conflict in responsibility concerning engineer matters between the joint task force J3 and the J4.

d) Revise Joint Publication 5-00.2 to outline the principles and options governing engineer staff placement and functions.

3. Develop joint tactics, techniques, and procedures (JTTP) to amplify concepts presented in a revised and/or new publication and to fill specific gaps identified in engineer doctrine.

a) Revise existing JTTPs and those in development to reflect the concept of contingency engineering and related principles, as presented in new overarching doctrine.

b) Evaluate the need and propose new JTTPs covering such topics as, but not limited to, topography, environmental mitigation, civilian contracting, real estate, wide-area decontamination, disaster recovery, and design standards.

4. Pursue a comprehensive strategy to increase knowledge of and competence in joint contingency engineering operations among combatant commanders and engineer staffs.

a) Establish a formal training program for joint force engineer staffs, building on work already completed by USACOM and the Army's Battle Command Training Program.

b) Promote a stronger role for engineers in Joint Chiefs of Staff-sponsored exercises and consider formulation of an ongoing engineer exercise program to run in parallel.

c) Introduce contingency engineering concepts and familiarization with emerging doctrine in the syllabus of service and joint command schools.

"Engineers Lead The Way!"

ICE BRIDGING IN ALASKA

By Captain Joseph E. Staton and Staff Sergeant Clinton K. Brown II

Soldiers participating in arctic operations must deal with extremely cold temperatures, long periods of darkness, and snow-covered terrain. In these conditions, simple tasks take much longer to accomplish, and new or complex tasks are difficult to complete. Units must be prepared to live, eat, and rest in the open at temperatures far below zero. The environment is unforgiving and mistakes can be costly.

This article provides information from several references and personal observations on reconnaissance of ice bridge sites and construction of ice bridges, which are one means of increasing mobility in severe weather conditions. Under arctic conditions, mobility requires unique considerations.

Cold temperatures and rapidly freezing water are beneficial in ice bridge construction, but they also create problems. Extreme cold takes a toll on soldiers as well as equipment. Since personnel involved in this type of construction are vulnerable to frostbite and hypothermia, tents are a necessity so that soldiers, hoses, and equipment have a place to thaw out.

Ice Crossings

Ice bridges are a viable means of crossing rivers in an arctic environment, because they are inexpensive and field expedient. They free up tactical bridging assets for maneuver operations, do not need to be taken up, and potentially can carry heavy loads. Disadvantages are that they are dependent on weather, are manpower intensive (they must be monitored constantly), take 2 to 8 weeks to build, and are usable only a few months of a year.

In Alaska, the 47th and 23rd Engineer Companies conduct annual training on ice crossings. Near Fort Wainwright, the 47th constructs and maintains several ice bridges that provide land access to large arctic training areas.

Arctic Strike '96

Recently, the 47th participated in Exercise Arctic Strike '96 at Fort Greely. The unit's primary mission was mobility and evaluation of possible crossing and helicopter landing sites. The exercise was a valuable training opportunity to work directly with and provide support to maneuver and aviation elements.

Conditions for building an ice bridge were favorable. Temperatures had been well below zero for more than 60 days, and the frozen rivers provided numerous crossing sites. Most of the exercise was conducted at temperatures ranging from -30 to -57 degrees Fahrenheit. When it warmed up to -20 degrees, the wind increased and the wind chill was at or below -65 degrees. With this chill factor, preservation of personnel—or asset conservation—was more important than the mission.

Reconnaissance

The success of a river-crossing operation depends on the reconnaissance crew's assessment of possible crossing sites. The ice-reconnaissance crew is a squad-sized element consisting of a squad leader, an ice measurer, a recorder, four auger operators, and two soldiers to measure for the next hole.

The crew uses an akio sled to transport the following equipment:

- ❑ Power augers (2)
- ❑ Hand augers (2)
- ❑ Dippers (2)
- ❑ Measuring rod (1)
- ❑ Measuring tape, 100-foot (1)
- ❑ Ice axes (2)
- ❑ Fuel can, 5-gallon (1)
- ❑ Safety rope, 100-foot (1)

Before the reconnaissance begins, the crew establishes security and erects a warming tent. Then it evaluates existing ice conditions to determine the best bridging method to use and the amount of time required to establish a crossing site. Ice uniformity varies along the length of a river or lake, and its thickness depends on snow depth, water current, and springs.

An ideal crossing site meets the following requirements:

- ❑ The river channel is straight at the crossing.
- ❑ The river occupies one main channel and is wide enough to allow a slow current.
- ❑ The bank approaches are gradual (less than three percent).
- ❑ The site is not immediately downstream from creeks or streams or near open bodies of water.
- ❑ The site is near an existing road network.
- ❑ The ice is level.
- ❑ The ice is free of warm springs, sand bars, and deep snow drifts.

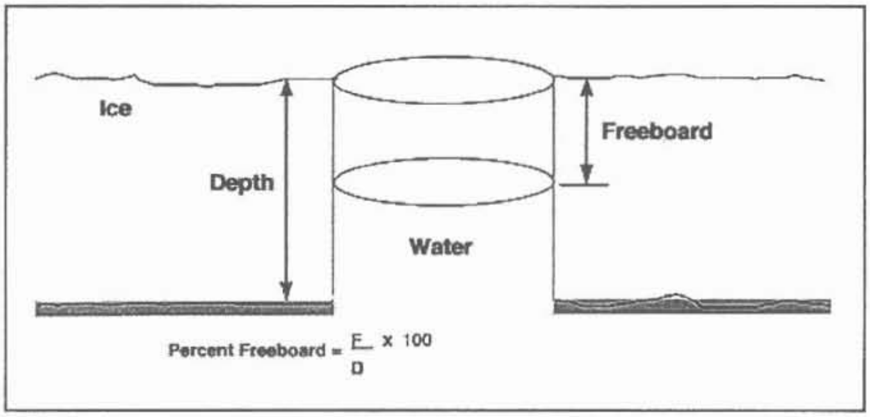


Figure 1 - Freeboard

To perform initial reconnaissance, the crew bores holes in the ice, measures its thickness and freeboard (the amount of ice exposed in the hole above the waterline (Figure 1), and completes an ice bridge profile.

The first hole is bored 20 feet downstream of the proposed centerline and 5 feet from the bank. Test hole distances and layout are shown in Figure 2. During the initial reconnaissance, the crew bores holes completely through the ice to ascertain how it is supported. They determine the bottom conditions and water depth under the ice, plot the borehole depths and the depth to the bottom, and estimate conditions between the holes by connecting the dots with a curve. Their ice bridge reconnaissance report includes:

- ❑ Date of the reconnaissance
- ❑ Individual and unit doing the profile
- ❑ Name of the bridge
- ❑ Horizontal and vertical scales
- ❑ Channel number of the bridge
- ❑ Classification data for that channel and whether the channel is critical or not (refer to the channel with the lowest military load class [MLC])
- ❑ Type of ice on the channel
- ❑ Graph showing ice and water depth and air voids

After the bridge profile is complete, the crew classifies the bridge using the following formulas:

$$W = \text{MLC (wheeled)} = \frac{(T^2)CS}{25}$$

and

$$A = \text{MLC (tracked)} = \frac{(T^2)CS}{20}$$

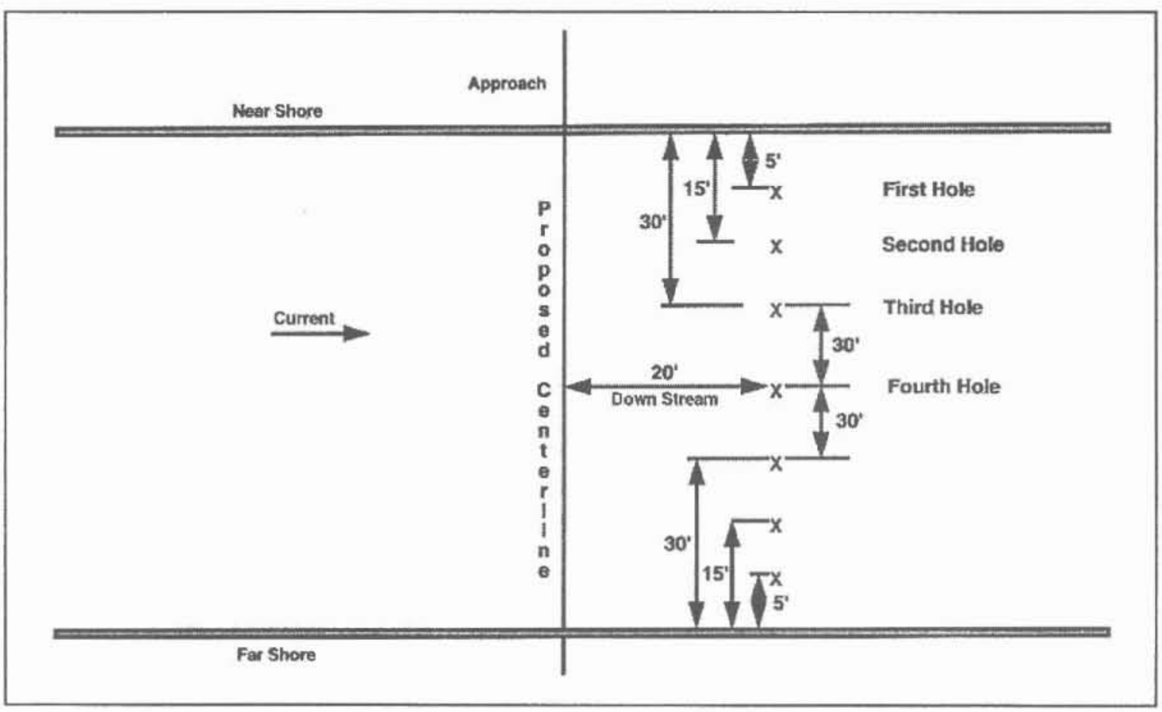


Figure 2 - Test Hole Layout

Note: To provide a safety factor, round down to the next whole number.

Where: T = ice thickness, in inches
C = color factor (Table 1)
S = strength factor (Table 2)

Table 1. Determining Color Factor of Ice

Ice Color	Factor (C)
Clear (transparent or black)	1.0
Semiclear (both transparent and black and white layers)	0.9
White (snow mixed with ice)	0.8
Discolored (stained yellow or brown)	0.7

Table 2. Determining Strength Factor of Ice

Ice Condition	Ambient Temperature	Factor (S)
Solid	Remained at or below freezing for the previous week	1.0
Solid	Above freezing during the day, below freezing at night	0.9
Solid	Water is running on the surface from runnoff or overflow	0.8
Not solid	Water or air pockets are found between layers	0.7
Has air under it	Ice is not supported by water (freeboard is <90 percent)	0.6

The reconnaissance crew determines the classification of each channel in the river based on the thinnest ice thickness found. The critical channel is the one that limits the entire class of the bridge and/or has the lowest MLC. If the ice is frozen to the bottom of the channel, it is classified as unlimited. The classification is also unlimited if 2 inches or less of water is under the ice, because the load on the bridge would flex the ice to the bottom of the channel.

A quick reference card (issued by the U.S. Army Cold Regions Research Engineering Laboratory [USACRREL]) provides information to quickly evaluate possible crossing sites (Figure 3, page 36 and Table 3, page 37). Note the distances between vehicles when using this card. The color and strength factors can be used with the card to further define the ice.

Landing Zones

When evaluating possible helicopter landing zones (LZs), consider the following:

- Helicopter spacing on ice is the same as that for vehicles (150 feet); however, helicopters must land harder on ice than usual (1.2 to 1.3 times the force of gravity) so the wheels will set down more firmly on the surface and avoid sliding.
- When evaluating lakes as LZs, bore the first four holes as if it were an ice bridge (Figure 2, page 34), then space the holes 100 feet apart.
- The MLC of static loads on the ice must be doubled (for example, a fully loaded CH-47 weighs 49,000 pounds, giving MLC 42 for ice LZs).
- When parking on ice, bore a hole 20 feet from the vehicle. If water flows out of the hole onto the ice, move to another location immediately.

Strengthening Natural Ice

If the strength of existing ice meets traffic requirements, the only necessary steps for building an ice bridge are to compact the snow layer to 2 inches, improve the approaches, and mark the centerline. If conditions do not meet the required specifications, two options are available: use standard Army bridge construction or strengthen the ice.

Ice forms naturally from the bottom of an ice sheet when the temperature is cold enough. Ice and snow are insulators and control the natural formation of ice—the thicker the layer of insulation, the slower the ice growth. The ice formation process can be speeded up by flooding the surface of existing ice where it is exposed to the air and not insulated. An ice bridge should be at least 150 feet wide to allow for ice strengthening along the entire section of the ice sheet carrying vehicular loads.

A flooding crew consists of a supervisor, a warming tent guard, an equipment operator, one to three pump operators, and a hose handler.

The type of pump used to flood the ice depends on the temperature and the pumps available. Submergible, electric pumps are best. They do not freeze up as easily since the water and ice are in equilibrium at or near 32 degrees. The 47th and 23rd Engineer Companies use surface-operated pumps (typhoon pumps manufactured by Wayjax, NSN 4320-00-Z27-5852). These pumps have gas engines that tend to freeze up every 20 to 30 minutes, requiring that they be rotated through the warming tent. Other pumps, such as chain-belt and Gorman-Rupp pumps (both with free-standing, gas-operated engines) may be used as long as the hoses can withstand sub-zero temperatures. The pneumatic tool and compressor outfit (250 cubic feet per minute [CFM] trailer) comes with sump pumps that continue to run below

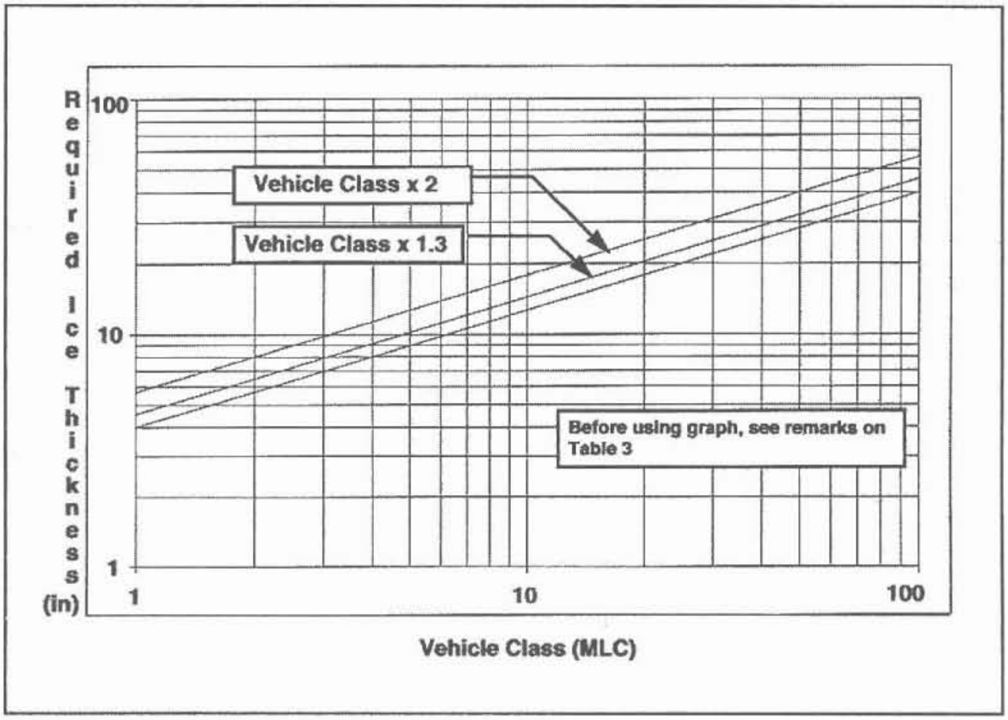


Figure 3 - Quick Reference Graph

the surface. The compressor hoses on the surface are exposed to sub-zero temperatures (down to -60 degrees). A concern is that the 1 1/2-inch hose, which operates at 100 to 200 CFM, may break and injure a soldier. However, arctic hoses that stay flexible to -60 degrees may be purchased locally.

If the snow layer is deep, pumping water on it may cause voids in the ice. Much of the snow must be removed by a crew consisting of a supervisor and equipment operators as necessary (for the SEE tractor, grader, bucket loader, snow blower, or shovel).

The snow removal crew must avoid pushing the snow into berms along the sides of the bridge area for two reasons. First, moving heavy snow from one area and concentrating it on the sides causes the ice to form into a crown in the center of the roadway. Then water applied to the center of the bridge will drain to the sides, failing to strengthen the roadway of the bridge. The crown also may develop an air pocket and become unsupported (freeboard less than 90 percent, which will not permit safe passage of vehicles). Second, ice will not form on the bottom of the ice sheet near the snow berm. This leads to thin ice along the edges, which can cause the bridge to fail (Figure 4 and Figure 5, page 38).

The crew removes the snow on the surface until the layer can be compacted to 2 inches or less. Then they flood for the first lift (layer). The flooding depth depends on the available equipment and the air temperature. Normally, one 2-inch lift can be completed in each 24-hour period. Under extremely cold temperatures, more than one layer may be applied per day. Once the first lift is completely frozen, successive lifts can be placed until the bridge reaches the desired classification. To avoid water pockets between the layers, each lift must be completely frozen before the next lift is added. The time required for the water to freeze depends on the air temperature, wind speed, and floodwater depth. As the ice thickens, the bridge takes on a dish shape because the heavy section of ice causes the water to pool naturally (Figure 6, page 38).

Bridge Maintenance

Ice bridges require daily maintenance, because river ice thickness can change daily. The thickness also varies throughout the winter and in different locations on the river. Thickness of river ice depends on the current strength and temperature variations (air and water). The critical ice channel depth must be checked and the bridge capacity reclassified daily. Constant travel over the same path may cause the ice to become thin in that area.

If temperatures rise above freezing, all channels of the bridge must be checked. During the daily check, look for changes in the color of the ice and strength factor requirements. Compact new snow to 2 inches or less and flood or remove the excess. If temperatures remain below freezing, check all of the channels every 3 days. If any of the channels must be strengthened, traffic cannot cross until the lift has frozen completely. When the ice bridge is thick enough to support the heaviest crossing vehicle, spread and pack 1 to 2 inches of snow over the roadway to provide traction and a wearing surface.

Table 3. Field Guide Quick Reference Card

Vehicle Class (wheeled or tracked)	Required Ice Thickness (inches = 4√veh class) (in)	(cm)	Distance Between Vehicles (about 100 x thickness [in cm]) (ft)	(m)
200 lbs	2	5	17	5
1	4	11	34	11
2	6	15	48	15
3	7	18	58	18
4	8	21	67	21
5	9	23	75	23
10	13	33	106	33
15	16	40	130	40
20	18	46	149	46
25	20	51	167	51
30	22	56	183	56
35	24	61	198	61
40	26	65	211	65
50	29	72	236	72
60	31	79	260	79
70	34	85	280	85
80	36	91	300	91

Before using table, see remarks below:

1. If the air temperature has been above freezing for more than 6 of the past 24 hours, multiply the vehicle class by 1.3 to obtain the required ice thickness. If the air temperature stays above freezing for 2 hours or more, the ice starts to lose strength, and the table no longer represents safe conditions. A rapid and unusually large temperature drop causes the ice to become brittle, and travel may not be safe for a period of 24 hours.

2. For the distance required between two vehicles of different classes, use the distance required for the higher class.

3. If you plan to park for extended periods, multiply the vehicle class by 2 to obtain the required ice thickness and maintain at least the original distance requirements. Drill a hole through the ice near the vehicle and move if the ice begins to flood.

4. The ice must have water support. Be very careful close to shore. Very often the water level will drop after freeze-up. When this happens, the ice close to the shore may no longer have water support.

5. Cracks are either dry or wet. If dry, they do not penetrate ice cover and can be ignored. If wet, multiply the vehicle class by 2 to obtain the required ice thickness and try to drive straight across the cracks (avoid going parallel to wet cracks).

During construction, cracks will appear everywhere in the ice bridge and loud snaps may be heard. The noises are caused by the thermal expansion and contraction of the entire ice mass and do not indicate failure of the bridge itself. Many cracks are caused by sudden changes in temperature. These are usually dry and do not weaken the bridge. They can be flooded and refrozen if desired. If a vehicle crosses that is classified at or above the bridge load class, wet cracks may form. They will refreeze, strengthening the bridge. If the temperature is below freezing, harmless cracks perpendicular to the flow of traffic will be visible.

If the bridge banks have a slope greater than 3 percent, use snow to reduce the slope. Pump water on a snow pile to make wet, heavy snow, which is good for construction. The snow pack will freeze and the 1- to 2-inch snow cover acts as a wearing surface.

Air voids normally occur near river shores because the water recedes after the initial freeze. Ice that is not supported by water is very weak. Breaking the ice sheet and setting it back on the water will greatly increase the strength of the ice. Use a wrecking ball and crane to break the ice, or load it with enough wet snow to cause it to break. Boring holes in the ice will also help. If the ice sheet does not break up, try another location. Push dirt or snow over the ice to the supported area of the bridge, especially near the banks, or use planks to move the load to the supported ice.

Crossing an Ice Bridge

Mark ice bridges like any other river crossing as shown in FM 90-13. Place signs near the bridge to inform drivers of safety precautions. Place a marker 150 feet from each shore to determine the proper vehicle spacing on the bridge.

Before vehicles are allowed to cross, drivers must be aware of the following safety precautions:

- ❑ Bridge classification is for one-way traffic only.
- ❑ Avoid crossing if the vehicle classification exceeds the limits of the bridge.
- ❑ Passengers need not dismount or open doors during a crossing.
- ❑ Stop vehicles before driving onto the ice bridge to reduce the impact.
- ❑ Space vehicles at least 150 feet apart.
- ❑ Maximum speed on the bridge is 10 mph. Keep vehicles in the lowest gear possible. Driving too fast may create a wave ahead of the vehicle and cause the bridge to fail.
- ❑ Avoid stopping on the bridge. A sudden application of brakes increases the weight pressure of a vehicle, especially in the front wheels.

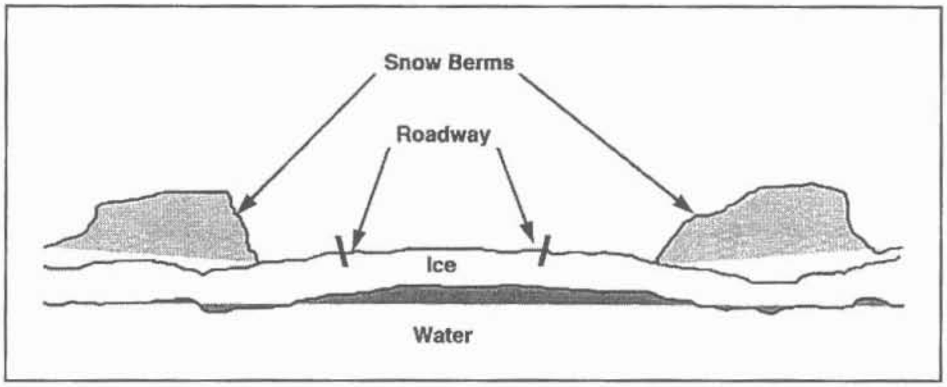


Figure 4 - Cross Section of Bridge and Berms

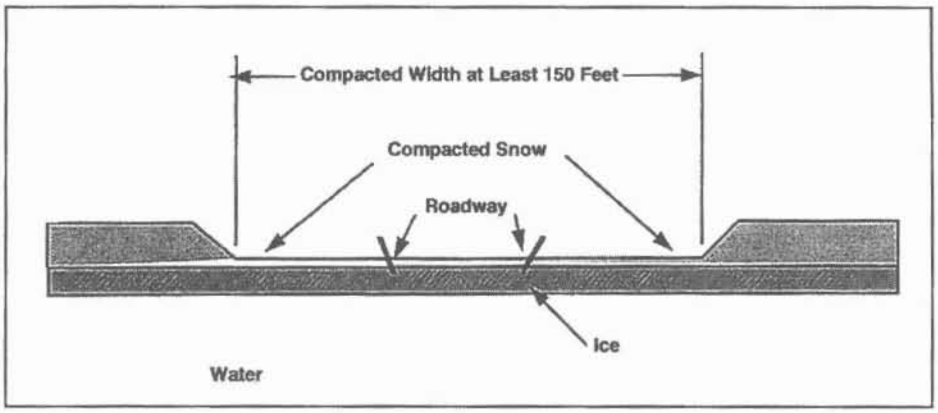


Figure 5 - Cross Section of Snow Compaction

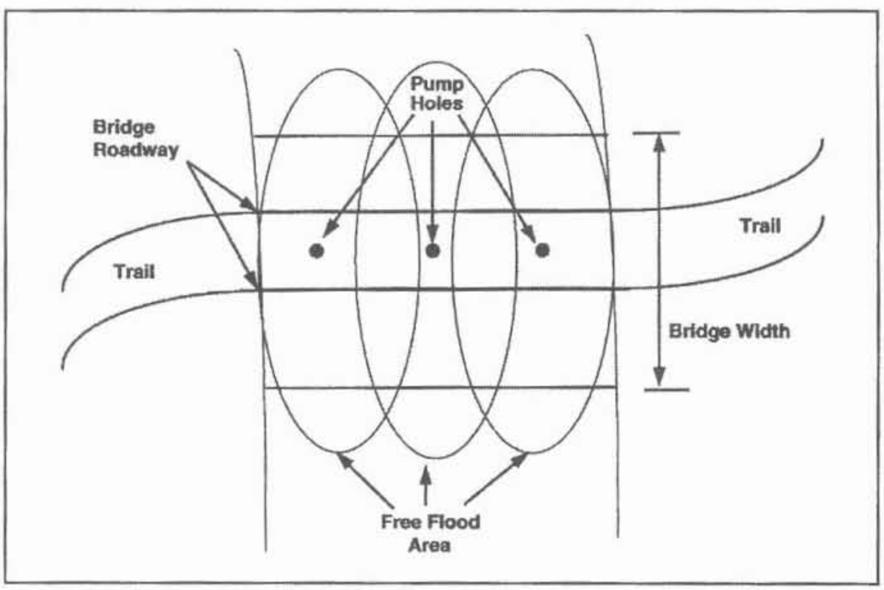


Figure 6 - Location of Pump Holes for Flooding the Bridge

- ❑ If parking on the ice is unavoidable, double the vehicle classification and bore a hole 20 feet from the vehicle. If water surges out of the hole and floods the ice, move the vehicle immediately.

Prepare a recovery plan for vehicles that break down on the ice bridge. During recovery, vehicles should not exceed the 150-foot spacing requirement unless the combined load is less than the bridge classification. If the combined load exceeds the classification, chose another recovery method. If the ice fails, a team must be prepared to react quickly. A slow response could allow ice to form around the vehicle, requiring demolitions to free it. The first vehicle at or near the maximum bridge classification should have a tow cable connected to the pintle and thrown on top of the vehicle to aid in recovery.

Conclusion

Engineers must be prepared to deploy anywhere in the world and to provide expertise in many areas. In cold environments, the battlefield may require that they build ice bridges to gain access to critical regions. Ice can enhance maneuverability for both vehicular and air mobile traffic. A thorough knowledge of ice bridging allows engineers to overcome one of the major problems faced in cold-weather operations.

References

1. 6th Infantry Division (L) Pamphlet 350-11, *Squad Leader's Guide for Constructing Ice Bridges*, October 1986.

2. USACRREL Report 76-29, *Failure of an Ice Bridge*, August 1976.

3. USACRREL Report 85-18, *Snow in the Construction of Ice Bridges*, October 1985.

4. USACRREL Report 93-12, *On Winter Warfare*, June 1993.

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6. Field Manual 90-13, *River Crossing Operations*, 30 September 1992.

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Engineer Problem

Using the information provided in the above article, test your knowledge by completing the following exercise.

Situation: Your company is deployed to a remote cold-weather region. The task force commander directs a reconnaissance of a possible ice bridge crossing site. The platoon you task to perform the reconnaissance provides the following report:

- ❑ Critical ice thickness = 43 inches
- ❑ Water depth below the ice = 60 inches
- ❑ Type of ice = Semiclear with dry cracks
- ❑ Temperatures have been below freezing for at least a week
- ❑ Freeboard = 25 percent
- ❑ Width of river = 600 feet
- ❑ Critical channel width = 335 feet

Use the equations on page 37 to determine the following:

1. Determine the military load classifications (MLCs) of the bridge for wheeled and tracked vehicles.

2. Determine how long it takes to increase the strength of the bridge to safely cross an M1A1 tank if temperatures remain below zero.

Engineer Solution is on page 47.

MANSCEN Construction

By Major Steven M. Herold and Major Neil F. Wilson

Realignment of the Chemical and Military Police Schools from Fort McClellan to Fort Leonard Wood grows ever closer to reality. The realization of the impending moves is brought to life in artistic renderings and models depicting $203.4 million (M) in construction projects for the Maneuver Support Center (MANSCEN). These construction efforts will propel the MANSCEN into the Army's showcase of consolidation, while retaining individual regimental identity and proponency. Construction will begin after the ongoing Environmental Impact Statement (EIS) is completed and approved. The EIS process is on schedule, which should allow the two-year construction effort to begin in the spring of 1997.

The MANSCEN is one of the future TRADOC *clusters* that will be organized around battlefield functions. The TRADOC concept will link like battlefield functions into mutually supporting school clusters to enhance execution of training, doctrine, and combat developments.

The table on this page shows the expected impacts of the two additional schools on the population at Fort Leonard Wood.

General Instruction Facility

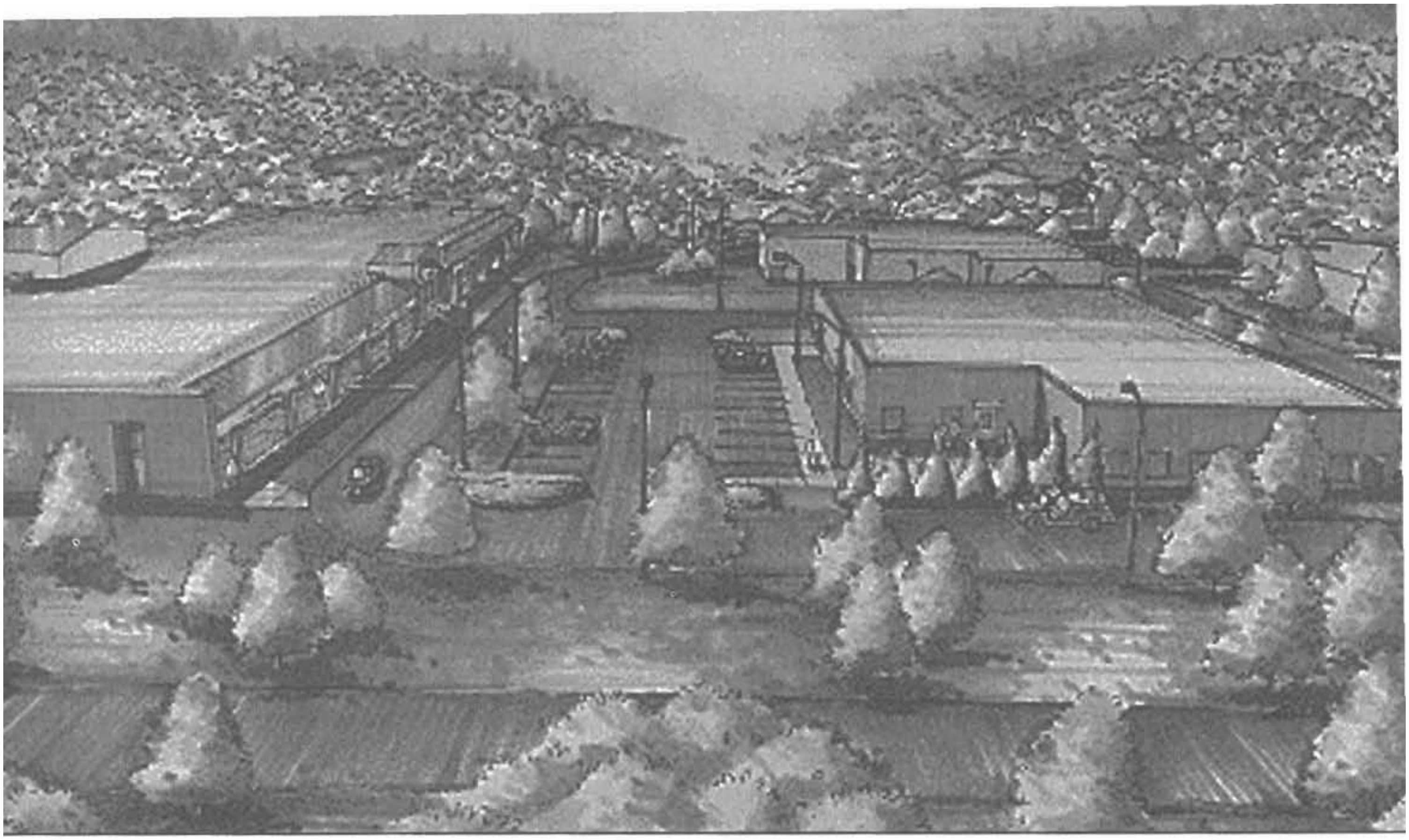
The General Instruction Facility (GIF), a $58M project, will connect to the current Engineer Center headquarters to form the MANSCEN headquarters and schools complex. The building plans should be 95-percent complete by December 1996. The MANSCEN staff and the Engineer, Chemical, and Military Police School staffs will take up residence in the new complex in the second half of FY99. While some of the building space is dedicated to unique branch control, much of it will be used by all the schools.

Many training functions will take place in the new building. It will include general instruction classrooms, numerous applied instructional facilities, and administrative areas that support the Chemical and Military Police Schools and the combined Noncommissioned Officer (NCO) Academy. Many classrooms are designed for small-group instruction and some have moveable walls to allow use by larger groups. Classrooms will have fully hard-wired multimedia and computer-linked training capabilities to support the high-tech Classroom XXI concept.

A computer-based simulations "Warfighter Training Center" will be located within the GIF, where Engineer, Chemical, and Military Police officers and NCOs will train on both combined and branch battlefield functions. Engineer officers and NCOs will train on mobility, countermobility, and survivability operations; and general and topographic engineering skills. Chemical officers and NCOs will use the intelligence-preparation-of-the-battlefield and the deliberate decision-making processes to advise battalion and brigade commanders on nuclear, biological, and chemical (NBC) contamination avoidance, protection, decontamination, smoke, and flame operations. Military Police officers and NCOs will train the Military Police

Projected MANSCEN population

Category	BRAC Impact	FY99 Post-BRAC Population
Military permanent party	1,599	6,231
Trainees/students (average daily load)	3,378	11,684
Civilian workers	498	4,892
Family members	3,621	12,005
Total	9,096	34,812



Artist's conception of the Military Police Village

battlefield missions of circulation control, area security, enemy prisoner of war, and law enforcement operations. The top-notch simulation capabilities will replicate contingency operations and provide Military Police leaders experience in planning and executing missions to support maneuver forces.

The General Instruction Facility will house some of the Chemical School's most critical training areas, such as the Radiological Laboratory (Rad Lab) and the NBC Reconnaissance and Biological Integrated Detection Systems (BIDS) training simulators. The Rad Lab will be used to instruct all Chemical Corps soldiers on the fundamentals of radiation protection, monitoring, and equipment operations. Instructors will also use the lab to train radiation safety officers assigned throughout the Army. The NBC Reconnaissance and BIDS training simulators will use state-of-the-art technology to provide advanced training to selected Chemical Corps soldiers.

Critical facilities inside the GIF for specialized Military Police training will provide physical security areas, including a mock arms room, interview and interrogations rooms, a computer fraud room, and mock crime scenes. Military Police officers and NCOs will use the high-tech classrooms for professional development courses.

Military Police Village

While the General Instruction Facility will provide the majority of resources to instruct officers and NCOs, the Military Police Village will be the primary location for Military Police one-station unit training (OSUT) and advanced law enforcement training (ALET). More than 15,000 military and civilian personnel will be trained in the Military Police Village each year.

The buildings in the Military Police Village that support the skill level 1 training tasks of OSUT soldiers will also provide classroom and administrative space for students and instructors. A weapons simulator will allow students to improve gunnery skills. Mock facilities include a Military Police station, a confinement facility, a communications lab, and a minimall storefront. In its entirety, the village provides OSUT students a mock community with streets, parking lots, businesses, and homes, where Military Police soldiers will practice patrolling and crime-scene techniques.

The Tactical Clearing Complex (TCC), part of the Military Police Village, will provide mock military installation facilities. These facilities will include a credit union, medical clinic, and single-family and duplex living quarters where soldiers and civilians will practice ALET techniques. The ALET staff will train about 5,700 students, including 3,300 federal, state, and municipal law enforcement personnel, in this state-of-the-art training complex. Two of the ALET's primary TCC users will be students in the Special Reaction Team (SRT) training course and the Counterdrug Special Weapons and Tactics Course. A large administrative building in the TCC will provide classroom and administrative areas.

Chemical Defense Training Facility

The "crown jewel" of the Chemical School facilities is the Chemical Defense Training Facility (CDTF). This $28M project will be the location of toxic agent training. The commandant of the Chemical School views this facility as the place where all Chemical Corps soldiers prove that chemical defense doctrine, training, and materiel (detection kits, decontamination kits and solutions, and protective equipment) work effectively. Most importantly, soldiers will become confident in their equipment, procedures, and themselves. This confidence will be transported to the soldiers' next units. Allied and international soldiers and personnel in various federal, state, and city agencies also will train at the CDTF.

Decontamination Apparatus Training Facility

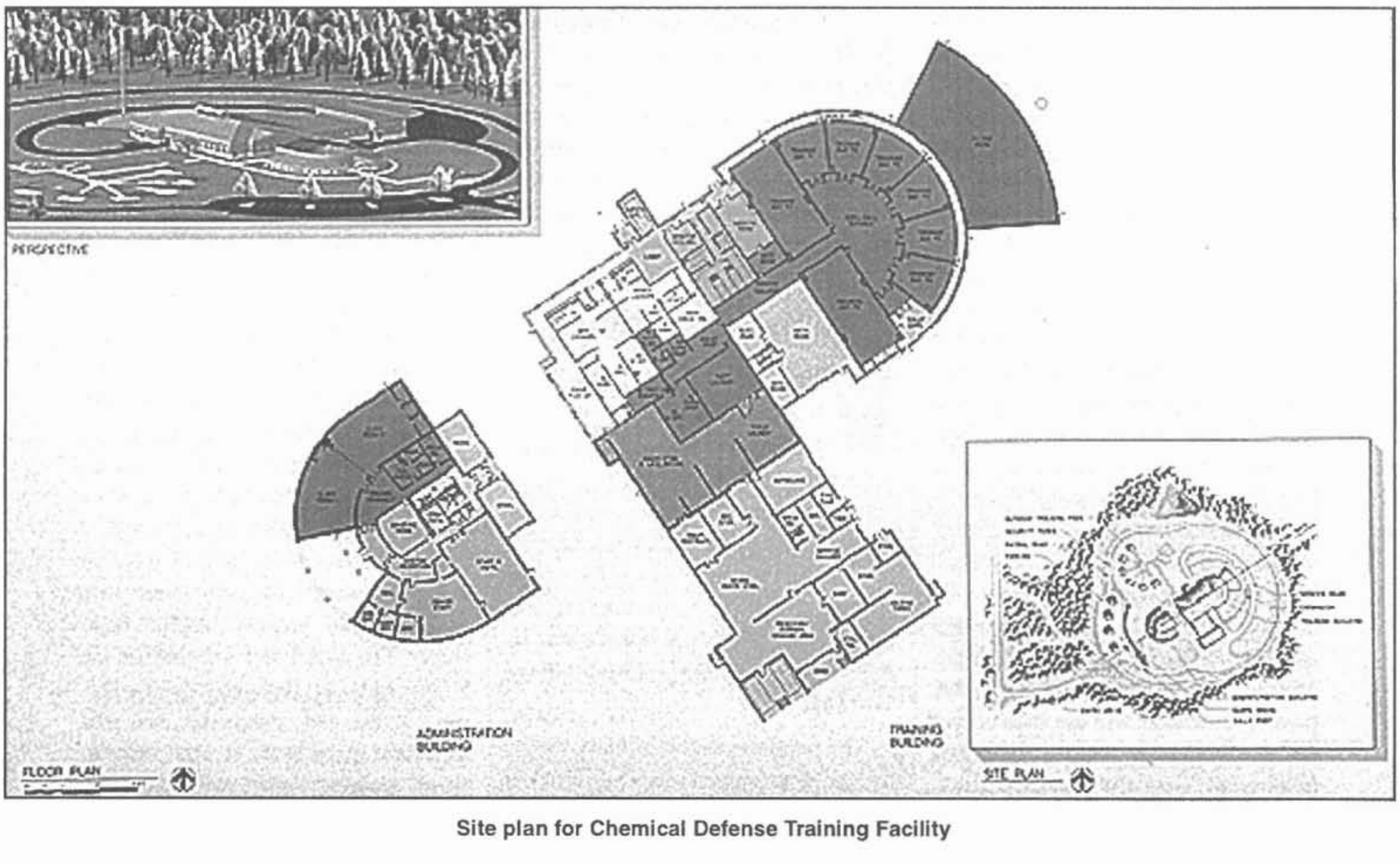
The other major Chemical School facility in the construction project is the Decontamination Apparatus Training Facility (DATF), used to instruct light and heavy decontamination equipment techniques. The interior will house the "hands on" equipment training while the exterior will provide a thorough decontamination site. There soldiers will apply their training knowledge to simulated contaminated equipment and personnel.

Ranges and Training Areas

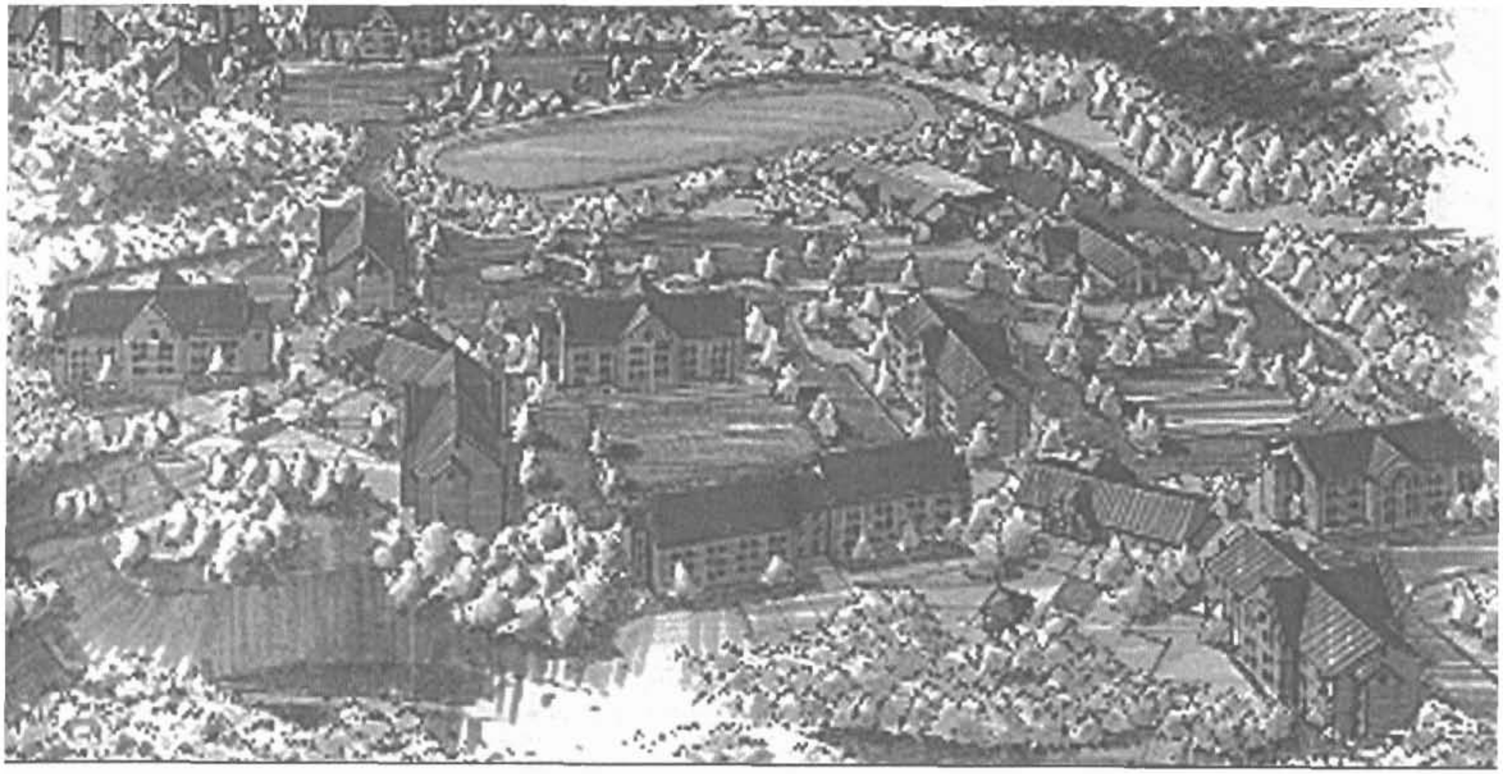
In addition to the facilities construction, the Chemical and Military Police Schools will receive new ranges and training areas to execute core training.

Chemical soldiers will train to standard on several new areas: Range 27/27A, the flame field expedience range; static and mobile smoke training areas; range instructional facilities; NBC Reconnaissance and BIDS field training exercise sites; and operational decontamination sites.

Range 19 on Fort Leonard Wood will be upgraded to an MK19 (40-millimeter grenade machine-gun) range for Military Police training. The Military Police will also receive Range 13, an SRT complex,



Site plan for Chemical Defense Training Facility



Artist's conception of new Unaccompanied Enlisted Personnel Housing Facility

where they will receive specialized training in weapons, to include mini-uzis, shotgun, pistol, and sniper rifles. Range 13 will allow live-fire building-clearing exercises that add a high degree of realism to SRT training.

Military Operations in Built-Up Areas Training Site

A military operations in built-up areas (MOBA) (formerly called military operations in urban terrain [MOUT]) training site will provide all Fort Leonard Wood soldiers the ability to train in a highly realistic urban environment. The MOBA village will consist of 16 buildings—9 intact and 7 partially rubbled. Several have two stories, and one is a three-story apartment building. The village also will contain an underground sewer complex that has safe subterranean egress and ingress routes.

Unaccompanied Enlisted Personnel Housing

NCO students will reside in a newly constructed unaccompanied enlisted personnel housing complex. The building will feature 888 beds, an operations center to provide soldier support services, a community building, and a dining facility. The building design, window styles, and landscaping provide a college-campus look to the dormitory setting. The facility is conveniently located adjacent to the General Instruction Facility, which houses the NCO Academy.

Artifact Storage Facility

A two-story, climate-controlled artifact storage facility will be added to the current Fort Leonard Wood museum. The Engineer, Chemical, and Military Police Schools will share equally in the new facility and the existing museum, where each regiment will display artifacts depicting unique branch history.

Conclusion

The quality of the planned MANSCEN construction will be commensurate with training facilities now on Fort Leonard Wood. Buildings will be all brick with architectural designs complementing existing structures. The well-planned and coordinated consolidation of the Engineer, Chemical, and Military Police Schools at Fort Leonard Wood will ensure that the MANSCEN stands as TRADOC's model cluster installation.

Major Herold serves as the Military Police representative for Base Realignment and Closure (BRAC) actions at Fort Leonard Wood, Missouri. Previous assignments include S3 and XO of the 793rd Military Police Battalion, Germany and Bosnia; Management Directorate, Office of the Chief of Staff of the Army; and recorder for the Secretariat for DA Officer Selection Boards.

Major Wilson is the U.S. Army Chemical School commandant's representative on the Fort Leonard Wood BRAC staff. Previous assignments include battalion chemical officer, 2-32 Armor, 3 AD; decontamination platoon leader, 22nd Chemical Company; brigade chemical officer and battery commander, 35th ADA Brigade; instructor/writer, Combined Arms Branch, U.S. Army Engineer School; and Chief, Chemical Branch Assistance Team, 5th U.S. Army Readiness Group.

The Total Army School System

By Major Larry Cerny

Over time, each of the three components of the Army—Active, Reserve, and National Guard—developed independent school systems, which gradually developed separate standards. The new Total Army School System (TASS) creates one system with identical tasks and standards for all three components.

The Engineer School's mission is to complete a transition to an effective and efficient TASS of fully accredited and integrated Active, Reserve, and National Guard schools that provide standard engineer institutional training and education for America's Army.

Organization

To understand this mission, we must first understand the TASS organization. The Continental United States is divided into seven regions, labeled A through G (Figure 1). TASS implementation began in 1994 with the standing up of Region C, which was used as a test bed. The other regions were activated in October 1996.

Implementation of this new system creates the following major changes:

- U.S. Army Reserve Force (USARF) schools were replaced with school battalions.
- Total Army Training System (TATS) courses are replacing Reserve Component Configured Courseware (RC3).
- Proponents are responsible for instructor certification.
- Proponents are responsible for accreditation of the school battalions.

Each school battalion is functionally aligned with a proponent school. Functional alignment is "a branch school's functional relationship with its affiliated Reserve Component training institutions and instructors, which provides current concepts, techniques, and equipment for that branch's courses." For example, the Engineer School, located at Fort Leonard Wood, Missouri, is functionally aligned with the seven Engineer School battalions.

In addition to their functional alignment, the school battalions have a command alignment (Figure 2, page 45).

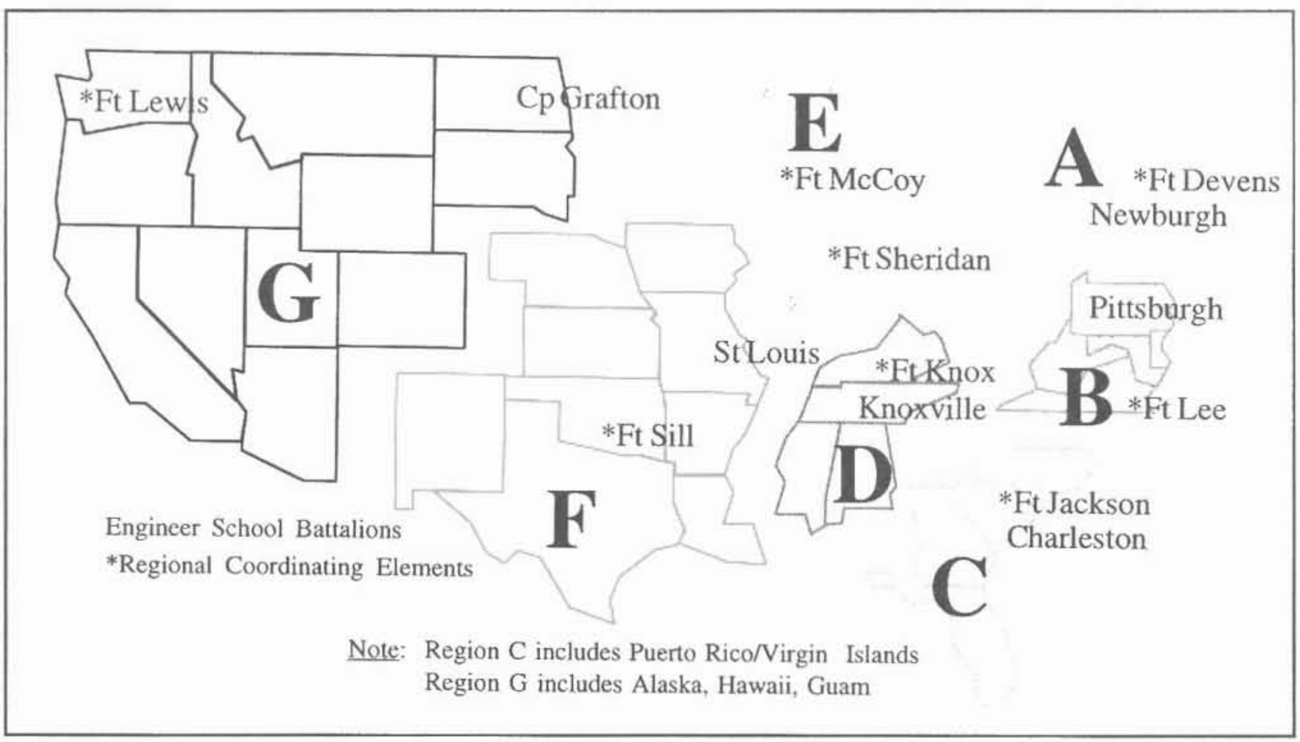


Figure 1. TASS regions

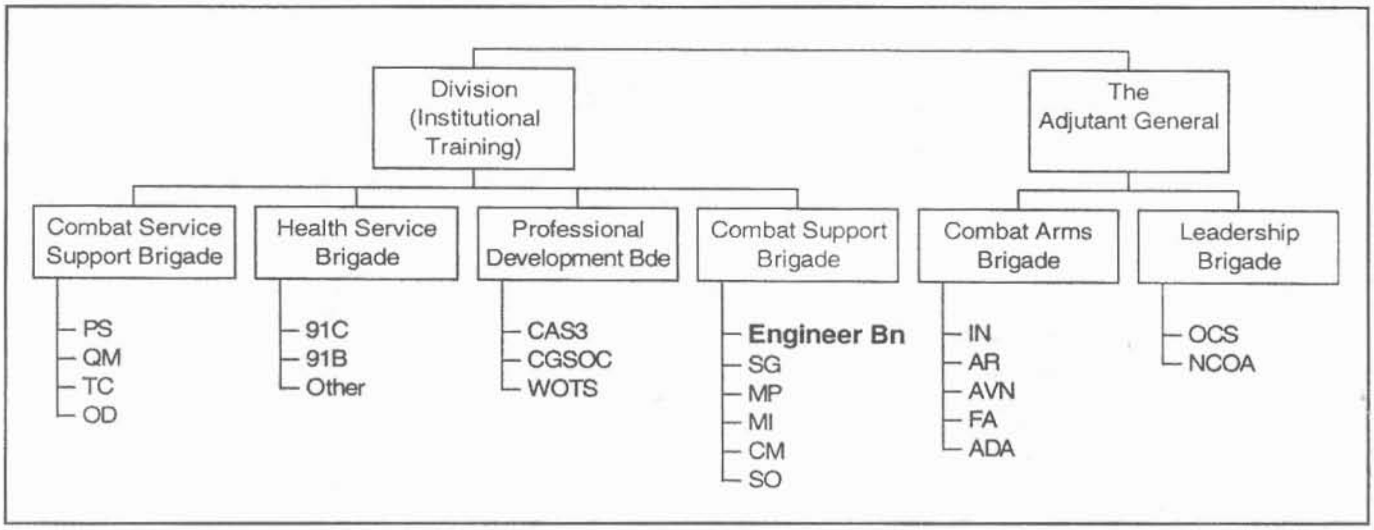


Figure 2. Command alignment of school battalions

School battalions report to school brigades. Combat arms and leadership brigades report to the Adjutant General (TAG). Combat service support, health service support, professional development, and combat support brigades report to reserve divisions.

The Engineer School's Department of Training and Doctrine Development created a TASS Division to control all the functions that TASS dictates. The division is responsible for the following areas:

- Codeveloping individual training courses with the Training Development Division.
- Maintaining functional alignment with the Engineer School battalions.
- Accrediting the Engineer School battalions.
- Maintaining a central point of contact concerning TASS issues.

Each of the seven TASS regions has a Regional Coordinating Element (RCE) that is staffed with Active Component, full-time Army Reserve, and full-time National Guard soldiers. They are a TRADOC element charged with being the overall TASS coordinator for their respective region.

"Title XI," the congressional action that authorizes and requires the use of active duty personnel for dedicated support of reserve units, supports the TASS structure. Title XI personnel are assigned to RCEs, proponent schools, and the Reserve Component school battalions.

TATS Courses

These selected courses are designed for military occupation specialties (MOSs) within all Army components. Although the training may occur at different sites and may use different media or methods, a TATS course trains all critical tasks to a common performance standard, including those for Department of the Army and TRADOC-directed courses.

Reserve Component soldiers normally have 16 hours of inactive duty for training (IDT) each month. They meet one weekend a month or once a week for 4 hours. In addition, they normally have a 14-day annual training (AT) period.

In the past, Reserve Component Configured Courseware was taught in U.S. Army Reserve Force schools. This courseware included only those tasks needed to prepare reservists for mobilization, not necessarily all the tasks for which active duty soldiers trained. Performance standards for each component differed. Trade-offs were made for reservists because of their time constraints.

TASS changes this process. Now one standard course replaces the separate Active and Reserve Component courses. Instead of the Training Development and TASS Divisions working independently, they work together to develop a product that fits the needs of both components.

Instructor Certification

Under TASS, proponent schools certify the Reserve Component instructors who teach in the school battalions. Each proponent school has a battalion in each of the seven regions. The Engineer School has a battalion in the following locations:

- Region A—Newburgh, New York
- Region B—Pittsburgh, Pennsylvania
- Region C—Charleston, South Carolina
- Region D—Knoxville, Tennessee
- Region E—Fort Sheridan, Illinois
- Region F—St. Louis, Missouri
- Region G—Camp Grafton, North Dakota

The school battalions send instructors wherever they are needed. For example, if a military unit located in southern California needs a course taught during IDT, the engineer battalion at Camp Grafton selects a Reserve Component instructor near that site to instruct the course.

Under TASS guidelines, the following certification standards apply to both Reserve and Active Component instructors:

- Meet mandated soldier requirements for height, weight, Army Physical Fitness Test, and security clearance.
- Have the MOS of the course being taught.
- Graduate from the course, be a subject matter expert (certified for specific blocks or lessons only), or test to proponent school standards.
- Graduate from an Instructor Training Course.
- Demonstrate teaching competence.
- Meet the specified minimum grade level for teaching the course.
- Fulfill additional proponent school requirements.

Certification requirements must be achieved in one Reserve Component training year, which equals two AT weeks and 12 IDT weekends. Together, AT and IDT will not exceed 39 training days.

School Battalion Accreditation

Beginning in FY98, and every three years thereafter, an accreditation team from proponent schools will evaluate the school battalions that are functionally aligned with them. The team will consist of a team chief, an evaluator, and a subject matter expert. Accreditation requirements involve two major areas: administrative procedures and records, and conduct of training. In the evaluation process, the team will use checklists that cover the following:

- Quality of instruction.
- Use of qualified instructors.
- Adequacy of facilities and equipment.
- Procedures to ensure that students meet established prerequisites.
- Compliance with approved programs of instruction and governing regulations.

To accredit a school battalion, proponent schools must evaluate one annual training period and at least one-third of the inactive duty training periods.

Distance Learning

Distance learning (DL), although separate from the other TASS responsibilities, plays a key role. DL applies multiple means and technologies to deliver standardized training to soldiers and units at the right place and time. At the center of DL is Classroom XXI, an Army initiative to place high-tech classrooms throughout the military community. The current TRADOC plan calls for fully implemented DL by the year 2010. By that time, TRADOC expects that 66 percent of our soldiers will receive DL and that 99 percent of our soldiers in the continental United States will be located within a 1-hour drive from a DL facility.

Conclusion

The TASS affects all Army soldiers. They can either attend training at the Active Component Teaching Institution (ACTI) or one of the Reserve Component school battalions. However, all initial-entry training occurs at the ACTI. No matter where they are located, the Army courses teach the same tasks and standards and are taught by instructors with identical certification standards.

To make TASS work for the engineer community, we need feedback on what is working and what needs to be improved in our individual training courses. Whether you are an Active, Reserve, or National Guard soldier, these are your courses and TASS is your school system, so send your ideas to: Commandant, U.S. Army Engineer School, ATTN: ATSE-TD-TASS, Fort Leonard Wood, Missouri 65473; or via email: cernyl@wood-vines.army.mil. The telephone numbers are: DSN 676-4114; commercial 573-563-4114.

Major Cerny is chief of the Schools Branch, TASS Division, DOTD, U.S. Army Engineer School. Previous assignments include training officer, 98th Division (Institutional Training); assistant S3, 367th Engineer Battalion (Combat Corps); and training officer/platoon leader, 760th Engineer Company (Combat Support Equipment).

References:

1. Total Army School System (TASS) OPLAN-2. TRADOC. 1 January 1995.

2. TRADOC Regulation 350-70, *Training Development Management, Processes, and Products.* 24 September 1995.

3. TRADOC memorandum, subject: *Total Army Training System (TATS).* 25 March 1996.

4. TRADOC memorandum, subject: *Policy for Certifying Instructors.* 20 November 1995.

5. TRADOC TATS/DL Workshop. 29 April - 2 May 1996.

Engineer Solution

1. Use the equations on page 37 of the Ice Bridging article to determine the military load classifications:

C = 0.9 (Semiclear)
S = 0.6 (Freeboard less than 90 percent)
T = Thickness of ice (in inches)
W = Wheeled vehicle MLC
A = Tracked vehicle MLC

$$W = \frac{(T^2)CS}{25} = \frac{(43)^2(0.9)(0.6)}{25} = 39.9 \text{ (round down)} = 39$$

$$A = \frac{(T^2)CS}{20} = \frac{(43)^2(0.9)(0.6)}{20} = 49.8 \text{ (round down)} = 49$$

Answer: The MLC for wheeled traffic is 39, and the MLC for tracked vehicles is 49. Vehicles will be spaced 150 feet apart (up to two vehicles may be on the ice at a time).

2. The MLC for an M1A1 tank is 70. To determine the ice depth required from the equation, complete the following:

$$\text{Thickness (inches)} = \frac{A(20)}{C \times S} \text{ or } \frac{70(20)}{CS}$$

$$\text{Thickness (inches)} = \frac{70(20)}{0.9 \times 0.6} = 50.9 \text{ inches (round up)} = \text{minimum ice thickness of 51 inches.}$$

Answer: There are currently 43 inches of ice over the river and 51 inches are required to safely cross the M1A1 tank. Therefore, 8 inches of ice must be added. Since 2 inches of ice may be added to the bridge per day, it will take 4 days to reach the desired strength.

Alternative Solution

The problem also can be solved by using the Quick Reference Card and Graph shown in Figure 3, (page 36) and Table 3 (page 37). They are used when time does not allow for a deliberate recon on the crossing site. The deliberate method gives a different answer because detailed information is known about the ice and safety factors are included in the calculations. When using the quick method, normally only the ice thickness and ambient conditions are known. The ice color and strength factors are not considered when determining a solution but can be added to further define the crossing site conditions. When time allows, a complete recon and ice-bridge profile should be completed.

1. It is given that the ice is 43 inches thick and the heaviest vehicle crossing the bridge is an M1A1 Abrams tank (MLC 70). Reading down column 1 on the Field Guide Quick Reference Card (Table 3) to MLC 70, the minimum thickness required is 34 inches and the required distance between vehicles is 280 feet.

2. The reference card indicates the ice will support MLC 70 vehicles, and further strengthening of the bridge is not required. Note the 280-foot spacing between vehicles, indicating that only one vehicle may cross the bridge at a time. The wear surface and approach and exit banks will require occasional maintenance.

The Engineer Jungle Warfare Course

By Captain Andrew V. Jasaitis

The Jungle Operations Training Center (JOTC), located at Fort Sherman, Panama, trains infantry battalions and engineer companies to conduct jungle combat operations. One of the programs offered by JOTC is the Engineer Jungle Warfare Course (EJWC).

The EJWC provides a unique opportunity for engineer companies and platoons to train in a jungle environment. The Jungle Operations Training Battalion normally supports four engineer company and ten engineer platoon rotations annually. The EJWC is open to almost any combat engineer company—airborne, air assault, wheeled, combat support equipment, combat heavy, etc. Most rotations are from corps-level engineer companies because divisional engineer platoons deploy and train with the Infantry Battalion Jungle Warfare Course rotations.

The Jungle Operations Training Center's primary objective is to keep the art of jungle warfare alive in the Army today. In concert with this mission, the Engineer Jungle Warfare Course prepares engineers to fight future battles and win in a jungle environment.

In addition to supporting U.S. Army combat engineers, the Engineer Jungle Warfare Course provides joint training to selected U.S. Marine Corps engineer platoons and some Latin American engineers.

Program of Instruction

The program of instruction for the EJWC is organized, manned, and equipped to provide training to three engineer platoons. Instructors from Alpha Company, Jungle Operations Training Battalion, conduct the training by committees. Team 6 provides instruction in engineer-specific tasks.

The four-week EJWC consists of two weeks of combat training (core jungle training and tactical operations) and two weeks of construction (Army Facilities Components System-Tropical).

Combat Training. Typical training during the first two weeks includes: jungle living, land navigation, mines and booby traps, jungle combat techniques, rappelling, advanced rigging and hauling, squad reconnaissance, squad react-to-contact (blank and live fire), waterborne and small-boat operations, basic and advanced demolitions, and platoon reconnaissance and demolition missions. Platoons also negotiate the rugged "Green Hell" obstacle course. The second week culminates in a two-day company field training exercise designed to meet the unit's mission essential task list (METL) training needs and to employ tactics, techniques, and procedures learned during core training. Company infiltration

An engineer squad from B Company, 27th Engineer Battalion (CBT) (ABN) conducts a reconnaissance mission on the Chagres River.

and movement is by several methods—landing craft, medium (LCM); F-470 Zodiacs, or Army aviation (air assault).

Construction Training. The third and fourth weeks of the course are spent on construction missions, which include carpentry, concrete and masonry, plumbing, and construction management tasks. Projects include bridge repair or replacement; target, rappel tower, obstacle, boat dock, fence, cage, and roof construction; office and classroom renovation; and window installation. Units normally provide eight days of construction effort. All projects are designed to support the training center so that the Jungle Operations Training Battalion can continue to provide high quality training opportunities.

Deployment Tips

Adequate planning is important for a successful deployment to the Jungle Operations Training Center. The following tips will help units planning to attend:

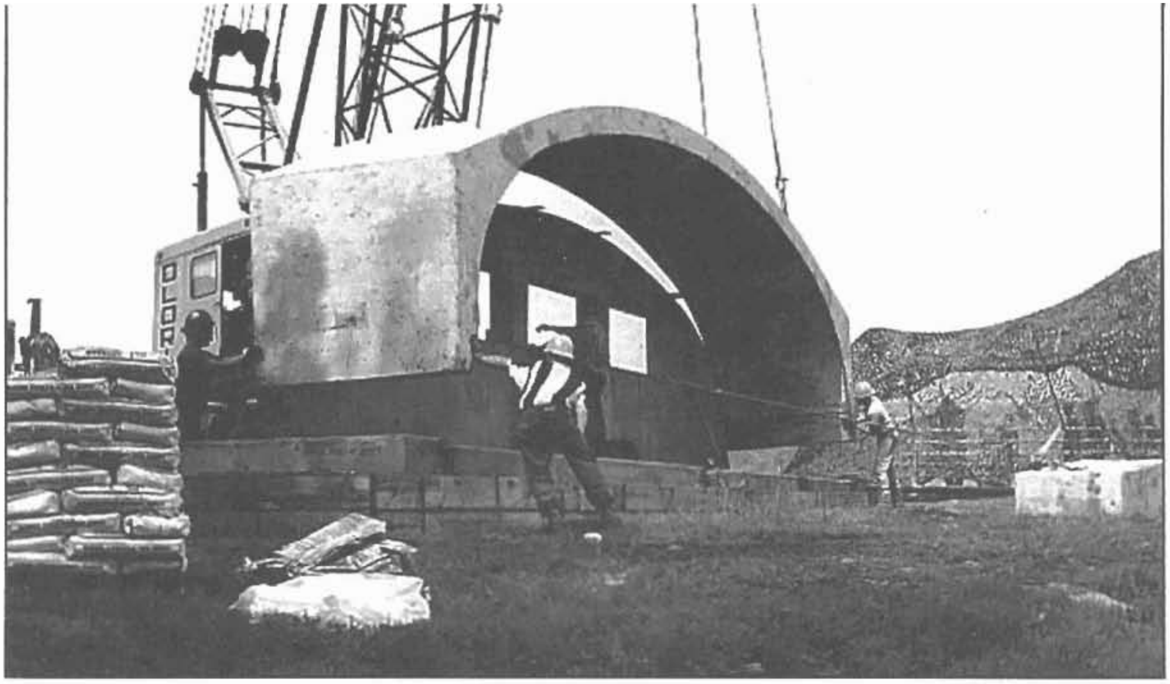
- Send a site survey team six months before deployment. The team should consist of two or three people who can make decisions on training and who have a working knowledge of construction.
- Allow five days (Monday through Friday) for the team's visit—two travel days, one day on the Pacific side, and two days at Fort Sherman for coordination.
- Plan for the main body to arrive on the Friday or Saturday before the first training day on Monday.
- Plan for the advanced echelon to arrive four days before the main body.
- Deploy with all necessary construction equipment (such as sets, kits, and outfits; power tools; and generators).
- Plan to be self-sufficient (special equipment will be coordinated in-country if needed).
- Focus home-station training on knots/rope management, basic land navigation, and battle drills in dismounted movement/patrolling at squad and platoon levels. Identify weak swimmers (water safety and drown-proofing classes must be conducted within three months of deployment).
- Units that conduct airborne operations must conduct B-7 training and request permission to jump in country.

Benefits

The benefits of a deployment to EJWC are many. Engineers receive METL-related training in deployment and numerous collective, leader, and individual tasks. The decentralized training allows squads to train soldiers and develop or improve standing operating procedures. Units can identify strong and weak performers as well as build teamwork and cohesiveness. Soldiers are allowed to make mistakes and train to standard without the pressures of higher headquarters. The Jungle Operations Training Battalion provides almost all training support, so that leaders can concentrate on meeting training objectives. Most of all, engineer units increase proficiency and gain confidence in conducting operations in a harsh jungle environment.

Engineer units should contact Forces Command for scheduling and funding to attend the Jungle Operations Training Center. Under the current Panama Canal Treaty Implementation Plan, Fort Sherman will remain open until the end of 1999. For more information, call the Jungle Operations Training Battalion engineer at DSN (313) 289-6411; Team 6, A Company, (313) 289-6057; or the S3, Jungle Operations Training Battalion, DSN (313) 289-6287.

Captain Jasaitis served as the senior engineer instructor-observer/controller at the Jungle Operations Training Center, Fort Sherman, Panama, from February 1995 to May 1996.



Precast Demolitions Training Range Bunkers

By Gerald L. Knapp and First Lieutenant Adrian Donahoe

Today's Army continually changes its training to fight different types of conflicts. Adjusting training is relatively easy, but adjusting training sites is not. It is difficult to move existing ranges, establish new ranges in a cost-effective way, identify range fans and safety or buffer areas, build new support facilities, and redefine impact areas while maintaining good environmental stewardship. Units must often adjust to the loss of training areas and the proverbial "doing more with less" situations. This article describes how the United States Military Academy successfully designed and installed a new demolitions training range bunker using state-of-the-art concrete technology.

Mission

The planning process for 1996 cadet field training revealed the need for more light infantry training and a larger training area. Since acquiring more land was not an option, we decided to maximize the use of existing training areas.

The demolitions range occupied prime areas needed for light infantry training. Range control personnel selected an alternate site adjacent to the existing artillery impact area and moved the demolitions range there. The impact area provides a safety zone around the new demolitions training site, which is an added benefit.

Overall design of the demolitions range was driven by the requirement to allow cadets to witness detonation of the demolitions charges they prepared. Since this was the third site for the demolitions range in five years, ease of construction and portability were primary issues.

While reviewing sales literature for precast concrete bridge spans for use in our range and training complex, we discussed whether these spans might also provide overhead cover protection for the range. We contacted the manufacturer, who indicated that a concrete precast bridge span had never been used for a bunker. We reviewed the construction details of the proposed unit and decided it would meet our needs. The manufacturer sent shop drawings, which were presented to members of the U.S. Military Academy Range Review Board. This group of trainers, range control managers, the Director of Housing and Public Works, and environmentalists routinely meet to plan and track range improvements. They approved our plan as presented.

Specifications

The bunker is made from four precast concrete pieces. The floor is two panels, each 9 inches thick, 21 feet long, 6 feet 6 inches wide, and weighing 7.8 tons. The panels are reinforced with Number 6 and Number 4 rebar. They are joined with a keyway filled with fast-setting construction grout.

A completed bunker built with precast concrete.

The 10-inch-thick reinforced end wall is 37 feet long and weighs 14 tons. It has three windows that are 6 feet long, 2 feet 6 inches high, and 2 inches thick. They are multilayered (laminated glass, polycarbonate, and lexan) and bullet-resistant to meet Army specifications. These are basic embassy windows that will resist 15 minutes of forced entry and impacts from three 7.62-millimeter rounds in an 8-inch circle. This is more than sufficient to stop fragments that may result from demolitons training. A replaceable scar shield of 1/4-inch Plexiglas protects both sides of the windows from vandalism and fragments.

A bridge span that is 38 feet long, 9 feet high at the apex, and 6 feet 6 inches deep provides overhead cover. It weighs 25 tons and is connected to the end wall at six points with 6-inch by 6-inch angle iron bolted to drop-in anchors installed during casting.

Construction

To prepare the bunker site, an engineer platoon removed existing mortar pits, moved a set of bleachers, removed the existing range tower, and hauled suitable fill for the walls of the demolitions pit.

The foundation has a 12-inch-high base of 3/4-inch stone to ensure good drainage around the bunker. The base is held in place by a curb made of 2 by 10 lumber and rebar. This is strengthened by backfilling around the curb with more stone.

The bunker arrived on three flatbed trucks at 1000 hours and was in place by 1800 hours. The following day the engineer platoon grouted the joints between the span and the base and caulked the arch/ end wall joint.

Personnel from the Directorate of Housing and Public Works installed the windows, which were mounted with 3-inch angle iron on both sides. They used sheet steel to shim the windows and fill the voids around them.

Cost Effectiveness

The total cost for the project was approximately $30K (see table). This sounds expensive for a bunker, but it is portable. If the demolitions site is moved, the bunker can go with it. It has an expected life span of at least 20 years.

Moving the "portable bunker" will be relatively easy. It requires fracturing the grout, unbolting the 6-inch angle iron connectors, removing the windows, and transporting the bunker to the new site. We left the lifting point exposed to facilitate rigging when the unit is moved.

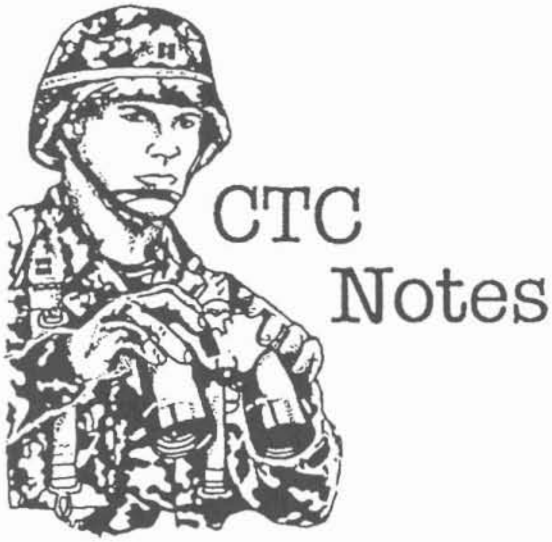
Cost of Precast Bunker

Item	Cost (K)
Precast bunker parts	$19
Windows	6
Crane and rigging	4
Site preparation	1
Total	$30

Moving and consolidating ranges to meet financial and environmental constraints is a fact of life in our current downsizing phase. By using state-of-the-art construction materials creatively in our training areas, we help ensure that training is effective for soldiers, friendly to the environment, and cost effective for the tax payers.

Mr. Knapp is the operations officer, Directorate of Housing and Public Works, U.S. Military Academy.

First Lieutenant Donahoe is the engineer platoon leader, U.S. Military Academy.



National Training Center (NTC)

Using Obstacle Group Designs

By Major Tom Buning

The last submission of *CTC Notes* from the National Training Center (August 1996) focused on the combat engineer platoon's role as executors. It emphasized that improvement in engineer platoon productivity in countermobiliity tasks requires taking action at all levels to narrow the platoon's focus in the defense to siting and emplacing minefields. Lessons learned at the NTC show that poor planning products at the engineer battalion and company levels are a primary cause of poor obstacle execution. This article provides a technique to produce an executable plan for the platoon leader as a way to improve productivity and support to the mission.

To provide an effective link between obstacle planning and execution, engineers need a tool that focuses the effort of the former to improve the efficiency of the latter. It is not sufficient to hand a set of obstacle graphics to a platoon leader and expect that a plan will be executed to a standard that either meets or supports the maneuver commander's intent. A recommended technique for providing the details required for timely execution is to introduce into the planning process an obstacle group design that includes each directed obstacle. (Note: Most tactical obstacles at the task-force level are directed; some may be reserve or situational.) Planners must provide a level of detail in the obstacle group design that enables platoons to emplace obstacles that meet the commander's intent.

Task force engineers (engineer company commanders) must produce an obstacle group design overlay that provides the following information as a minimum:

- Tentative layout of the obstacle group depicted on a 1:25,000- or 1:12,500-scale map showing (to scale) the size, shape, location, and orientation of each obstacle.
- Operations graphics showing the applicable engagement areas, battle positions, and target reference points.
- Various terrabase pictures from both friendly (key direct fire systems) and enemy (engagement area) perspectives.
- Text, including both the resources and effort required to execute the obstacle group and any special instructions. This information tells the platoon leader what he is siting, the effort he must commit to the project, and the expected duration of the effort.

Production of an obstacle group design will force planners to more clearly understand the effort they are committing as they lay out the details of a directed obstacle group. It also forces planners to clearly and accurately define the Class IV/V requirements needed to integrate obstacles into the combat service support plan. *Commitment* is the key word. The value of preparing an obstacle group design is that it forces planners to provide the level of details required for the platoon to execute the plan. It also provides the capability to more accurately track the precious platoon hours and resources needed to accomplish the plan. The countermobility/survivability time line used to track planned versus executed performance enables engineer staff officers to better inform the chain of command on the status of building the defense.

Successful execution of an obstacle group design by task force engineers requires a task organization constraint. Engineer platoons cannot be placed in direct support to a maneuver company and remain effective in their ability to execute the plan established by the assistant and task force engineers. Therefore, combat engineer companies cannot be task organized beyond direct support to the supported task force. This does not mean that the engineer platoon leader is relieved of the responsibility to properly coordinate with the maneuver company team that owns the engagement area where they are constructing an obstacle group.

From a current doctrinal perspective, use of an obstacle group design fills a void. FM 90-7, *Combined Arms Obstacle Integration*, establishes that task force engineers (engineer company commanders) are responsible for planning. FM 20-32, *Mine/Countermine Operations*, recommends an obstacle group design method as an initial step toward establishing a framework for emplacing obstacles, while FM 90-7 states that a platoon leader executes intent. This is where doctrine fails to discuss in detail the need to produce a detailed plan or the important role of the engineer platoon as its executor. In fact, chapter 5, FM 90-7, warns that given a plan with too much detail, a platoon leader will emplace minefields as articulated in concept and disregard proper obstacle siting. Given this line of thought, it may be argued that use of the obstacle group design will increase the problem of improper obstacle siting, because this technique places greater emphasis on precise design/execution standards. However, NTC engineer trainers submit as a strong counterpoint that, for efficiency in execution, it is a lesser training challenge to make lieutenants and platoon sergeants understand that they must site obstacles and adjust a given design to the terrain than to generate the design itself.

The goal of these two submissions from the NTC (August 1996 *Engineer* and this article) is to ensure that engineer leaders and staff officers manage the precious time available to engineers in establishing the defense. The most effective way to accomplish this is to prepare an executable plan that allows for the efficient use of engineer platoon hours. It is not sufficient to point out a problem without suggesting a solution. This article provides a technique (the obstacle group design) that will narrow the focus of the platoon to its organizational capabilities and instill discipline into obstacle emplacement. Disciplined execution of an obstacle plan will allow our combat engineer force to maintain its credibility as a member of the combined arms team. It will enable us to deliver what we promise—obstacle effects on the ground to shape the fight for the commander. With victory as the only acceptable alternative, there is no other choice.

Battle Command Training Program (BCTP)

By Lieutenant Colonel David Snodgrass

Recent BCTP Warfighter exercises show that targeting enemy capabilities presents a significant challenge for divisions. Complete targeting of an enemy capability almost always requires a combined arms operation. If successful, it provides an excellent opportunity to upset the opposing force (OPFOR) plan and time line and improve our position on the battlefield. For example: Some divisions use air interdiction (AI) missions to destroy fixed bridges over rivers deep in the enemy rear area, theoretically to slow enemy follow-on echelons and force him to expend various critical resources (time, bridging, and engineer effort). Unfortunately, they target only the fixed bridges and not the full spectrum of components that comprise the enemy force and its capability to move rapidly across a river. The usual result is only a minor inconvenience to the OPFOR and has little impact on their overall plan.

Consider for a moment how rare and valuable AI missions are and the risks we take to fly behind enemy lines to hit bridges. Are we accomplishing our objective if we fail to track the movement of the enemy force, interdict the bridges too early, or allow the enemy sufficient time to change routes without delaying his time line? Worse yet, what if we hit the bridges after he has already crossed? Assuming that the enemy's bypass options are difficult, how effective is knocking out a bridge if we fail to detect or target enemy engineer bridge units located near the bridge? How effective is the action if we fail to dedicate reconnaissance assets to watch the damaged/destroyed fixed bridges and detect his attempts to construct float bridges or repair the damaged fixed bridges? Have we maximized the delay time of the enemy force if we allow enemy engineers to work unimpeded? If we do not dedicate additional reconnaissance efforts to identify and report the enemy maneuver elements stacked up on routes into the crossing area, or if we do not dedicate assets to strike "target rich" environments, have we fully realized the maximum benefit of our actions? If we lose aircraft and pilots on the AI mission and the enemy has bridges up and forces moving again within a few hours, was the cumulative effect worth our efforts?

Our best option is to hit the enemy, specifically his capability to rapidly move forces across a river, with multiple problems from multiple directions and present him with more than one challenge to solve at any given time. Doctrine states and experience shows that an obstacle is effective only when it is combined with other types of obstacles and integrated with planned, dedicated direct and indirect fires to achieve a specific effect. To accomplish this, we must attack the spectrum of assets that comprise the enemy capability as well as the enemy forces. We must remove his ability to use fixed bridges, take away his crossing alternatives and bridge-repair capability, consider other means to make an obstacle complex (i.e., Gator minefields), and then strike his forces as they wait for an opportunity to move forward.

Division decision makers, in this case the combined arms deep operations coordination cell (DOCC), need a cost-benefit analysis to assist their decision making. After we clearly define the desired effect, we should clearly identify the targeted capability, component pieces, and resources required; determine if the resources are available and in the proper position; and quantify the risk associated with the mission. Once this analysis is complete, the decision makers will clearly understand the challenges involved in the mission. Then they can determine if the committed resources and risks involved are worthy of the net effect gained over the enemy. Planners should brief the division commander on the high-risk operations that commit limited resources, potentially impact other operations, or have a potential payoff that is not clearly in our favor to assist him in the decision to execute an attack.

AI missions against bridges are one example of this concept using the mobility/survivability battle operating system (BOS). Enemy capability targeting challenges are found all across the battlefield, in each of the BOSs, and require a combined arms effort for success. Complete targeting of an enemy capability provides a much greater opportunity to significantly impact the OPFOR plan, presents the enemy with more than a minor inconvenience, and significantly improves our position on the battlefield.

Joint Readiness Training Center (JRTC)

Minefield Battle Tracking and Influencing the Low-Intensity Fight

By Captain Jeff Farnsworth

Enemy minefield battle tracking is an improving trend for units rotating through the JRTC. Successful units expend considerable effort to ensure their minefield-tracking charts and feeder reports include the information elements needed to show the mine threat across the battlefield. Many units disseminate minefield feeder reports widely and post them in all vehicles throughout the brigade. The flow of obstacle intelligence (OBSTINTEL) from subordinate units is improving, although the accuracy and timeliness of reporting still need attention. Detached engineer platoons are getting better at flipping the switch on their SINCGARS and reporting minefield incidents to the engineer company/brigade engineer cell as they occur. Engineer conference calls facilitate information flow to confirm/deny other OBSTINTEL at the brigade level. The engineer at the brigade level is better integrated with the intelligence and maneuver battlefield operating systems (BOSs). Most OBSTINTEL is captured and posted. Brigade engineers consistently confirm/deny and exchange information with the S2. These actions are positive indicators that systems are in place for commanders to "see" the battlefield. They set the stage for the application of battle command in the countermine fight.

To increase the effectiveness of their combat operations, units should focus training efforts on the dissemination and analysis of battlefield information. Some successful techniques follow:

Dissemination. Units typically disseminate updated minefield tracking reports as an engineer annex to daily brigade fragmentary orders. Most successful units ensure this information is quickly passed to company and platoon levels, where it is integrated into current operations. This technique, however, does not allow for rapid dissemination on a fluid, nonlinear battlefield. As minefield incidents occur, consider sending "flash minefield reports" over command nets, in much the same way that units disseminate flash NBC reports. This technique provides subordinate units and small unit leaders immediate access to this critical information and enhances their situational awareness.

Analysis. The brigade and task force engineers who are able to influence the maneuver targeting process experience significantly more success against an austere enemy than those who are not. Sharing, confirming/denying, and disseminating information is not enough. Engineers also must aggressively influence the S2's analyses and ensure that updated situational templates accurately reflect the relationship between enemy activity and disposition to OBSTINTEL. The engineer must advise and assist the S2 in adjusting templated caches, supply transfer points, and, therefore, likely enemy unit locations. Jointly with the S2, update the S3 on the current enemy situation. This information helps focus the intelligence picture used in targeting meetings at brigade and task-force levels. Engineers typically are passive observers during the targeting process. Instead, they should—

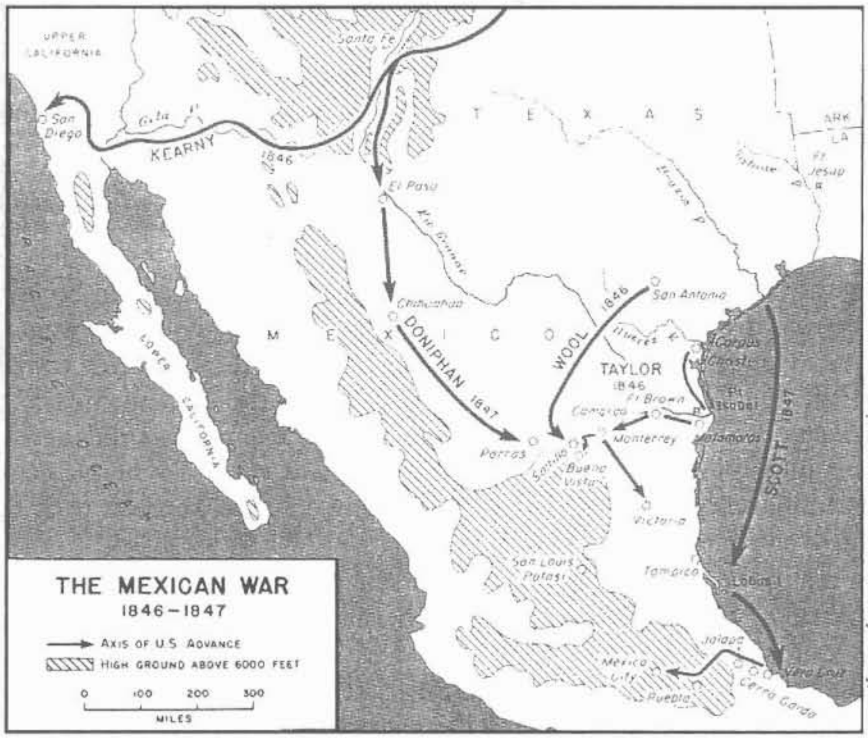
- Recommend a focused area around high-density enemy minefield activity for designation as named areas of interest and high-priority targets.
- Recommend using scouts and other intelligence assets to monitor enemy activity in these areas.
- Recommend that counterreconnaissance efforts and ambushes be employed near reseeded minefields.

By employing a combination of these efforts, engineers will assist maneuver commanders in exercising effective battle command to win the countermine fight.

War With Mexico: The Northern Campaign, 1846-1847

By Paul K. Walker

In the mid-1840s, the United States and Mexico went to war over the annexation of Texas as a state and an unresolved boundary dispute. Mexico claimed the Nueces River; the U.S. claimed the more southerly Rio Grande.



Map taken from *American Military History*, 1969

As the crisis worsened, the U.S. Army readied for possible hostilities. Authorized strength was only 8,500, but in 1845 considerably fewer men were available for service. The situation resulted from a long period of relative peace and traditional bias against standing armies and large military budgets in favor of the militia.

The Army's engineers were organized in two corps—a Corps of Engineers and a Corps of Topographical Engineers. The Corps of Engineers, under Colonel Joseph G. Totten, numbered 43 officers; the Topographical Engineers, under Colonel James W. Abert, numbered 36. The top graduates of West Point filled their ranks. Indeed, a West Point education was a unifying factor among the engineers who served in the war with Mexico.

By the 1840s, the Corps of Engineers' primary duties involved coastal fortifications, while the topographers (topogs) were engaged in river and harbor improvements, road building, Western exploration, and mapping. Neither corps had a troop unit assigned to it and had to rely on soldiers detailed from other branches and hired civilians.

In June 1845, President James K. Polk ordered Brevet Brigadier General Zachary Taylor to move his forces from Louisiana to Texas. Taylor first set up camp on the Nueces River at Corpus Christi (on the northern edge of the disputed territory). By fall his force numbered 4,000, about two-thirds of the actual strength of the entire regular Army. Initially Taylor had two engineers and three topographers with him. Second Lieutenant George G. Meade, a topographer, was one of them.

After a diplomatic mission failed, President Polk ordered Taylor to move through the disputed territory to the Rio Grande. On 8 March 1846, Taylor set out for Matamoros. Captain Jared K. F. Mansfield led the reconnaissance and selected camp sites along the 150-mile route. After they reached the north bank of the Rio Grande, across from Matamoros, there was little rest for the engineers. The topographers reconnoitered the surrounding area, while Mansfield directed construction of a 6-bastioned earthen fortress capable of holding 2,000 men and their horses.

The stage was set for conflict. On 24 April 1846, Mexican forces ambushed an American patrol, killing or wounding 16 soldiers. Two battles followed in early May. One, at a watering hole called Palo Alto on the way to Matamoros, gave Lieutenant Jacob Blake (a topographer), his moment of glory. Blake volunteered to inspect the enemy's positions. An artillery captain described the action: Blake "dashed off from the right of our line to within musket-shot of the enemy's left. Here he dismounted, and with his field glass coolly counted the number of men in one of the enemy's squadrons, which of course enabled him accurately to estimate the enemy's entire cavalry force. Blake then remounted his horse and galloped from left to right of the enemy's line, stopping from time to time and carefully observing the formation and number of his infantry, as well as the position, number, and calibre of his field guns, all of which information was fully verified by the subsequent events of the day." Blake's report helped the outnumbered Americans prevail.

In official reports, maps, and drawings, the Topographical Engineers of the Mexican War period helped detail the wonder and beauty of a vast, previously unknown territory. Lieutenant James Abert's sketch of Cheyennes is an example.

Meade also described his role at Palo Alto: "I was in the action during the whole time, at the side of General Taylor and communicating his orders. I may justly say I have had my '*Baptem de feu*!' An officer of the general's staff had his horse shot under him, not two yards from me, and some five horses and men were killed at various times close to me." The Mexicans retreated, but Taylor encountered them again the next day a few miles south at Resaca de la Palma. In what amounted to a pitched infantry battle, experienced American regulars and the skilled leadership of junior officers helped carry the day.

After the two battles, Taylor commended Blake and Meade, as well as Lieutenant Wood, another topographer, who helped set up and fire the artillery's 18-pound cannon at Resaca de la Palma. In those two days of battle, American casualties totalled 175, with less than 40 killed, and Mexican casualties numbered 1,000.

The Mexican army retreated across the Rio Grande to Matamoros, but Taylor did not pursue them. He was outnumbered and lacked equipment to cross the river. The delay frustrated Meade. In his view, Taylor had the time but did not know how to use his staff, especially his engineers. "Had Taylor known," Meade wrote, "he would have had us at work experimenting and when any plan proved successful, had a bridge constructed and put in depot, and then on the tenth (of May), in three or four hours, the whole army, artillery and all, could have crossed and the Mexican army been prevented from retreating with some twelve pieces of artillery." By the time the American soldiers crossed the river eight days later, using captured boats, the enemy had withdrawn. Matamoros belonged to Taylor, but the Mexican army remained alive.

Slow communications kept word of the 24 April attack and American deaths from President Polk until the evening of 9 May. That news was all he needed to obtain a declaration of war from Congress, along with $10 million, an increase in authorized Army strength to 18,000 by expanding existing units, and authority to raise 50,000 volunteers.

On 15 May 1846, Congress established a 100-man company of sappers, miners, and pontoniers whose duties included assisting laborers in erecting fortifications and then supervising the finished fortifications. The company was to consist of 10 sergeants, 10 corporals, 78 privates first and second class, and two musicians. This unit was the forerunner of today's 1st Engineer Battalion, stationed at Fort Riley, Kansas.

For years, Chief Engineer Totten had argued in vain for such a company. Commanding General of the Army Winfield Scott, a staunch admirer of the engineers, had echoed his support. But it took a declaration of war to win Congressional approval.

Even so, preparations had been underway at West Point. From the faculty, Captain Alexander Swift was designated for command and had already spent two years at the French school of military engineering at Metz. When Congress acted, Swift selected Lieutenant Gustavus W. Smith, a fellow faculty member, as his second in command. Experienced in company administration and infantry drill, Smith complemented Swift's technical expertise. As the third officer for what would be known as Company A of Engineers, they selected George B. McClellan, a soon-to-graduate cadet.

The three officers immediately began the challenging job of obtaining equipment and recruiting and training men. Totten's instructions were specific: "We must have smart, able-bodied young men, who can read and write, and have knowledge of a relevant mechanical trade." He urged Swift not to recruit married men and naturalized citizens and declared that, except for the musicians (buglers), their minimum height should be 5'6" with preference for those 5'8" to 5'10."

Promotions in the Army were rare. Lacking a retirement program and a mandatory retirement age, senior officers stayed on and many were too old to serve in the field. McClellan was ecstatic to be graduating and immediately going to war. "Hip! Hip! Hurrah!" he wrote home. "Ain't it glorious!" George Derby, another member of the class of 1846 who joined the topographers, wrote to his mother, "Nothing is heard but promotion, glory, and laurels."

Still, recruitment was slow. The company never reached full complement and waited until 12 September for orders to join Taylor's army in Texas. Finally on 26 September, 3 officers and 71 enlistees with basic training at West Point under their belts, sailed from New York harbor. All but two were native-born. Only four had previous military experience. After arriving in Texas in December, Company A moved to Tampico and became involved in preparations for Vera Cruz.

Meanwhile Taylor's army in Texas grew by adding new recruits, volunteers, and topographers. Captain William G. Williams was fresh from the Great Lakes survey when he became Taylor's chief topographic engineer.

In early August, Taylor started for his next objective—Monterey, the capital of the Mexican province of Nueva Leon, which had a population of 10,000. His engineers accompanied an advance party to reconnoiter and repair the roads. As Taylor drew near, Captain Mansfield's party obtained information on the city's defenses. Based on Mansfield's findings, Taylor decided to cut off Monterey from the west.

The attack began on 20 September. Officers of both engineer corps participated, fighting side-by-side and working together on reconnaissance and planning assaults. Chief topographer Williams died in the fighting, and Mansfield was wounded. On the 24th, the Mexican commander offered to surrender if he could withdraw his army and obtain an 8-week truce. Taylor agreed. For their parts in the action, several engineers received brevet promotions.

This news from Mexico angered President Polk, and he ordered Taylor to resume operations. Meanwhile, Polk recognized it would take more than a few victories in the north to bring the Mexican government to the peace table. Adopting a new strategy, he shifted operations from northern Mexico and put General Scott in charge of a landing at Vera Cruz and a march to Mexico City. This decision assured that Taylor's army would soon be severely reduced in size and that the remaining units would become in essence an army of occupation on the defensive in northern Mexico.

Before that happened, Taylor fought one last battle at Buena Vista in February 1847. Joining him were forces under Brigadier General John E. Wool, who had advanced into Mexico from San Antonio. Wool brought with him a strong engineer component, including West Point graduates Captains Robert E. Lee and William D. Fraser. Captain George W. Hughes, one of the few non-West Pointers involved, was chief topographic engineer. On their way to join Taylor, Wool's army made the 164-mile march to the Rio Grande in just 11 days, using roads and bridges provided by the engineers. Unlike Taylor, Wool planned his Rio Grande crossing in advance. Led by Lee, the engineers assembled a 'flying bridge,' prefabricated in San Antonio, which carried Wool's men across in a single day. From there, they proceeded in stages deeper into Mexico.

Hughes' report on the march detailed the difficult challenges and significant roles of engineers and topographers. The going was not easy. Hughes related: "We were almost literally compelled to grope our way and like a ship at sea to determine our positions by astronomical observations. Thus topographical parties usually had to be kept on the advance seeking camps and supplies of water, food, and fuel."

At Buena Vista, Taylor met a large Mexican army under General Santa Anna. In a complicated battle on 23 February 1847, the American forces formed a wide-angle "V" to turn the battle against the Mexicans. It was one of the most vicious engagements of the war. Once again, the engineers and topographers earned recognition and brevet promotions for their actions. As was their custom, the topographers prepared a detailed after-the-battle map of the action.

As the war in northern Mexico came to a close, peace was still more than a year away. The U.S. Army began to reflect on some sobering lessons of the campaign. Engineers had proven they could work together on the march and on the battlefield. Commanders had an opportunity to see firsthand the results of years of training at West Point.

The war with Mexico was the United States' only major war between 1815 and 1861. As such, it was a training ground for the Civil War.

Dr. Paul K. Walker is chief historian, Headquarters, U.S. Army Corps of Engineers, Alexandria, Virginia.

All quoted material is taken from the following sources:

Eisenhower, John S.D., *So Far From God: The U.S. War With Mexico*, 1846-1848 (1989), Random House.

Traas, Adrian G., *From the Golden Gate to Mexico City: The U.S. Army Topographical Engineers in the Mexican War*, 1846-1848, U.S. Government Printing Office (1993).

ENGINEER UPDATE

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

Department of Training and Doctrine Development (DOTD)

Engineer Unit Directory. Units are reminded to check their entries in the *Engineer Unit Directory* and send changes no later than 15 January 1997 to: Commandant, U.S. Army Engineer School, ATTN: ATSE-TD-D-P, Fort Leonard Wood, Missouri 65473. Changes also may be sent via e-mail: bakern@wood-vines.army.mil. The updated directory is scheduled for distribution in mid-March 1997. POC is Nancy Baker -4100.

Doctrine Product Updates. Several engineer-proponent doctrine products are accessible on the Engineer School Publications home page on the world wide web. The file location is: www.wood.army.mil/DDD/PUBS/pubs.htm. The following doctrine products are scheduled for distribution in printed media in the next few months:

Title	Initial Draft	Final
FM 5-428, *Concrete and Masonry*	Sep 96	
FM 5-116, *Engineer Operations Echelons Above Corps*	Nov 96	
EXFOR ST 5-105-1, *DigitizedTopographic Operations*	Nov 96	
FM 5-105-1, *Topographic Operations*	Nov 96	
FM 5-499, *Hydraulic Power Control Systems*		Mar 97
FM 5-250, *Demolitions and Explosives*	Jan 97	
FM 20-32, *Mine Countermine Operations*	Jan 97	
FM 5-572, *Materials Testing*		Mar 97
FM 5-424, *Interior Wiring*		Mar 97
FM 5-34, *Engineer Field Data*	Feb 97	
EXFOR Special Texts Update (Bn, Co, Plt)		Nov 96
EXFOR ST 5-71-100-5, *Digitized Division Engineer Combat Operations*		Nov 96
FM 90-13-1, *Combined Arms Breaching*	Mar 97	
FM 90-13, *River-Crossing Operations*		Mar 97
FM 5-415, *Firefighting Operations*		Mar 97
FM 5-170, *Engineer Reconnaissance*	Apr 97	
FM 20-400, *Environmental Management*	May 97	

POC is Sandra Gibson, -4115.

NATO STANAGs. The Engineer School is working with NATO countries to revise STANAG 2036, *Land Mine Laying, Marking, Recording, and Reporting Procedures*, for which the school is custodian. FM 20-32, *Mine/Countermine Operations*, incorporates much of this STANAG. The Engineer School also is developing a proposal for a new STANAG that deals with countermine activities. Comments on STANAG 2036 or topics to be included in the new countermine STANAG are welcome. POC is CPT Joe Birchmeier, -4115.

Engineer Doctrine for Joint Operations. On 22 October, the Joint Doctrine Working Party approved a proposal to develop an overarching engineer doctrinal publication. The first draft is scheduled for review in summer 1997. (See article on page 26.) The Engineer School, the Army's representative on the working group, is developing the doctrine. We received a tremendous response to a recent request for information about joint engineer operations (such as tactics, techniques, and procedures; standing operating procedures; and operations plans) that will assist the development effort. If you haven't already done so, please forward material covering doctrinal "work arounds" your organization has developed. POC is MAJ Richard Graves, -4115.

Field Manual Inventory Reduction. The TRADOC Chief of Staff directed that all proponent schools reduce the number of field manuals in their inventory, and the number of pages in those manuals, by at least 20 percent. Each TRADOC school must prepare a plan to reach its established goal. The Engineer School is considering the following actions:

- Retain core manuals containing doctrine for units at brigade level and below.
- Consolidate like information in selected field manuals.
- Purchase commercial, "off-the-shelf" technical publications for low-density MOSs.
- Update engineer publications to support multiservice use.
- Place selected publications in "Inactive Publications Storage" until assets are available to permit updating.

A study addressing these options was provided to field commanders at the October 1996 Council of Colonels and the commanders' and directors' meetings. Units are encouraged to review the study and submit recommendations. POC is Lucius Warrick, -4115.

Directorate of Combat Developments (DCD)

Partnership Conference on Future Engineer Operations Concepts. Nearly 50 representatives from Army laboratories and research and development activities met at the Engineer School on 9-10 October for the Partnership Conference on Future Engineer Operations Concepts. Planned by the Futures Division of the Directorate of Combat Developments, its purpose was to show how attendees' organizations fit into the emerging Force XXI Army and the overall modernization equation. Additional meetings are planned to refine the process. The end result will be an Engineer Corps that is better able to support the total force. POC is Brian Murphy, -7214.

Engineer Personnel Proponency Office (EPPO)

Officer Development System Review. The Chief of Staff of the Army directed an Officer Personnel Management System task force to review the officer development system. The task force will review leader development, assignments, career management, character development, and the new Officer Efficiency Report. The Director of Training is the Engineer School's representative to the task force. This review provides an opportunity for you to express concerns and provide input into your future. For more information, visit the Engineer Personnel Proponency Office's home page at http://155.9.32.3/EPPO/eppo_hp.htm. The e-mail address is: zajacm@wood-vines.army.mil. POC is CPT Matt Zajac, -4087.

BRIDGE THE GAP

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

The Centralized Promotion System

While traveling through Army installations, I often hear false myths and incorrect perceptions about the Army's centralized promotion system. To correct the many misconceptions, I will present the facts about the promotion system, which affects the career of every member of our Engineer Regiment.

A centralized system for the promotion of enlisted soldiers has been in effect since 1969. It became effective for the promotion of sergeants major on 1 January 1969, for master sergeants on 1 March 1969, and for sergeants first class on 1 June 1970.

The system is composed of several centralized enlisted promotion boards that have the following missions:

- Select candidates for promotion to sergeant first class, master sergeant, and sergeant major, and appoint command sergeants major.
- Select attendees for the resident Sergeant Major Course and the Advanced Noncommissioned Officer Course.
- Provide qualitative management program screening and an appeals process.
- Provide a qualitative management program final board.
- Provide standby advisory boards, as necessary.

The Secretary of the Army, through the Deputy Chief of Staff for Personnel, selects the individuals who sit on the boards. Each board includes both officers and noncommissioned officers (NCOs), and a general officer serves as board president. Nine to eleven panels comprise each board, with at least four members on each panel. The panels are organized by career management field (CMF), and the size varies in proportion to the number of records to be considered. Each panel has a nonvoting administration NCO, who controls the flow of records. A typical panel organization follows:

- Colonel (Engineer)
- Lieutenant colonel (Armor)
- Command sergeant major (CMF-19)
- Command sergeant major (CMF-12)
- Sergeant major (CMF-19)
- Sergeant major (CMF-51)

Training is an important first step for panel members to ensure that they vote consistently on each soldier's file. During this intensive training, they develop panel standards, practice voting on sample records, analyze practice votes, adjust standards, practice voting on additional sample records, make final adjustments to the standards, and obtain the board president's approval of the final standards.

During selection board proceedings, three board members review each soldier's individual record. They review the official military personnel file, microfiche, DA photo, DA Form 2A, DA Form 2-1 and other hard-copy documents, and compare them with the approved panel standards. Then they place a numerical score ranging from 6+ to 1- on each soldier's board file. This process ensures that no single success or failure is an overriding factor in determining the soldier's standing in relation to his/her peers. Panel members are charged to consider the "total soldier" in determining those best qualified for promotion.

The following chart shows the scoring system:

Score	Performance	Select
6+/6/6-	Excellent	Now
5+/5/5-	Excellent	Definitely
4+/4/4-	Strong	Should
3+/3/3-	Fully qualified	If room
2+/2/2-	Qualified in current grade	Retain in grade
1+/1/1-	Substandard	Quality Management Program referral

The Noncommissioned Officer Evaluation Report (NCOER) is the single most important document in determining the promotion potential of senior NCOs. It must be a clear and concise document that tells panel members how the soldier performed and where he can best serve the Army in the future. Despite its importance, many NCOERs do not provide the information panel members need to adequately assess the performance and potential of the rated NCOs. There is nothing an NCO can do to compensate for a poor or mediocre NCOER.

Let me share a few observations about NCOERs reviewed by the FY96 master sergeant selection board.

Part III Duty Description

Part III (a) is extremely important. It tells the panel what job the NCO actually performed. The job description on some NCOERs did not match the soldier's principal duty title and/or the duty MOS. This reflected negatively on the soldier because the information did not provide a clear picture of what the soldier did on a day-to-day basis. It is especially important that the duty description of a soldier in a nontraditional or TDA position clearly state the specific duties and responsibilities of the position. That information enables panel members to make a reasonable decision as to the importance of the rated soldier's duties and the quality of his/her performance.

Part IV Values

In some NCOERs, the rated soldier received a "NO" block checked with a supporting bullet comment, but nothing was annotated on the back of the NCOER by the rater or the senior rater. The comments on the back of the form must be specific and provide details that support the "NO" in the value block. They ensure that promotion board members get the intended message.

Part V Overall Performance and Potential

These two areas are most important when selecting the soldiers best qualified for promotion. Senior rater bullets are critical in determining promotion potential. The senior rater's comments should state clearly and concisely what he recommends Army leaders do with the rated NCO (promote ahead of peers, promote with peers, promote immediately, etc.). Senior raters also must ensure that the performance and potential blocks checked are consistent with the associated bullet comments. For example, a "Promote with peers" bullet and a "1" rating in the potential block are not consistent. The comments must focus on potential and help panel members make tough calls to clearly identify those soldiers who are superior to their peers. The statement, "The best platoon sergeant of five I currently rate" provides a definable standard that helps the panel make an informed decision.

The centralized promotion system is a creditable system. To keep it creditable, leaders must be involved in the NCOER process and educate their soldiers about the system. With sufficient leader involvement, the centralized promotion system will continue to meet the Army's needs.

(Continued from page 16)

The software also will display associated minefield records and query the database.

This subsystem includes a PC with CD-ROM reader, a JINC connected to the tactical SINCGARS UHF or an HF radio, a printer, and a Global Positioning System (GPS) card.

Digital Reconnaissance System

Reconnaissance teams use the DRS to collect minefield, obstacle, or other battlefield data. This information is digitally stored in a PC during the collection process. After collecting the data, reconnaissance units hand carry ("Sneaker Net" or floppy disk transfer) or use communications devices to transmit the results to higher headquarters.

This subsystem is identical to the DMRS but also has a digital camera and laser binoculars. The camera allows the user to photograph the target and store the digital photograph with the report. Laser binoculars allow the user to capture accurate coordinates from a standoff of up to 1,500 meters. The PC captures the distance from the observer's location to the target object and the azimuth, directly from the binoculars, via a serial connection.

What's Next?

Parts of the interim system may go to Bosnia. Parts will play in the Task Force XXI exercise scheduled for March and April 1997. Most will be used in the JCM-ACTD in August 1997. Feedback from these events will shape the design characteristics of the objective minefield-database system.

By 2001, the objective system should seamlessly integrate with other Army Battle Command System (ABCS) programs operating at that time. Obstacle information managed by the system will integrate with other engineer command and control information and engineer intelligence throughout the ABCS. This system will ensure that commanders, planners, and soldiers have access to accurate and timely minefield information regardless of the theater or mission.

Major Taylor serves in the Directorate of Combat Developments, U.S. Army Engineer School. Previous assignments include tours with the 249th Engineer Combat Battalion (H), Germany, and the 52d Engineer Combat Battalion (H), Fort Carson, Colorado. He holds a master's degree from New Mexico State University.

Scene from the Battle of Palo Alto during the war with Mexico. For accompanying article, see page 55. Artwork courtesy Library of Congress.

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