ENGINEER

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Front cover: U.S. Army Soldiers, assigned to the 23d Brigade Engineer Battalion, 102d Stryker Brigade Combat Team, have been working from sun up to sun down to combat wildfires in the Umpqua National Forest, Oregon. (U.S. Army photo by SPC Adeline Witherspoon)

Back cover: U.S. Army photos

DEPARTMENTS

FEATURES

Clear the Way

Brigadier General Robert F. Whittle Jr.
Commandant, U.S. Army Engineer School

The engineer castle is one of the most recognized and respected brands in the world. Colonel Jonathan Williams, an American spy and Benjamin Franklin's nephew, was the first Chief of Engineers, the first commandant of the U.S. Army Engineer School (USAES), and the first superintendent at the U.S. Military Academy at West Point—and he designed the engineer castle. The castle represents our engineering history. It represents the fortifications that were built by engineers centuries ago, as well as the trenches that sappers dug in order to position artillery.

Our engineer castle now adorns completed projects in every nation where our Regiment has served. The castle is stitched into the engineer flag that flies proudly at every engineer headquarters. We take great pride in our Regiment and its symbols. We frequently receive feedback from across the other Army branches about the tremendously positive esprit de corps of our Engineer Regiment. Our mission to solve problems and support the Army with tremendous engineering capabilities bonds us together.

Today, our No. 1 priority is readiness and we must ensure that the Engineer Regiment remains ready and relevant for the current and future fight. We can do that by leveraging the great bonds in our Regiment and by communicating. We must work with each other to identify problems and develop and resource solutions. Coming to agreement and then advocating for the resources are critical to the success of the Engineer Regiment.

We are all part of the solution for improved networking and communication. We have engineers all over the Army, the joint force, the Department of Defense, and interagencies. We must stay linked together and ensure that we remain abreast of developments in the Engineer Regiment.

We are already doing many things to communicate well across the Regiment, to include conducting monthly forums such as brigade commander video teleconferences, Korea theater of operations engineer deep dives, and the engineer regimental synchronization. We send out quarterly updates from USAES to the engineer general officers across the total Army. The USAES command sergeant major sends e-mail updates directly to every command sergeant major and sergeant major across the Engineer Regiment in all three components. We also obtain feedback on engineer issues from the combat training centers. There are many formal and informal meetings between engineer leaders.

We are now sending regimental updates directly to battalion commanders. We are also speaking to engineer battalion commanders, as well as their respective brigade combat team commanders, after they complete combat training center rotations. We are frequently engaging with our intermediate-level education program students at Fort Leavenworth, Kansas, as well as the students in the brigade commander training and development program, which includes brigade commanders from all branches.

Our ultimate goal is to become so well-networked that engineers at all echelons are able to communicate critical modernization efforts; answer questions about the Engineer Regiment position on critical issues; and notify USAES and the Office of the Chief of Engineers about critical upcoming events, decisions, and forums. This helps to ensure that we will have an engagement plan when opportunities arise.

In addition to communicating with each other, we must communicate with the rest of the Army. We must communicate our capabilities, gaps, and solutions to the force. We must ensure that we are keeping an open dialogue with maneuver commanders. This is the responsibility of every engineer in the force.

All of us at USAES are ready to serve you. If you are headed to a meeting in which you receive questions or anticipate being asked about engineer modernization or organization issues, let us know. We can help you answer the questions. We can ensure that you are prepared and that you have the right talking points.

Together, we can advocate for an engineer force that will enable the U.S. Army to win in future conflicts. Thanks for all that you do to ensure that we remain ready and relevant to the Army and our Nation.

Lead the Way

Command Sergeant Major Trevor C. Walker
U.S. Army Engineer School Command Sergeant Major

Essayons! Greetings fellow engineers. 2018 is another great year for the Engineer Regiment. We have started this year by blazing a path for others to follow. As we continue to focus on training, leadership, education, and personnel at the U.S. Army Engineer School, we are improving the way we support the Army in its overall mission.

As I continue to visit the engineer force as much as I can, I am still amazed at everything we engineers do. Over the past few months, I have visited a number of units and met with some future senior leaders. On 1 November 2017, I visited the Soldiers of the 91st Brigade Engineer Battalion, 1st Brigade, 1st Cavalry Division, at the National Training Center, Fort Irwin, California. I was only there for a few days but was able to watch them conduct a live breach of a complex obstacle. It was an awesome event that showed what engineers can do on the battlefield.

In December, I briefed the U.S. Army Sergeants Major Academy, Fort Bliss, Texas, on the Engineer Regiment capabilities and force structure, giving the 700 students of Class 68 an idea of what we bring to the fight. While at Fort Bliss, I also visited the 16th Brigade Engineer Battalion, 1st Stryker Brigade Combat Team, 1st Armored Division. The battalion presented an engineer capability briefing to the brigade, making sure that everyone understood the battalion capabilities and how they can shape the battlefield for the rest of the brigade. This is something that I suggest all units practice in the future.

I recently returned from Fort Knox, Kentucky, where I visited the 19th Engineer Battalion and spent quality time with its leaders and Soldiers. I was truly impressed by the way the battalion supports the post and leads the way as one of the pilot battalions for the new Army Combat Readiness Test.

The Regiment has recently been working on several projects. When Hurricanes Harvey, Irma, and Maria hit land, we deployed 28 personnel to support the U.S. Army Corps of Engineers hurricane relief efforts. We used students awaiting class start dates or follow-on assignments. This effort provided valuable training and development of officers and Noncomissioned Officers who were working with central government agencies by giving them hands-on experience with the ways the Corps can help our Nation recover from devastating events.

Continuing to improve readiness, the Engineer Regiment received approval for the P6 Additional Skill Identifier (ASI), which will be awarded to NCOs who complete the requirements for project management. This will bring the enlisted cohort in line with the officer cohort. With the approval of ASI S4–sapper leader for Military Occupational Specialties 12C, bridge crewman, and 12N, horizontal construction engineer—we are coding the modified table of organization and equipment positions in Stryker brigade combat teams and airborne variants of the infantry brigade combat teams and the engineer support company. This removes the S4 coding from an under-used demographic —the Military Occupational Specialty 12B4O, combat engineer platoon sergeant—in armored brigade combat teams and places it against the 12C and 12N positions in the Stryker brigade teams and infantry brigade combat teams.

We are leaning forward and putting the final touches on implementing leader core competencies, which will add 55 hours of instruction to the engineer Advanced Leader Course and Senior Leader Course. Leader core competencies, which will go into effect in 2021, will cover readiness, leadership, training management, Army and joint operations, program management, and communications. This is part of Line of Effort No. 1, Development, of the NCO 2020 Strategy.[1] On 1 June 2018, current structured self-development courses will be replaced by distributed leader courses, starting with Basic Leadership Course students. As the year progresses, all structured self-development courses will be replaced. The distributed leader courses will consist of 40 hours of training and will support the next level of professional military education for Soldiers.

Everyone should be tracking the new Department of the Army Pamphlet 600-25, *U.S. Army Noncommissioned Officer Professional Development Guide*, which was published in December 2017.[2] It codifies all key developmental positions

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Show the Way

Chief Warrant Officer Five Jerome L. Bussey
U.S. Army Engineer School Command Chief Warrant Officer

Greetings from the U.S. Army Engineer School. Our team here at Fort Leonard Wood, Missouri, and the team at the U.S. Army Human Resources Command continue to do an outstanding job in training and managing the talent of junior and senior warrant officers. We continue to evaluate and update our program of instruction to ensure that it meets the needs of our warfighters. Over the past 6 months, we have rewritten and obtained approval for three warrant officer professional military school programs of instruction; this process, which usually takes more than a year to complete, was accomplished in one-sixth the time estimated by the U.S. Army Combined Arms Center. This is a testament to the hard work, dedication, and long hours that are put in here at the Engineer School. As new demands and more requirements come our way, assignment officers at the U.S. Army Human Resources Command are leading the way in ensuring that our best officers are in the right position to give sound technical advice to their leaders and are in the right position to succeed. Thanks, team.

We got a chief warrant officer five position located at the Construction Research Laboratory of the U.S. Army Corps of Engineers Engineer Research and Development Center in Champaign, Illinois. This position includes (but is not limited to) providing senior-level technical expertise and performing assessments on horizontal and vertical construction, water, sewerage, operational energy, and electrical distribution systems. Thanks to the Corps of Engineers and the Office of the Deputy Chief of Staff for Personnel, Department of the Army, for making this happen.

Along with our U.S. Army Training and Doctrine Command Capability Manager–Geospatial, I traveled to the campuses of the National Geospatial-Intelligence Agency at Fort Belvoir, Virginia, and in St. Louis, Missouri. During great visits to both campuses, I learned a lot about what engineer warrant officers are doing at the National Geospatial-Intelligence Agency. In addition to the three legacy warrant officer positions required at Fort Belvoir, there are three additional positions that typically go unfilled because of Army manning guidance and requirements. The agency agreed to move the three additional positions to St. Louis, effective in fiscal year 2019. Thanks to the Training and Doctrine Command Capability Manager–Geospatial team for facilitating this action and getting it across the finish line.

In July 2018, the warrant officer cohort will celebrate its 100th anniversary. The warrant officers of each branch have rich histories and have played vital roles in the wars and conflicts that the Nation has fought over the last 100 years. Engineer warrant officers can trace their history back to 1918. Along with masters and mates in the U.S. Army Mine Planter Service of the U.S. Army Coast Artillery Corps, there have been chief engineers and assistant engineers employed in this organization.

The ranks of Engineer Regiment warrant officers consist of two military occupational specialties (MOSs): 120A, construction engineering technician, and 125D, geospatial engineering technician. Despite many name changes throughout the history of the two specialties, many of the duties remain the same, with a few more duties added to enhance the skills of engineer technicians.

The construction engineering technician MOS is composed of eight Army feeder MOSs and sister Service specialties. Training at Fort Leonard Wood consists of instruction in construction, surveying, and power systems. Construction engineering technicians serve in multifunctional capacities across the diverse spectrum of engineering operations in operational and nonoperational units. They provide subject matter expertise to support commanders and their staffs in areas related to warrant officer grade, position, and duty title.

Geospatial engineering technicians are the Army's technical and tactical experts in terrain analysis and geospatial information and services. They assimilate, integrate, and manage geospatial intelligence data and products for use in Army mission command systems and perform analysis that aids commanders and staffs in visualizing terrain and understanding its impact upon friendly and enemy operations. As the geospatial technical experts in the geospatial

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Task Force Spearhead: 2017 Wildland Firefighting Mission

By Lieutenant Colonel Nicholas O. Melin and Major Joseph K. Byrnes

On 1 September 2017, the 23d Brigade Engineer Battalion (BEB), 1st Stryker Brigade Combat Team, 2d Infantry Division, received a 30-day deployment order to fight wildfires in central Oregon in support of the National Interagency Fire Council (NIFC). With 17 active fires burning 757,862 acres of forest on federal lands in the Pacific Northwest alone, resources were stretched to their limit and Department of Defense support was needed. The 23d BEB rapidly transitioned from training on collective warfighting tasks at Joint Base Lewis–McChord (JBLM), Washington, to traversing rugged terrain on a fire line in the mountains of Oregon, executing real-world fire suppression missions.

As the I Corps unit assigned to execute the active duty wildland firefighting (WFF) mission for the 2017 fire season, the 23d BEB had only 4 days to alert; assemble; deploy to the Umpqua National Forest near Glide, Oregon; and train on firefighting techniques. The battalion transitioned to Task Force Spearhead and executed 26 days of continuous firefighting operations on the Umpqua North and High Cascades fire complexes as part of an interagency team. This mission was the first of its type for a Regular Army engineer unit since 2000 and only the second WFF deployment of Regular Army forces since 2006. As part of the BEB mission-essential task list under Defense Support of Civil Authorities (DSCA), the WFF duty offered Task Force Spearhead the opportunity to improve its readiness. This included deploying on short notice, exercising the headquarters ability to execute mission command over a dispersed operational area, and enabling engineer Soldiers and leaders to employ their unique skill sets.

This article provides context for engineer units that receive this mission in the future. It also highlights lessons learned from the deployment and demonstrates the potential for the Engineer Regiment to embrace this mission as a part of its broader DSCA requirements.

History of Regular Army WFF

Though WFF is a common mission for Army National Guard units, the use of Regular Army forces to fight wildfires is strictly governed by an agreement among the Departments of Defense, Interior, and Agriculture. WFF on federal lands is executed with resources from the Departments of Interior and Agriculture. The National Multi-Agency Coordinating Group organizes the interagency response to wildfires, monitors wildfire activity, and determines the National Preparedness Level, thereby driving the regional and/or national mobilization of resources. Department of Defense assets are typically requested only when Preparedness Level Five is reached, indicating that several regions are experiencing major fires with the potential to exhaust all agency fire resources.

From its inception in 1988, 35 Regular Army WFF task forces have been deployed, mostly before 2006. These task forces were assigned to U.S. Army North for the duration of their activation and attached to an interagency management team (IMT) conducting operations at a single fire or a grouping of geographically proximate fires, referred to as a *fire complex*. When alerted, the 23d BEB was the first Regular Army unit to execute the WFF mission since 2015 and only the sixth engineer unit assigned to this mission.

Soldiers work alongside firefighters from the Bureau of Land Management to combat wildfires in the Umpqua National Forest.

Mission Requirements, Training, and Task Organization

Though there was little warning for the task force activation on 30 August 2017, on 1 May the unit had received guidance about the nature of its mission and its readiness and task organization requirements. The 23d BEB was required to—

- Maintain a roster of 200 deployable Soldiers organized into 10 firefighting crews.
- Provide a mission command node, to include signal support for dispersed operations.
- Maintain a small bench of Soldiers ready to backfill injuries or redeployments during the 30-day activation period.
- Maintain total task force size at or below 250 Soldiers.

Once a unit is activated, the NIFC deploys a training team to the unit's home station to equip the deploying Soldiers with the gear necessary to execute the mission and conduct training on the tasks that the Soldiers are expected to perform, including—

- Digging 2- to 3-foot-wide containment lines through restricted terrain.
- Systematically checking burned-out areas for hot spots and fires and extinguishing them (referred to as gridding).
- Emplacing water distribution networks of pumps and hoses.
- Clearing brush and undergrowth from threatened areas.
- Employing emergency fire shelters to be carried by each Soldier throughout the mission.

The NIFC augmented the task force with 20 civilian firefighters to advise each military firefighting crew and attached an experienced firefighting crew (the Devil's Canyon crew from Wyoming) to provide specific firefighting capabilities, such as controlled burning, tree felling, and chainsaw use, that fell outside the training program.

The battalion leaders constructed a solid task organization to stand up a battalion size interagency task force. The task force established three company size strike teams, each with three platoon size crews. The strike teams were also task organized with a team from the Devil's Canyon crew. A task force headquarters able to conduct distributed contributions via a tactical operations center was created, with all primary staff sections represented. While the IMT was responsible for all firefighter medical care, battalion leaders decided that a dedicated medical capability was essential to mitigate risk to Soldiers working in remote, austere areas. This included a Role 1 aid station and a medic for each of the 10 crews.

Mission Execution and Accomplishments

On 6 September 2017, Task Force Spearhead deployed 247 Soldiers to the Umpqua fire complex to reinforce fire containment and suppression operations to protect lives, property, and public lands. Upon arrival, the task force conducted 2 days of field training along active fire lines to certify the 10 military firefighting crews. For the 26 days that followed, Task Force Spearhead executed 43 multiday firefighting missions across more than 150 square miles of national forest land to emplace and enhance fire containment measures.

Fluid Command–Support Relationships

Task Force Spearhead served as a subordinate unit for three separate IMTs and deployed a company size strike team to a different fire complex (the High Cascades complex near Crater Lake, Oregon), 43 miles to the south. Flexible task organization was critical for maximizing military contributions to the firefighting requirements in the region.

The task force medical capability proved valuable to the IMT. The team conducted three injury medical treatments at the point of injury and 44 noninjury medical treatments for military and civilian firefighters. There was also a requirement for a public affairs capability, which was provided by the 20th Public Affairs Detachment. Interest in military and civilian circles was high, with a total outreach to 2.8 million people through various media platforms over the course of the deployment.

Lessons Learned

In preparation for the deployment, 23d BEB leaders relied heavily on the after action review conducted by the 5th Battalion, 3d Field Artillery Regiment, JBLM, for its 2015 deployment. The 23d also developed an extensive review for U.S. Army North after completing its deployment in September 2017. However, there were several unique challenges associated with the WFF mission.

Prepare for changing deployment rosters and attrition. WFF is a *be prepared to* mission. Soldiers assigned by the battalion to execute the tasking were also required to execute the brigade's primary warfighting mission. When activated, roughly a quarter of the task force strength was unavailable due to previous U.S. Army Forces Command-directed taskings. Thus, Task Force Spearhead received 60 Soldiers from 1st Battalion, 23d Infantry Regiment, who were rapidly integrated into the task force. The Soldier readiness processing that was executed after activation also revealed nondeployable Soldiers who had to be replaced.

Prepare to execute rapid equipping, deployment, and operations within legal guidelines. The NIFC must provide all required equipment for the deployment

Members of Task Force Spearhead clear flammable brush and debris to halt the spread of the flames.

> ***"Whether cutting containment lines to halt the spread of a fire or repairing drainage patterns to prevent erosion and damage to the natural habitat, Army engineers bring a skill set that no other military unit can provide."***

and must reimburse the military for any expenses incurred while activated. This is significant since the BEB was required to—

- Receive an NIFC logistical team and facilitate the rapid equipping of firefighting gear, to include uniforms and boots, for the entire task force in just 2 days.
- Forecast deployment-related expenses such as transportation, fuel, and medical supplies and secure approvals through military and NIFC chains of command.
- Send an advance party to the IMT base camp to coordinate life support systems, logistics, and signal support and to prepare to receive the arrival of the main body.
- Minimize the use of military equipment and vehicles in favor of civilian transportation and locally procured equipment to address movement- and mission-related requirements.

Understand the interagency incident management system and conduct a reconnaissance. Once assigned to the Umpqua North fire complex, the 23d BEB fell under the on-site IMT. Daily missions for the task force strike teams were developed through the incident management planning process, and all classes of supply were furnished by the IMT. It is critical for the military task force to understand the DSCA process, the way interagency teams plan, and how they execute operations. A leader reconnaissance at an active wildfire incident command post is the best means of identifying how the task force will integrate into the interagency team.

Prepare for dispersed operations across a large area. The arrival of more than 200 Soldiers on site represents a significant increase in capability for an incident response team and presents a large logistical requirement. The impact of Task Force Spearhead at the Umpqua North fire complex was immediate. Within 10 days of its arrival, the fire was largely contained and the focus had shifted from containment to suppression repair operations. As requirements at the Umpqua North fire subsided, Task Force Spearhead repositioned a strike team 43 miles south to provide military firefighting crews to support the High Cascades fire complex containment efforts. Units assuming the WFF mission needed to be prepared to have their strike teams deploy across broad geographical areas. The greater the ability of the task force to operate in a dispersed fashion, the more beneficial the task force becomes to the firefighting effort in the region where it is assigned.

Prepare to operate in rough terrain and in all weather conditions. Wildfires on federal lands tend to occur in remote and mountainous locations in national forests. Also, activation for a military task force typically occurs in late August or early September, during the transition from summer to fall. For Task Force Spearhead, the mission began in dry, 90-degree weather at JBLM and ended in snowy, 30-degree weather in the mountains of Oregon. Soldiers and leaders need to be prepared with a robust packing list and the equipment necessary to address extremes of temperature and terrain.

Continually reinforce risk management principles and responsibility. While the IMT directs the task force missions and the civilian firefighter advisors provide input on how to execute them, military leaders own every risk decision during the deployment. It is important to reinforce this early and often with company commanders, platoon leaders, and civilian firefighting teams. Some factors to consider are—

- IMTs and teams of civilian advisors are composed of veteran firefighters with decades of experience, while the military firefighters have only 4 days of training when they start executing missions. Everyone must understand this difference in experience and factor it into mission planning and execution
- As the WFF mission is a new one for everyone in the military task force, it offers a great opportunity to train risk management. Young leaders can see the importance of conducting a reconnaissance before execution, deliberately planning routes, conducting mission briefings, planning for contingencies, and rehearsing medevac operations.

Review and augment the medical support plan. When activated, Task Force Spearhead was initially directed to use the medical resources provided by the IMT at the fire location. This was meant to eliminate redundant medical capabilities and to ensure that the maximum number of military firefighters were deployed within the 250-Soldier cap. However, task force leaders discovered shortfalls and secured approval to deploy medical capability.

- Firefighting crews work in extremely restricted terrain, often far from the nearest road. Moreover, the presence of qualified civilian emergency medical technicians with equipment is limited. The task force mitigated the risk by assigning one medic with an aid bag and evacuation equipment to each of the 10 firefighting crews to ensure care at the point of injury.
- IMTs must evacuate all injured firefighters to civilian hospitals, but lack the ability to provide Level 1 trauma care in the "golden hour" after severe injury. To mitigate this risk, the battalion deployed its Role 1 aid station with a physician's assistant to the incident command post and provided routine care to Soldiers and civilian firefighters.

Soldiers put their tactical firefighting training to good use by digging out burning embers, known as hot spots, beneath tree roots, in the Umpqua North Complex.

Engage additional training and engineer capability early on. There were a number of areas where the military task force could have further augmented the firefighting efforts if given the proper time to conduct training. Deploying with Soldiers trained and certified on chainsaws, wood chippers, and other tools to dispose of combustible materials along the fire line would also have been valuable. Finally, leader training on fire behavior and the techniques for employing firefighting crews would have made the learning curve less steep early in the 30-day deployment.

Value to the Unit and the Engineer Regiment

For the 23d BEB, the WFF provided a real-world deployment that tested unit readiness. Reporting readiness on a unit status report Microsoft® PowerPoint® slide and executing a rapid deployment are two very different things. Task Force Spearhead Soldiers and leaders learned valuable lessons to apply to the unit wartime mission. Additionally, the process of deploying and executing mission command across a dispersed operational area increased mission-essential task list proficiency. Although executing a rapid DSCA deployment compressed the unit training glide path for an April 2018 deployment to the National Training Center, Fort Irwin, California, the rewards of executing a mission in support of the homeland outweighed any short-term impacts on training.

WFF missions play to the strengths of the Engineer Regiment. Whether cutting containment lines to halt the spread of a fire or repairing drainage patterns to prevent erosion and damage to the natural habitat, Army engineers bring a skill set that no other military unit can provide. The fact that the Engineer Regiment is the Army's proponent for military firefighting only strengthens the case for engineer units executing WFF missions.

Given the Engineer Regiment role in the homeland and the ongoing engineer commitment to DSCA, there is already an established linkage between U.S. Army North and the NIFC that could be further leveraged by supporting the Regular Army WFF requirement.

Finally, the opportunity for engineer Soldiers and leaders to learn about, and participate in, a homeland defense mission is invaluable for their professional development. After a 17-year hiatus from active duty WFF, this may be the right time for engineers to advocate for proponency for this mission.

Lieutenant Colonel Melin is the commander of the 23d BEB. He is a graduate of the U.S. Army Command and General Staff College, the U.S. Army Ranger School, and the Sapper Leader Course. He holds a bachelor of science degree from the U.S. Military Academy–West Point, New York, a master's degree in military arts and science from the U.S. Army Command and General Staff College, and a doctorate in engineering science from Oxford University.

Major Byrnes serves as the operations officer for the 23d BEB. He is a graduate of the U.S. Army Command and General Staff College, the U.S. Army Ranger School, and the Sapper Leader Course. He holds a bachelor's degree in environmental design from the University of Colorado Boulder and a master's degree in environmental management from Webster University.

Volcano System Effectiveness in Terrain Shaping:

National Training Center and 29 Palms Case Studies

By Lieutenant Colonel Anthony P. Barbina and Captain Neal A. Stainbrook

Introduction to Terrain Shaping

Nowhere in the realm of combat engineering is terrain shaping more vital than for countermobility operations in support of the commander's defensive scheme of maneuver. Field Manual 3-34, *Engineer Operations*, describes countermobility operations as "those combined arms activities that use or enhance the effects of natural and manmade obstacles to deny an adversary freedom of movement and maneuver."[1] Terrain shaping by engineers restricts the freedom of enemy maneuver and protects friendly forces from the effects of weather and enemy offensive actions. This article uses three combat training center case studies to analyze the terrain-shaping capabilities available to brigade engineer battalions (BEBs) supporting a Stryker brigade combat team (SBCT).

Terrain shaping, much like mission command, is an art and a science that has evolved over time through the use of a variety of assets and techniques. The art of terrain shaping involves sculpting an engagement area using block, turn, fix, and disrupt obstacles to achieve the commander's defensive intent by allowing the rapid seizure of the initiative upon culmination of the defense. The science of terrain shaping involves haul capacities, running estimates of resources, objective proficiencies of Soldiers and their equipment work rates, and detailed synchronization matrices for excavation and obstacle emplacement. With changes in terrain-shaping assets, the ground Volcano mine-dispensing system has become the premier terrain-shaping asset available to maneuver commanders and will remain so until fundamental changes shift the spectrum of protection tools that are materially and legally available.

Evolution of Terrain-Shaping Assets

Today, the organic BEB within an SBCT helps to shape the physical terrain for countermobility support to combined arms maneuver. Previous generations of engineer battalions supporting light and armor brigade combat teams (BCTs) enjoyed a wide spectrum of assets at their disposal and a flexible policy regarding the use of land mines. The terrain-shaping assets in the commander's arsenal included—

- Mines delivered by field artillery (FA).
- Modular pack mine systems.
- Conventional, non-self-destruct, hand-emplaced mines.
- Blade-emplaced ditches.
- Explosively formed obstacles.
- Wire obstacles.
- Volcano mine-dispensing systems.[2]

The Convention on the Prohibition of the Use, Stockpiling, Production and Transfer of Antipersonnel Mines and on their Destruction (Ottowa Treaty) and subsequent presidential orders set policy limitations on the use of non-self-destruct antipersonnel mines (in 1999) and non-self-destruct antitank (AT) mines (in 2004 and 2011) and placed restrictions on the use of all self-destruct antipersonnel mines (in 2016). These limitations have greatly reduced the terrain-shaping assets available to BCTs by taking away hand-emplaced AT mines and removing antipersonnel mine-containing systems like modular pack mine systems. Volcano and artillery-delivered mines survived these restrictions because of their programmed self-destruct capabilities and the purely AT mine composition of specific rounds.[3]

Given changes in policy and employment guidance, the BEB must combine a variety of terrain-shaping assets to gain maximum countermobility effect for an SBCT, including—

- ***Blades.*** The BEB blade assets include bulldozers, Deployable Universal Combat Earthmovers, motorized graders, and High-Mobility Engineer Excavators. These assets work effectively in blade teams but require haul assets to quickly move into position. Shortages in haul assets require multiple lifts to move all blades around the battlefield, and the BEB must balance blade use for terrain-shaping countermobility with force protection survivability efforts on tactical operations centers and defensive positions.
- ***Explosives.*** The explosive methods that a BEB can use include road charges, airfield charges, and timber charges. While these methods are effective means of temporarily closing a lane in tight corridors or denying specific terrain to the enemy, they cannot deny or shape large formations across expansive terrain. Because threat engineers can quickly repair or breach these obstacles at specific points to maintain their own mobility, explosive methods of terrain shaping must complement other assets.
- ***Artillery-delivered mines.*** The BEB may also coordinate with the FA battalion to emplace a Remote Anti-Armor Mine (RAAM) obstacle. RAAM obstacles give commanders obstacle effects forward of troops, along flanks, or in dead space. Although RAAM obstacles provide commanders with tremendous terrain-shaping flexibility, they require FA units to fire RAAM projectiles into position for 30 minutes to several hours. This option requires extensive emplacement time and coordination; prevents FA units from firing missions in support of maneuver; requires survivability moves for the FA batteries firing the mission; and consumes many storage and transportation assets that could otherwise hold high-explosive, illumination, and smoke munitions.
- ***Wire.*** Wire assets, such as concertina and barbed wire emplaced by engineers or infantry Soldiers, provide the basic element of almost every terrain-shaping obstacle. Wire obstacles emplaced by the BEB help disrupt mounted and dismounted maneuver and, when combined with other terrain-shaping tools, can achieve tremendous effect. Wire obstacles take considerable time to emplace, have limited effect on mounted vehicles, and can be easily breached if not combined with other obstacles or fires. Although no longer explicitly required by international law, doctrine and command guidance often direct emplacement of wire fratricide fences marking family of scatterable mines minefield locations to prevent friendly casualties and to mark minefield engagement areas.

Soldiers from the 70th BEB troubleshoot the Dispenser Control Unit of the M139 Volcano weapon system during a field training exercise at Donnelly Training Area, Fort Greely, Alaska.

Soldiers from the 478th Engineer Battalion escort an M139 Volcano while engaging targets during a live-fire qualification at Wilcox Range, Fort Knox, Kentucky.

- ***Mine dispensers (Volcanos).*** The limitations of each of the assets mentioned above, combined with the current restrictive land mine policy, have increased the importance of the Volcano. The Volcano mine-dispensing system provides the BEB with a ground-based mine delivery system that can produce AT minefields of variable widths and depths. The SBCT BEB currently fields a number of Volcanos that are capable of being mounted on the heavy expanded mobility tactical truck (HEMTT) cargo deck or on the flat rack of the palletized loading system HEMTT. Engineers above the brigade level provide additional ground Volcano capacity, and aviation units can emplace air Volcano missions (in limited quantities) that can assist the BEB in employing maximum Volcano effects. All Volcano minefields require a considerable amount of planning, but the Volcano goes into position quickly and can block, turn, fix, or disrupt enemy maneuver with great effect, thus making it the premier terrain-shaping asset available to maneuver commanders.

Volcano Case Studies

After a generation of counterinsurgency and stability operations focused on the human terrain, the mine-dispensing Volcano, developed for defending the valleys of Europe in 1983, reemerged as an important terrain-shaping tool in the past decade. As the Army focuses on readiness as its top priority, BCTs have begun repairing Volcano systems while retraining or relearning how to employ the once-forgotten system to properly shape terrain. As a result of the Volcano's potential terrain-shaping effectiveness, the 70th BEB, assigned to the 1st SBCT, 25th Infantry Division, Fort Wainwright, Alaska, repaired, prepared, trained on, and employed the ground Volcano in three recent field training exercises that provide useful case studies and hint at the future Volcano evolution required for the Army and the U.S. Marine Corps.

In the first case study, the 1st SBCT deployed to the National Training Center, Fort Irwin, California, to test the brigade readiness against a professional, near-peer opposition force. During the large force-on-force defensive engagement in the famed Central Corridor, the 70th BEB simultaneously used its palletized load system-mounted Volcanos across two separate engagement areas to effectively shape enemy movements into the desired locations. The Central Corridor was large enough to rule out major wire obstacles, antivehicle ditches, or cratering options in locations other than those around the critical town of Razish or in the mountain passes to the north and south. This made the Volcano a critical asset in the Central Corridor defense due to its speed of emplacement, its ability to cover both engagement areas, its daunting length and depth, and the effectiveness of its mines. By simultaneously executing all available Volcano systems just moments before the enemy arrival, the brigade denied key terrain to enemy vehicles, turned the enemy attack elements from high-speed avenues of approach, and

> *". . .the Volcano mine-dispensing system provides a flexible option, proves useful in training and live-fire scenarios, and increases the effectiveness of direct- and indirect-fire weapons during the defense and offense."*

fixed the enemy commander in an area designed for maximum kill percentages. The final Volcano system completed mine emplacement just as the opposition force came within the maximum effective range of the obstacle-emplacing engineers. The Volcano system also achieved maximum surprise and, in conjunction with other wire, road block, and antivehicular obstacles, shaped the terrain while completely altering the opposition force scheme of maneuver.

In the second National Training Center Volcano case study, the 70th BEB received live Volcano canisters to replicate obstacle effects and increase the realism of the minefield emplacement. To improve training effect, each Volcano received live canisters that shot out several inert, blue training mines to show where the minefield would land. The maneuver commander plan for the Northern Corridor defense near Drinkwater Lake required the use of natural terrain, an antivehicle ditch, and the Volcano minefield to block the advance of a large tank force against SBCT positions. The 70th BEB emplaced the first Volcano minefield as a thick, block obstacle that was set for a 4-hour self-destruct time. The minefield was emplaced just as opposition force reconnaissance troops arrived in the defensive area, effectively stopping their initial advance. Because the enemy attacked in waves separated by several hours, the defense required Volcano emplacement and one reseeding mission to repair breaches and prevent gaps due to programmed mine self-destructions. The second Volcano proved just as successful as the first in blocking the enemy. After the obstacle system effectively blocked the enemy advance, the maneuver commander took advantage of the Volcano's second self-destruction. When the time expired and the mines exploded, the programmed self-destruction opened a small lane for friendly-force engineers to lead a maneuver counterattack that seized the initiative and defeated remnants of the enemy force.

In the third Volcano case study, the 70th BEB deployed to the Marine Corps Air Ground Combat Center at 29 Palms, California, to support Marine Air Ground Task Force (MAGTF) 1 with unmanned aerial system and Army engineer assets during a predeployment intensive training exercise. During the exercise live-fire events, the MAGTF staff had planned to use FA-emplaced RAAM to block a 250-meter-wide mountain pass forward in the task force sector. One-third of the available Marine artillery assets were required to fire for more than an hour to emplace the scatterable mines. The task exposed friendly artillery units to enemy counter-battery attacks but represented a critical piece in the MAGTF defense. During the first of two live-fire rotations, MAGTF 1 executed the RAAM minefield as planned to great effect, but after action comments showed the cost to FA assets in terms of task saturation and estimated loss from enemy counter-fire. To free the Marine FA assets and improve their survivability during the second rotation, the 70th BEB received approval to emplace the first live Volcano system ever used at 29 Palms, where the RAAM projectiles had gone during the earlier live-fire event. Additionally, because the Volcano had a smaller safety zone compared to the RAAM minefield, it provided a better obstacle for direct-fire overwatch and engagement by MAGTF reconnaissance forces. The use of an Army Volcano system proved extremely effective and accurate, fixed the enemy within the kill zone for 17 minutes, and allowed friendly artillery units to deliver continuous fire rather than shoot RAAM projectiles. By comparing the videos of both live-fire rotations, MAGTF 1 estimated that the Volcano minefield allowed it to destroy an additional four mechanized and four reconnaissance vehicles, delivering a major blow to the enemy attack.

Status of the Volcano Today

The three case studies show the speed, versatility, and effectiveness of the ground Volcano to Army and Marine units. For the 70th BEB to execute these events, support was required from the U.S. Army Forces Command engineer section to issue three newly repaired systems to the 1st SBCT and countless hours of training by the staff and engineer companies were required to effectively emplace the obstacle. The unit benefited from having several trained Volcano experts who understood effective planning, preparation, and emplacement techniques. Other engineer units have not been as fortunate as the 70th BEB in the materiel support and resident expertise. The lack of upgrade money or the fielding of modern replacements for the Volcano could leave engineer units with aging equipment in support of countermobility operations. To increase Volcano and terrain-shaping capabilities, units must improve in the areas of materiel support, training focus, and leader education regarding scatterable mine tactics.

For materiel support, fielding full Volcano systems and providing immediate repair to existing systems would improve system output. In current issue plans, armored and Stryker BCTs will have full Volcanos. Outfitting all armored and Stryker BCTs with full Volcano systems would provide an immediate improvement in minefield size and flexibility for maneuver commanders. To effectively maintain the aging Volcano, units must place renewed emphasis on the maintenance of currently fielded systems while the Army must furnish replacement and repair components to all available systems. Within the 70th BEB, Volcano systems went from an operational readiness rate of 0 to nearly 100 percent, with all systems remaining fully mission-capable thanks to the U.S. Army Forces Command fielding of two refurbished systems and parts support from Anniston Army Depot, Alabama, for the battalion's existing systems. With the battalion treating the Volcano as an internal "pacing" item and sending Soldiers on unit-funded trips to the depot to help with maintenance and to learn key maintenance techniques, the unit's high state of Volcano readiness should continue well into the future.

Given the effectiveness of the Volcano in terrain shaping, units should incorporate the Volcano and other family-of-scatterable-mines employment into their training plans and do so during full-scale exercises whenever feasible. Due to a lack of employment in the last 2 decades, Volcano operator skills and unit training levels within the Engineer Regiment have atrophied. During home station training before and after the National Training Center and 29 Palms rotations, the 70th BEB conducted extensive operator and leader training. The Volcano was incorporated into every squad and platoon evaluation, and company level external evaluations were supported with Volcano missions. By using the unit's allocated training canisters deployed from fully mission-capable systems under realistic training conditions, the BEB highlighted this vital countermobility asset to maneuver commanders and increased the chances of use during future operations. Increased training led to increased use, which led to increased demand. BEBs need to make Volcano system training a priority and create opportunities to employ the Volcano, especially in support of a maneuver element, regardless of Service or component, so that commanders understand and leverage this premier terrain-shaping asset.

Finally, leader education within the Engineer Regiment is critical for effective tactical emplacement of the Volcano. Although institutional courses do not exist now, engineer enlisted Soldiers, noncommissioned officers, and commissioned leaders must train on the tactical and technical points of the Volcano system at the U.S. Army Engineer School and within their units. Operators need to learn the finer technical points of maintenance and employment through established Volcano courses. Leaders must understand family-of-scatterable-mine planning, decision point development, terrain management, and engagement area development to properly plan for, explain, and champion a commander's use of the Volcano during defensive and offensive terrain shaping. The Volcano page link in the Hot Topics box on the Engineer Skills Knowledge Network provides helpful resources for leaders and operators as long as they understand how to leverage the site and interpret the available products.[4]

Volcano as Premier Terrain-Shaping Asset

As indicated by 70th BEB experiences at Army and Marine Corps training centers, when paired with other obstacles, the Volcano mine-dispensing system provides a flexible option, proves useful in training and live-fire scenarios, and increases the effectiveness of direct- and indirect-fire weapons during the defense and offense. It truly provides today's premier terrain-shaping asset. Because the Volcano has already been fielded, is known across the force, and complies with current mine restrictions, the Engineer Regiment and its tactical BEBs must leverage it to support maneuver commanders on short- and long-term battlefields. While materiel support, training focus, and leader education can help improve our current use of the Volcano system, access to a wider spectrum of terrain-shaping tools to complement the Volcano can only improve the overall effectiveness of countermobility operations. Modernization initiatives such as the M7 Spider networked munition and the Spider-Activated Volcano Obstacle offer promising terrain-shaping tools that can complement—not replace—the ground Volcano as the premier terrain-shaping tool within the SBCT. As a result, the 70th BEB will continue to reenergize Volcano use in battalion and brigade training scenarios, develop the expertise for this vital piece of the countermobility puzzle, and continue to educate the force on the importance of the Volcano in terrain-shaping operations.

Endnotes:

[1]Field Manual 3-34, *Engineer Operations,* 2 April 2014.

[2]Field Manual 90-7, *Combined Arms Obstacle Integration,* 20 September 2012.

[3]Jen Judson, "U.S. Army Dusting Off Volcano Mine Dispensers," 21 December 2016, https://www.defensenews.com/land/2016/12/21/us-army-dusting-off-volcano-mine-dispensers/>, accessed on 8 March 2018.

[4]Department of Defense, *Joint Engineer Operations Course Student Handbook*, Government Printing Office, Washington, D.C., 2011.

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ONE TEAM, ONE FIGHT: ENGINEER INTERSERVICE TRAINING

By Lieutenant Colonel Aaron D. Bohrer, Captain Lauren B. Cooper, and Captain Drew A. Maci

Situated at the home of the U.S. Army Engineer Regiment at Fort Leonard Wood, Missouri, is the most diverse and geographically dispersed engineer training battalion in the Army. The 169th Engineer Battalion trains eight of the Army engineer military occupational specialties (MOSs) and two skill identifiers—S4, Sapper, and 5V, Engineer Diving Officer—at five widely separated locations. The geographical separation and circumstances of operating in a joint environment create some unique challenges to the companies of the battalion. However, interService training provides tremendous fiscal advantages, offers valuable opportunities, and forces daily execution of mission command.

InterService Training Review Organization Background

The types of interService training available through the 169th Engineer Battalion are InterService Training Review Organization (ITRO) training, Department of Defense executive agent training, joint training, and quota training. ITRO training, which develops individual skills across military functional areas in an institutional environment, is characterized by the military doctrine used, the authority, military Service participation, and the policy for curriculum development. ITRO was established in 1972 to consolidate resources and improve training efficiency among the Services. Units operate on Army, U.S. Navy, and U.S. Air Force installations. ITRO consists of representatives from each Service who determine the requirements of interService training while combining resources. ITRO is further broken down into collocated and consolidated training.

Collocated training simply refers to a situation in which one Service trains on another Service's installation, with separate curricula and personnel. Consolidated training refers to a situation in which one Service component takes responsibility for a course, with all participating Services providing qualified instructors in a consolidated instructor pool. The 169th participates in collocated and consolidated ITRO training to develop engineer technical skills common across the Services. Requirements for fair-shared resources are dependent on the annual student throughput of each Service.

Army and Air Force students review course material while conducting a survey practical exercise at Fort Leonard Wood.

Challenges of an ITRO Environment

The 169th Engineer Battalion must use mission command, balancing the art of command and science of control, to accomplish daily operations across the United States. The battalion must synchronize, communicate, and build relationships with the host Services with very few face-to-face meetings. Instead, the battalion functions through weekly teleconferences and quarterly visits to each off-site company to ensure proper control and influence. The organizational structure is challenging but not defeating. It forces leaders to share different experiences from each installation to develop unique solutions and foster strong, cohesive teams. A significant amount of trust is necessary to successfully execute in an ITRO environment—trust that subordinates can make the right decisions consistent with the regulations of the Army and the host Service and trust that personnel are not just good stewards of the battalion and brigade but of the Army as a whole. ITRO leaders are representatives of the Army who help form the impression formed by sister Services.

In an ITRO initial-entry training environment, leaders must find the balance between the host Service standards and the standards outlined in U.S. Army Training and Doctrine Command Regulation 350-6, *Enlisted Initial Entry Training Policies and Administration*.[1] Standards can be challenging, especially when Soldiers observe the liberties granted by other Services. Army students typically have less freedom and fewer privileges than Marine Corps, Navy, and Air Force students in an ITRO environment. However, the regulation sets forth the requirements that are essential for a demonstration of character, competence, and commitment for Army professional Soldiers and ultimately reduces incidents of sexual harassment and alcohol-related offenses compared to the other Services. It is also important to have extensive messaging from leaders and top-notch cadre members who emulate the Army standards. Soldiers must know the rules and goals they need to achieve to be successful throughout the course. Leaders cannot assume that Soldiers have thoroughly researched policies and regulations, and they must find ways to motivate their Soldiers to achieve excellence.

Another challenge associated with ITRO is cadre training. Commanders face unique challenges when training permanent-party personnel. In ITRO, all cadre members are under operational control of the host Service during academic hours. To meet the Army-specific requirements outlined in Army Regulation 350-1, *Army Training and Leader Development*,[2] and higher headquarters training guidance, companies must be creative and flexible. Sometimes training compliance means starting earlier or working longer so that Service-unique requirements do not interfere with the host Service academic or program of instruction hours. The best practice is to consolidate general military training for the Service-unique staff with the host Service whenever possible. In any initial-entry training company, a version of the cadre training course is necessary for every duty position. These courses are Army-unique and offered only on certain Army training installations. A greater budget for temporary duty is necessary due to the extra travel required for this duty-specific training. Companies must also become familiar with, and develop relationships with, the closest Army installation for cadre duty position and instructor training.

Overall administrative system interoperability is also an obstacle in an ITRO environment. The host computer network does not interface with the other Services, and the access security requirements also differ. Something as simple as sending an e-mail may become difficult due to issues with access to the different Services' global address lists. In an ITRO environment, use of the higher headquarter's MicroSoft® SharePoint® and shared computer drives for the collaboration needed to accomplish daily operations is out of the question. Fortunately, the 169th Engineer Battalion tackled this major partnership issue by using the Global Electronic Approval Routing System, which allows companies to access, review, and edit documents or briefings. Other systems, such as Global Combat Support System–Army and the Unit Commander's Finance Report System, can also have glitches associated with network settings.

Medical support and associated administrative functions vary from one Service installation to another. Medical terminology and documentation may be similar, but medical systems may not communicate. The most daunting task in an ITRO environment is ensuring that personnel meet Army medical readiness standards. Each company must know which forms are required for annual checks, physicals, and profiles. Soldiers must have their medical provider fill out the appropriate forms, then deliver them to the company to be sent to Fort Leonard Wood for updates into Army medical systems. It is important for the command teams to develop relationships with the host Service medical staff to further understand their medical terminology and operating procedures, which must then be translated into Army medical terms. Administrative separations and medical evaluation boards required for some Soldiers complicate the issues linked to medical support. In these instances, commands must seek out the closest Army military treatment facility and coordinate travel for the Soldier to be evaluated by a provider who is familiar with Army medical fitness standards.

Advantages of ITRO Partnerships

Although operating on the installation of a different Service with different rules may be challenging, there are benefits and opportunities that are unique to ITRO. The 169th Engineer Battalion contributes to the development of various engineer core competencies across Services. Common engineer skills taught through inter-Service Department of Defense agent and ITRO training at company locations are as follows:

Company A. Located in Panama City Beach, Florida, has an ITRO partnership with the Naval Diving and Salvage Training Center. The center hosts a premiere training environment for joint Service divers to learn the science of diving. Company A provides all levels of engineer institutional training necessary for Army divers. Two of the dive courses considered ITRO are the 26-week 12D Army Diver Phase II Course and the Joint Dive Officer Course, which hosts Army, Navy, U.S. Coast Guard, and Department of Defense civilian students. The 12D Course is conducted twice a year, while the Joint Dive Officer Course occurs only once a year. Army divers perform engineer tasks such as reconnaissance, demolition, and salvage in underwater conditions. They master the underwater skills needed to support combat, general, and geospatial engineering as well as provide direct support to the U.S. Army Corps of Engineers and defense support to civil authorities

Company B. Company B is located within the battalion footprint at Fort Leonard Wood and provides MOS training in the following technical areas:

- MOS 12 interior electrician.
- MOS 12Y geospatial engineer.
- MOS 12T technical engineer.

(The company also provides Phase I training for MOS 12D diver.)

On average, Company B has 240 Soldiers in training from all components and also serves as the battalion higher headquarters company. Advanced individual training (AIT) for MOS 12T is the only ITRO course to fall under Company B. The Army, Marine Corps, Navy, and Air Force participate in the 17-week consolidated course. The ITRO class size of 24 students typically consists of 10 Army students, with the remaining seats filled by other Services. The course provides phased training and learning objectives from drafting to surveying. Upon graduation, 12T Soldiers have the technical capabilities needed to support vertical- and horizontal-construction projects.

Soldiers and Sailors practice their corner lead concrete masonry skills at the Naval Construction Training Center at Gulfport, Mississippi.

Company C. A long-standing ITRO partnership between the Army, Air Force, and Navy at the Naval Construction Training Center in Gulfport, Mississippi, facilitates a fully joint training environment for the Army's MOS 12W, carpentry and masonry specialists. The Army provides the greatest annual student throughput for the Gulfport school, with an average of 700 Regular Army, Army National Guard, and U.S. Army Reserve Soldiers per year. The engineer skills taught range from construction mathematics to the hands-on applications of exterior finish. Instruction at the school is divided into phases that align with structure development from the ground up. Soldiers who graduate from 12W AIT go on to serve in vertical-construction units and assist in troop construction projects that enhance the lives of Soldiers, while reducing government expenses. MOS 12W graduates can also work alongside civilian organizations to recover, rebuild, and train following a disaster or crisis.

Company D. Company D provides leadership and support for two Texas installations—Sheppard and Goodfellow Air Force Bases. The company participates in ITRO and Department of Defense executive agent training by training MOS 12K, plumbers; MOS 12Q, power line distribution specialists; and MOS 12M, firefighters. MOS 12K AIT is a 6-week course that trains approximately 300 Regular Army, Army National Guard, and U.S. Army Reserve Soldiers annually. The MOS 12Q AIT is a 13-week course that hosts 7 Soldiers per year. MOS 12M Soldiers complete their institutional training through tiers of the U.S. Air Force Fire Protection Courses. These courses serve as the Department of Defense training for all military and civilian firefighters. The 12M, firefighter, course has an average throughput of 150 Soldiers per year.

In addition to multiService engineer institutional training, ITRO offers junior leaders diverse experiences that are not common among typical commands. Company leaders and cadre members are exposed to visits from prominent members from each Service. Each visit illustrates the corresponding Service's commitment to the ITRO partnership and emphasizes the importance of the transformation process from civilian to trained military professional. Company command teams also act as Army liaisons and are nested into collective installation leadership through attendance of synchronization meetings, special events, and support to overarching initiatives. The integration gives command teams a direct role in organizational-level planning and aids in the understanding of the planning process for each Service. Additionally, Soldiers get vital experience working with Marines, Sailors, and Airmen early in their careers, fostering esprit de corps among the Services and setting conditions for success in the joint operational environment. ITRO offers the perfect opportunity to develop cross-Service relationships and understanding to work effectively in the operational force.

ITRO partnerships are vital to the success of engineer training for all Services, as they create resource efficiencies across the joint force engineer fields. All participating Services operate under an interService support agreement that designates roles and responsibilities for the host and participating Services. The agreement outlines the use of consolidated resources such as human resources, equipment, and facilities. Each location is set up with an instructor pool, which enables a shared approach to the multiService training of a common-core curriculum. For example, Navy students may have an instructor from the Air Force or Army. Additional resource efficiencies are developed through the shared use of the equipment and training material required for course execution, enabling conservation and standardization across Services. Lastly, requirements for military infrastructure are reduced by using the host installation for two or more participating Services. Staff support offices, barracks, and training facilities are developed to meet the training requirements of each Service, thus reducing infrastructure and operational costs that would have been necessary for the Services to operate independently.

As the Army moves forward with an uncertain budget and an ever-changing global security climate, one thing is certain—the 169th Engineer Battalion partnership with the Marine Corps, Navy, Air Force, and Coast Guard develops thousands of newly trained engineers each year. Each company faces unique support challenges associated with operating under its hosting Service. However, with competent and creative leaders, the battalion develops unique solutions and enhances the Engineer Regiment with the next generation of technically skilled engineers.

Endnotes:

[1]U.S. Army Training and Doctrine Command Regulation 350-6, *Enlisted Initial Entry Training Policies and Administration*, 20 March 2017.

[2]Army Regulation 350-1, *Army Training and Leader Development*, 19 August 2014.

Lieutenant Colonel Bohrer is the commander of the 169th Engineer Battalion, Fort Leonard Wood. He holds a bachelor's degree in geology from the University of Northern Colorado, a master's degree in military arts and science in theater operations, and a master's degree in public administration. He is a graduate of the Engineer Basic Officer Leadership Course, the Engineer Captains Career Course, the U.S. Army Combined Arms and Services Staff School, the U.S. Army Airborne School, the Joint Engineer Officers Course, the Joint Firepower Course, the U.S. Army Space Operations Course, the U.S. Army Command and General Staff College, and the U.S. Army School of Advanced Military Studies.

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An Analysis:

Rough-Terrain Airborne Operations are Impractical

By Major Michael P. Carvelli

The Engineer Regiment and the airborne community at large need to recognize the infeasibility of rough-terrain airborne operations and remove that niche capability from the Army arsenal. Although the capability appears realistic at first glance, detailed planning reveals a myriad of problems. Weight limitations restrict paratroopers from carrying the required loads to clear wooded areas to receive aerial deliveries of equipment, supplies, and personnel and to construct helicopter landing and pickup zones. This article constructs a reasonable scenario to illustrate the impracticality of rough-terrain airborne operations.

An operation order for a theoretical operation directs an engineer company to create a helicopter landing zone capable of receiving at least one CH-47 Chinook helicopter in a hostile environment. Possible enemy operations in the area require paratroopers to carry weapons and a basic load of ammunition. The terrain and climate are similar to the coastal region of the Pacific Northwest. The wooded area is void of usable landing zones. The full-strength company is inserted via an airborne operation supported by U.S. Air Force fixed-wing aircraft. During troop leading procedures, the company commander decides that external demolition charges are the most effective and efficient means to reduce the standing trees. Chainsaws are available to the company, but the paratroopers cannot carry additional fuel due to safety concerns. The commander chooses to use C4 blocks as the base charge to construct the external charges. Each charge will use 10 feet of detonation cord and M11 blasting caps.

The mission is to construct a fully capable landing zone. When helicopter landing zones are bordered by tall obstacles such as trees, power lines, or steep mountains, the approach and departure ends need an obstacle ratio of 10-to-1.[1] This means that for every foot in height of an obstacle, a helicopter requires a horizontal clearance of 10 feet for safe operation. The trees in the area have an average height of 55 feet. Helicopter operations will occur only during daylight hours, and the helicopter needs several approach and take-off directions. Therefore, the cleared landing zone requires a cleared radius of 550 feet, totaling 22 acres. An average acre of land near the objective contains 22 trees with an average diameter of 12 inches, two trees of an average diameter of 30 inches, and one tree with an average diameter of 45 inches.[2] Using external demolition charges, the commander estimates that more than 150 pounds of C4 (or more than 100 blocks of M112) will be needed per acre. The company needs more than 3,250 pounds of C4 (or more than 2,500 blocks of M112) to remove the trees for the landing zone.

Here, the commander begins to identify problems. The static line retrieval system in an Air Force C130 or C17 cargo aircraft has a maximum weight limit of 350 pounds.[3] Accounting for the fighting load, rucksack, helmet, uniform, boots, weapon container, weapon, ammunition, parachutes, rough-terrain protective clothing, and average Soldier weight, each paratrooper weighs more than 325 pounds. At full strength, the company has more than 90 paratroopers. The mission requires radio systems, chainsaws, *"The Engineer Regiment and the airborne community must seriously reconsider the concept of rough-terrain airborne operations."*

M249 squad automatic weapons, and M240 machine guns, reducing to 75 the number of paratroopers available to carry additional explosives. Spreading the load of explosives across 75 paratroopers creates an additional burden of nearly 50 pounds each. Accounting for the weight limit of the static line retrieval system, there is an overage of more than 20 pounds per paratrooper or more than 1,500 total pounds of explosives for the mission.

What options are available to the commander? Door bundles can get stuck in the trees. A landing zone for a smaller helicopter, such as a UH-60, has the same obstacle clearance need as the CH-47. Clearing an area for a computer-aided release point drop zone for a containerized delivery system bundle from a transport airplane requires another 1,700 pounds of explosives. Leaving behind automatic weapons and radios creates an unacceptably high risk based on intelligence. Overloading the paratroopers risks their lives should one become a towed parachutist. Abatis charges hinder landing-zone operations, and internal charges take too long to emplace. All the commander's options look dire.

This scenario is based on the simplest possible helicopter landing zone location in a realistic wooded environment. Increasing the landing zone size or placing it in a more densely wooded site would increase the required load of explosives. Reducing the number of paratroopers would increase individual risk because each person would be required to carry greater weight. Using helicopters to insert paratroopers in a forcible-entry operation would also carry greater risks due to slower speeds. There are many ways to make this mission more difficult to accomplish, but none that appear to make it easier.

If rough-terrain airborne operations were used for domestic scenarios such as firefighting or search and rescue, then paratroopers might not require weapons and ammunition. However, advertising these operations as a distinct niche capability to access key but severely restricted terrain in support of forced-entry operatons for a joint force commander is misleading. Domestic operations are not the *raison d'être* for the rough-terrain airborne capability. If rough-terrain airborne operations are a legitimate form of forced entry, then expectations must be realistic and planners must be armed with the relevant knowledge to integrate them into operational and tactical plans.

Additionally, Army doctrine does not account for the planning of rough-terrain airborne operations. The phrase *rough terrain* appears only once in each of the three fundamental pieces of Army airborne operation doctrine.[4] Rough-terrain operations are not taught in the U.S. Army Jumpmaster School, nor are they included in the *U.S. Army Jumpmaster School Student Study Guide*.[5] These operations are not covered in the main joint publication addressing forcible-entry operations.[6] Not only is doctrine for these operations missing from Army publications, but also missing is a database to draw information concerning tree density and average tree diameters for the myriad of possible forced-entry operations in wooded terrain.

Although rough terrain operations appear useful as a niche capability to the joint force, they are not a realistic tactical solution to creating drop, landing, and pickup zones in wooded terrain. Overloaded paratroopers create practical and safety issues of concern for commanders. Army and joint doctrine do not discuss rough-terrain capabilities in any of the foundational airborne and forced-entry operational publications. The Engineer Regiment and the airborne community must seriously reconsider the concept of rough-terrain airborne operations. If the Army needs these operations, then doctrine must reflect them in field manuals, training circulars, and other reference publications. If deemed unnecessary, the capability should be removed. This article and the accompanying scenario show that the latter is the preferred choice.

Endnotes:

[1]Field Manual (FM) 3-21.38, *Pathfinder Operations*, 25 April 2006.

[2]U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, "Washington's Forest Resources, 2002–2006," April 2010.

[3]Training Circular 3-21.220, *Static Line Parachuting Techniques and Training*, 12 November 2014.

[4]FM 3-99, *Airborne and Air Assault Operations*, 6 March 2015; FM 3-21.38, *Pathfinder Operations*, 25 April 2006; Training Circular 3-21.220, *Static Line Parachuting Techniques and Training*, 12 November 2014.

[5]*U.S. Army Jumpmaster School Student Study Guide*, Fort Benning, Georgia, January 2017, <http://www.benning.army.mil/infantry/rtb/1507th/jumpmaster/content/pdf/STUDENT%20STUDY%20GUIDE.pdf?5DEC2016>, accessed on 8 March 2018.

[6]Joint Publication 3-18, *Joint Forcible Entry Operations*, 27 November 2012.

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Engineer Noncommissioned Officer Partners With Caterpillar, Inc.

By Master Sergeant Justin R. Payne

The Training With Industry (TWI) Program is a broadening work experience opportunity that gives Regular Army commissioned officers, warrant officers, and noncommissioned officers (NCOs) wide-ranging exposure to private industry communities and offers them a better understanding of best practices not found in Army institutional training. Caterpillar®, Inc., offers TWI positions in a number of specialties, including—

- Military occupational specialty (MOS) 12N, horizontal-construction engineer—staff sergeants and sergeants first class.
- MOS 91L, construction equipment repairer—staff sergeants and sergeants first class.
- MOS 91X, maintenance supervisor—staff sergeants and sergeants first class.
- MOS 915A, automotive maintenance warrant officer—chief warrant officers three.
- MOS 915E, senior automotive maintenance warrant officer—chief warrant officers three.
- MOS 919A, engineer equipment repair warrant officer—chief warrant officers three.
- Area of concentration 90A, multifunctional logistician—captains.
- Area of concentration 91A, material maintenance and munitions management officer—captains.

Horizontal-construction engineers reporting to the Defense and Federal Products Division of Caterpillar are assigned to the Edwards Demonstration and Learning Center, Edwards, Illinois. There they are trained by Caterpillar experts who teach industry leaders about equipment that features the latest technology. They also participate in demonstrations of equipment capabilities while executing real earthmoving operations. TWI students become active participants in the daily operations of Caterpillar.

After a 1-year tour of duty with Caterpillar, TWI students bring value back to the Army by receiving utilization assignments that leverage the skills they have learned. TWI students have two goals: learn everything they can by maximizing their learning and training opportunities and bring their knowledge and training back to the Engineer Regiment. This allows the Regiment to remain flexible and able to adapt to an ever-changing environment. By taking part in the TWI Program, students can exert influence over future generations of engineers by helping to update lesson plans and programs of instruction. They are in a unique position to improve Army engineer processes and bring about real change.

The U.S. Army and Caterpillar, Inc., are organizations that are based on values that share common principles. Those shared principles allow TWI students to become easily integrated into the Caterpillar culture. The Army and Caterpillar entities value people, whether deployed in a combat zone or globally providing construction equipment. Both value people as their greatest assets. The Caterpillar code of conduct stresses loyalty and integrity, as do the Army values. This allows the Army to face future challenges with innovation and helps the Army stay abreast of the latest industry trends.

The Army operates in an ever-changing global environment and must remain flexible and adaptable. The TWI Program illustrates how NCOs play a vital role in shaping the future of the Engineer Regiment and the Army. TWI students do not sit on the sidelines at Caterpillar. They are expected to execute their duties while simultaneously learning how the corporation is run. They gain insight into operations they have never seen before, and those insights arm them with new ideas about how to solve problems in the future.

Students write three reports during their tours of duty at Caterpillar. The initial report outlines what they will do during their time with the company. This report is a living document that is subject to change. Therefore, the students should not put on blinders, focusing only on the duties described in the initial report. Unexpected opportunities will arise during their time at Caterpillar, and students should exploit them. The interim report describes what the students have been doing during their first 6 months of time with the company. The final report outlines everything the students have accomplished as participants in the TWI Program. These reports inform the Engineer Regiment and the Army of the students' activities and the new acumen they bring back to the Service.

TWI gives students a chance to establish a network of people with whom they would otherwise never interact. The program offers unique perspectives on training and business practices from the Army's civilian counterparts. One of the core competencies of horizontal engineers is operating heavy machinery. The demonstrator/instructors at the Edwards Demonstration and Learning Center do more than just operate machinery. They are some of the best equipment operators in the world, and they develop and teach course material. TWI students spend a great deal of time learning technical skills and improving operating abilities from these experts. New, more efficient methods of moving earth can be integrated with the current Army method. Blending these skills makes use of the best of both worlds, allowing strategic improvements during earthmoving operations.

This knowledge may also help Soldiers better understand which qualities are desired by the civilian construction industry and help bridge the knowledge gap between Army and civilian engineers. This may make Soldiers more marketable when they transition out of the military. As the use of sophisticated technology spreads, it is only a matter of time before the Army is using the same operating systems as civilian entities. TWI students will help bring an understanding of those technologies to the Army.

TWI students must also add value to their host company. They are just as important to Caterpillar as they are to the Army. Students don't work solely on projects involving the U.S. Army; Caterpillar has many projects involving foreign militaries. This is where the special skills of the NCO come into play. For example, when Caterpillar personnel realized that I was knowledgeable about the D7 Track-Type Tractor, I was asked to be part of the remote-control military dozer project. I was able to provide on-the-spot critiques that were instrumental in the developmental stages of the project, helping developers tune the machine to the varied environments where the Army operates. Through it all, lasting relationships were created that will extend far beyond the TWI Program.

Lessons Learned

The TWI Program helps close the gap between Army and civilian equipment operators. This partnership ensures adaptability to any environment and keeps the Army current on best practices and the latest industry trends. By networking with different sections within Caterpillar's Defense and Federal Products Division, I had opportunities that would not have materialized if I had stayed in a bubble and focused solely on the tasks in front of me. TWI students should be proactive, requesting classes and experiences beyond those listed in their initial report. The program will prove to be a crucial broadening assignment for NCOs and a way to advance their individual development plans.

Master Sergeant Payne is a general engineering supervisor with a horizontal-engineer background. He has been in the Army for 20 years. He holds an associate's degree from Central Texas College and Six Sigma Green and Black Belt certifications. He is pursuing a bachelor's degree in construction management with Park University, Fort Leonard Wood, Missouri. Upon completion of his TWI fellowship with Caterpillar, Inc., he was assigned as the engineer credentialing program manager at the U.S. Army Engineer School, Fort Leonard Wood.

("Lead the Way," continued from page 3)

by military occupational specialty and grade, defines key developmental requirements at 18 months, and gives retroactive credit toward key developmental time for Soldiers who were rated in that duty position. The publication is also synchronized with all professional development models on the Army Career Tracker Web site at <https://actnow.army.mil>. I urge everyone to frequently check the Enlisted Engineer Community page on the Army Career Tracker Web site to view policy updates and initiatives that the Engineer Regiment is working on. From the dropdown menu, select *Enlisted*, then *Career Management Field (CMF) 12*.

We will continue to push to further improve the Engineer Regiment, and I hope that you will do so too.

Essayons!

Endnotes:

[1]NCO 2020 Strategy, *NCOs Operating in a Complex World*, 4 December 2015.

[2]Department of the Army Pamphlet 600-25, *U.S. Army Noncommissioned Officer Professional Development Guide*, 7 December 2017.

("Show the Way," continued from page 4)

intelligence cell, they collaborate with the planning staff and participate to provide the right information at the right time to facilitate the military decision-making process.

Our recruiting efforts are getting better, but there is still work to be done in the Regular Army and the Reserve Component. We continue to assess and select quality noncommissioned officers who bring a depth of knowledge and experience to the engineer warrant officer cohort. Congratulations to all the noncommissioned officers who were selected in the last warrant officer selection board. However, they should remember that their journey has just begun. There is a selection board twice a year, and I look forward to seeing more packets come our way. Noncommissioned officers who are interested in becoming engineer warrant officers should visit the following Web site: <http://www.usarec.army.mil/hq/warrant/WOgeninfo_mos.shtml>.

Thanks to our engineer warrant officers who continue to lead the effort in construction and geospatial engineering.

Adopting the Chemical, Biological, Radiological, and Nuclear Reconnaissance Platoon *Into the Brigade Engineer Battalion*

By Captain Ian T. Swisher

Training year 2015 brought the new brigade engineer battalion (BEB) force structure, and with it came the chemical, biological, radiological, and nuclear (CBRN) reconnaissance platoon into the headquarters and headquarters company (HHC). Training, integrating, and employing this platoon is a new concept for the Engineer Regiment, but its task and purpose are familiar. Army Techniques Publication (ATP) 3-11.37, *Multi-Service Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Reconnaissance and Surveillance,* describes CBRN reconnaissance as operations undertaken to obtain information on the potential or actual CBRN hazards and threats in an area of operations by visual observation or other detection methods.[1] Furthermore, surveillance is the systematic observation of aerospace, surface, or subsurface locations, places, persons, or things by visual, aural, electronic, photographic, or other means to confirm or deny the presence of CBRN hazards.[2]

For engineers, this definition of reconnaissance should seem eerily familiar, but the two concepts of reconnaissance and surveillance should not be confused with each other. Reconnaissance is an active means of observation, characterized by movement, to collect technical CBRN information about a specific location—for example, when a hazard at a named area of interest is located, surveyed, or marked. Conversely, surveillance is a very passive, often continuous method—for example, when Soldiers monitor the CBRN situation by

Soldiers perform preventive maintenance checks and services on a nuclear, biological, and chemical (NBC) reconnaissance vehicle.

A CBRN Soldier performs vehicle startup procedures and prepares to launch the chemical-biological mass spectrometer system.

using detection equipment while in, or transitioning to, a defensive posture. Although fundamentally different activities, when conducted simultaneously, reconnaissance and surveillance can result in an information-creating interaction effect that provides commanders with situational awareness of conditions in an area of operations.

Two important questions are where and how the platoon should be task-organized upon integration into the Stryker brigade combat team. Since it was formerly part of the reconnaissance squadron, it would be natural to realign it with the cavalry or any other task force or maneuver battalion. This would allow the brigade to task the supported battalion with specific information collection regarding CBRN objectives.

On the other hand, the CBRN reconnaissance platoon is the only organic CBRN information collection asset in the Stryker brigade combat team. Therefore, it is desirable to integrate it directly into the brigade information collection effort, in the same way that engineer reconnaissance teams are integrated, supported, and tracked by the higher headquarters.[3] This method would collocate the platoons with the CBRN staff officer (and the brigade current operations cell) who, along with the operations and intelligence officers, determines what data can be collected and writes specific CBRN tasks into the brigade information collection plan and operations orders.

Another technique could be to integrate the CBRN platoons with chemical support received from echelons above brigade. In the Stryker brigade combat team, the CBRN platoon is equipped with nuclear, biological, and chemical reconnaissance vehicles built on the Stryker platform. These vehicles are equipped with an overpressure system that allows the team to operate in a CBRN environment. The brigade will require decontamination support from higher echelons if the platoon is employed to locate, survey, and mark CBRN hazards on the battlefield. It is reasonable to assume that the supporting unit will be able to integrate the reconnaissance platoon and compile the gathered intelligence data for analysis.

These different task organizations are feasible and acceptable, although to different degrees. Opinions differ among leaders of different units, and it is my opinion that the platoons should be integrated directly into the brigade information collection effort. When integrating with a maneuver task force, the risk of the platoons being misused is too great. Various lessons learned sources cite the misuse of technical reconnaissance teams. Technical reconnaissance frequently gets lost in the shuffle of the larger, more general reconnaissance effort, and units like CBRN reconnaissance platoons may be used as glorified security elements. Training opportunities to build coalitions with maneuver battalions and with support from echelons above brigade are lacking. This is particularly true of Army National Guard units, which may only face this prospect during a combat training center rotation. Furthermore, supporting CBRN units may not understand how to effectively employ the reconnaissance platoon's organic assets. For example, the table of organization and equipment for CBRN support companies provides their reconnaissance platoons with a different vehicle package. Therefore, they will

"Adopting the CBRN reconnaissance platoon into the formation has been a learning experience and is an integral part of enabling the different warfighting functions."

probably not be familiar with the capabilities of the vehicles organic to the reconnaissance platoons.

The CBRN platoon belongs to, and should be task-organized to, the unit that can best collect, process, and analyze the CBRN information required to answer the commander's critical information requirements. Members of the brigade CBRN staff are the most senior CBRN specialists in the Stryker brigade combat team and are the best equipped for this purpose. In collaboration with the intelligence and operations staffs, they are charged with planning, assessing, and directing collection efforts.[4]

A truck commander occupies the surveyor's station and checks for onboard faults and alarms using the CBRN Detection Analysis Communication System.

The onus for training and developing CBRN reconnaissance fundamentals is on the commander, and that officer's perspective on how the CBRN platoon is used will affect the training strategy. Unsurprisingly, there is nothing regarding CBRN reconnaissance platoon operations on the headquarters company mission-essential task list. Leaders must delve into the combined arms training strategy for a starting point for backwards planning of training schedules and into the chemical area support company mission-essential task list to find copies of the relevant training and evaluation outlines. Devising methods to train a CBRN unit may be daunting at first, but leaders will soon realize that most of a CBRN reconnaissance situational tactical exercise consists of familiar drills, such as conducting troop leading procedures, evacuating a casualty, establishing security at the halt, reacting to direct fire contact, reacting to near ambush, and reacting to indirect fire. Adding the CBRN reports from the battalion's tactical standard operating procedure will result in a 95 percent solution. The final, toughest 5 percent of the solution will consist of developing, planning, and resourcing realistic CBRN training scenarios.

There are other hurdles beyond the expected teamstorming issues in the adoption and training of the CBRN reconnaissance platoon. One difficulty may be in convincing experienced CBRN Soldiers and noncommissioned officers to adopt their new mission set. Teaching them their new role within the unit may require considerable learning on the part of leaders. Regardless of how some personnel may have trained in previous units, CBRN individual task training is no longer the annual culminating training exercise. Soldiers need to learn that they are no longer serving in a biological detection platoon and that they will be tasked with more than conducting mask fit testing.

Vertical integration of CBRN reports is necessary. When leaders begin to write their platoon standard operating procedure, they may discover that CBRN report formats are not nested from platoon to brigade level, providing consistent information at each node. In some cases, CBRN reporting has not been exercised in so long that report formats were allowed to decouple. Leaders should track down these formats to start smoothing out their reporting processes.

Furthermore, balancing reconnaissance, gunnery, and traditional CBRN defensive tasks within compressed training timelines is always difficult. With the advent of Objective T, which emphasizes mission-essential task list and live-fire proficiency, it is increasingly important for units to meet their training objectives each year in order to communicate their readiness to deploy, fight, and win. It is imperative that junior leaders plan, rehearse, and conduct opportunity training. There is not enough white space in the training schedule to deliberately set aside time for training each individual supporting task. This training should be conducted on an opportunity basis, whether it is during downtime on the gunnery range, sergeant's time, or any other chance that presents itself. This will help ensure preparedness and utility during team and platoon training events.

(continued on page 34)

Engineer Environmental Officers: A Force Multiplier

By Mr. Douglas M. Rule and Mr. Clay R. Young

The U.S. Army Engineers can trace their proud lineage back to 16 June 1775, when the Continental Congress authorized the first Chief of Engineers position for the new Continental Army. In those early days, the duties of the U.S. Army engineer were vast and numerous, including tasks such as conducting reconnaissance missions, overseeing the construction of roads and fortifications, and creating maps for commanders. Since then, the duties have expanded and increased greatly in scope and complexity. For example, it has only been in the past 25 years that Army engineers have often been tasked with the important role of environmental officer within their units.

Environmental officers have the monumental task of managing the unit environmental protection program on behalf of the commander and advising the command on environmental issues. Their duties include—

- Serve as environmental subject matter experts.
- Act as liaisons between the commander and external environmental personnel.
- Ensure that environmental considerations are integrated into unit activities.
- Coordinate unit environmental training.
- Conduct unit assessments.
- Oversee corrective actions for deficiencies.
- Maintain records and documentation.

The success of environmental officers is important, and their mission should not be taken lightly. When environmental consideration is properly integrated into military operations, it contributes to mission accomplishment and serves as a force multiplier rather than a mission distractor. Successfully integrating environmental considerations sustains resources, reduces logistic requirements, promotes positive community relations, supports stability efforts, and reduces financial liability. In addition to protecting the environment, the environmental officer protects Soldiers and the local population.

Unfortunately, certain driving forces can push environmental considerations upward or downward on the list of priorities. The resources, money, and personnel needed for the Army to accomplish its mission do not come from an infinite pool; in fact, they always seem to be limited. Environmental officers are expected to be creative and resourceful in meeting requirements because the health and safety of those defending the Nation are always paramount. Soldiers should never be placed at risk without just cause. Therefore, the job of environmental officers is critical in conserving resources, preventing and mitigating environmental damage, and protecting the health and safety of Soldiers.

Army engineers typically receive their environmental training as newly commissioned lieutenants during the Engineer Basic Officer Leadership Course (EBOLC) at Fort Leonard Wood, Missouri. The environmental officer training is a 3-day, 24-hour course taught by personnel from the U.S. Army Engineer School Directorate of Environmental Integration (DEI). Lesson topics include—

- Environmental laws and regulations.
- Air quality.
- Cultural and natural resource protection.
- Threatened and endangered species.
- Water resources.
- Hazmat.
- Unit environmental program.
- Closures and transitions.
- Sustainability.
- Management of nonhazardous solid waste, hazardous waste, medical waste, and wastewater.

The training builds on classroom instruction with practical exercises that focus on a hands-on approach by the students. The students conduct an environmental baseline survey during a field exercise, and they develop and brief an integrated waste management plan for a proposed contingency location that is based on an operations order-type exercise, their environmental baseline survey, and the classroom lessons. The training they receive goes beyond just skimming the surface of the subject areas. It attempts to integrate environmental management with the civil engineering requirements. Burn pit and burn box design and operational requirements are presented. Wastewater lagoons are discussed with respect to design, construction requirements, operations, maintenance, and troubleshooting procedures. Wastewater treatment plant operations and procedures are defined to prepare students for a later tour of a functioning local wastewater treatment plant. Students even practice calculations that establish land and volume requirements for sanitary landfill operations and wastewater lagoons.

"The training they receive goes beyond just skimming the surface of the subject areas. It attempts to integrate environmental management with the civil engineering requirements."

The Engineer Regiment has been tasked as the proponent for environmental management. Engineer lieutenants are not left in isolation to carry on with this essential mission. Although they receive environmental management training in their EBOLC, that training should be only the first in a series of lifelong learning events, not a culminating occurrence. Engineer captains, warrant officers, and battalion and brigade level commissioned and noncommissioned officers receive additional environmental management training during their professional development courses. The additional subject matter and broader scope result in enhanced environmental management that starts at the unit level and continues on through joint and North Atlantic Treaty Organization operations.

An EBOLC student checks a hazardous waste containment area.

In addition to the resident Environmental Officer Course, DEI hosts numerous online, Blackboard™-based environmental courses tailored to the specific operational location needs of units. Available course topics address issues ranging from those associated with local training area setup and management to environmental impacts incurred during continental U.S.-based

EBOLC students inspect a gray water filtration system.

training. They also expand to the larger scope of overseas operations and the challenges associated with maintaining compliance with host nation-specific environmental laws and regulations. The importance of protecting historic and cultural property and threatened and endangered species a concept that is not always captured in deliberate risk assessments) is identified and discussed, as the inclusion of these concerns aims to mitigate the unintended loss or destruction of irreplaceable resources.

Online course titles include—

- Environmental Officer Course.
- Cultural Property Protection.
- Local Training Area Environmental Considerations.
- Manage Base Camp Waste.

DEI also produces multiple graphic training aids covering topics such as environmental management, spill response, hazmat and hazardous waste management, and the environmental compliance checklist.

As the Army proponent for environmental training, DEI has historically focused on operations outside the continental United States. Now, however, it has widened its focus to include training for garrison operations in the United States as well. For Soldiers who would like to receive environmental training but are unable to attend a course at Fort Leonard Wood, online training is available from DEI. In addition, DEI can conduct mobile training team instruction worldwide, provide subject matter expertise, and respond to requests for information as the need arises.

DEI contact information is as follows:

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Directorate of Environmental Integration

14010 MSCoE Loop, Suite 3623

Fort Leonard Wood, MO 65473

Phone: (573) 563-3550

Internet: <http://www.wood.army.mil/usaes/DEI.html>

E-mail: <usarmy.leonardwood.engineer-schl.mbx.dei@mail.mil>

Mr. Rule is a DEI training instructor who teaches resident environmental courses and is the primary coordinator for several distributed-learning modules offered by the directorate. He is a former Army engineer and holds a degree in criminal justice.

Mr. Young is an environmental training specialist with DEI. He is a retired chemical, biological, radiological, and nuclear specialist with 22 years of service. He holds bachelor's degrees in biology and environmental science and a master's degree in environmental management with an emphasis in environmental sustainability.

A Primer on Microbial Fuel Cells

By Sergeant Michael K. Forlife

As we move into the future, energy will become our most essential resource. The pursuit of energy can best be managed by improving the sustainability of existing resources and by developing new technology. Exploring all available options will result in efficient and productive energy use and provide necessary energy security. Fuel cells represent a technology that could be used to manipulate energy in a broad spectrum of situations. While fuel cells have already proven themselves in versatility and resourcefulness, there is another derivation that deserves attention: the microbial fuel cell.

Fuel cells are capable of converting different forms of energy for power generation. Microbial fuel cells take this capability a step further by introducing *exoelectrogens*, which are naturally occurring bacteria that produce electricity outside of their cells. While the transfer of electrons within the cell is a key component of conventional cellular respiration, the respiration of exoelectrogenic bacteria differs in that electrons are transferred outside, rather than inside, the cell. These electrons can then be harvested as an electrical current. This biologically produced electricity is the mechanism that has led to the development of microbial fuel cells. The bacteria used feed on organic matter, with organic waste as a common food source. As long as the bacteria are fed and maintained in their required environmental conditions, cellular respiration continues and electricity is produced. This relationship, harnessed by the microbial fuel cell, is worth noting due to its ability to produce energy from what would otherwise be waste, such as sewage or wastewater. During the life cycle of the microbe, energy is produced and waste is processed simultaneously.

Microbial fuel cells can be further modified to enable other capabilities. In microbial electrolysis cells, additional electricity is added in order to reduce protons and create hydrogen. With the exoelectrogens producing a portion of the electricity required for the electrolysis of water, the microbe-assisted process requires less electrical input than the non-microbe-assisted process. Another modification—microbial desalination cells—makes use of the electrical current generated by the microbial colony to drive desalination. Saltwater is passed through a chamber between two semipermeable membranes, where the sodium and chloride that make up the salt follow the electrical current to positive and negative terminals, desalinating the water in the process. This can serve as a low-energy option to produce freshwater, providing an essential survival resource in coastal operations and remote locations limited to saltwater reservoirs. All of these microbial fuel cell variations are powered by their biological engines, which can consume a form of organic waste and generate electricity from it.

The use of organic waste as a source for electricity generation provides a method of using existing waste as an energy resource and offers an incentive to process waste locally rather than through an external municipal waste system. Shredded documents, expendable supplies, and food and hygienic wastes are examples of items worth exploring for on-site breakdown. Processing waste locally, when appropriate, can reduce security risks and eliminate costs of energy generation and management. The ability to generate electricity from daily waste products offers resiliency and a tool that can be strategically employed in operations. Furthermore, there are specific circumstances that warrant the use of microbial fuel cells rather than other types of sustainable energy generation. By modeling a base of operations as a self-sustaining ecosystem, solutions can be designed to accomplish multiple goals at once, with microbial fuel cells being one tool to accomplish a more significant mission.

Microbial fuel cells in their various forms are versatile in purpose, sustainably driven, and able to harvest energy from waste products. Energy solutions should not simply be answers to energy deficits, but a means to support specific and long-term operational goals. Multifaceted solutions that can simultaneously provide security, redundancy, and resiliency should continuously be evaluated and integrated in our operations, especially when it comes to energy.

References:

Bruce E. Logan, *Microbial Fuel Cells*, John Wiley and Sons, Inc., Hoboken, New Jersey, January 2008.

Bruce E. Logan et al., "Microbial Fuel Cells: Methodology and Technology," *Environmental Science and Technology*, Volume 40, Issue 17, 1 September 2006, pp. 5181–5192.

Xiaoxin Cao et al., "A New Method for Water Desalination Using Microbial Desalination Cells," *Environmental Science and Technology*, Volume 40, Issue 18, 24 July 2009, pp. 7148–7152.

Sergeant Forlife serves as a chemical, biological, radiological, and nuclear specialist in the 17th Combat Sustainment Support Battalion at Joint Base Elmendorf–Richardson, Alaska. He holds a bachelor's degree in anthropology from Queens College, New York, and a master's degree in environmental engineering and science from Johns Hopkins University, Maryland.

TRADOC COMMAND: THE BEST COMMAND

By Captain Clint J. Munson

It is 0300, and the platoons are preparing for the company mission. The company spent the last few days and nights rehearsing and preparing in a patrol base near the forward operating base. First platoon is tasked with the decisive operation, while 2d and 3d platoons shape and support its efforts. First platoon must secure a small village, then clear the area of four to five enemy forces, while searching for a high-value target. Second and 3d platoons conduct a countermobility mission to prevent enemy reinforcements from approaching south of the objective, and they secure the helicopter landing zone. Upon mission success, the task force commander maneuvers deeper into enemy territory. The company commander coordinates and synchronizes the movement, fires, and control measures necessary to make the mission successful.

It is now 0400, and the mission begins—as it would in a real-world operation. However, in U.S. Army Training and Doctrine Command (TRADOC) one-station unit training (OSUT) companies, this mission is conducted three times a year. TRADOC commanders work with a team of 15–20 members comprised of the most professional noncommissioned officers (NCOs) in the Army. These highly skilled NCOs give 100 percent to the mission and each other every day. Commanders get to observe how drill sergeants transform civilian volunteers into disciplined Soldiers. TRADOC commanders are present at the starting point of every enlisted Soldier's career, while enjoying the benefits of conducting mission command, building teams, and nurturing the seeds of character through the stewardship of the Army profession. With every graduation, OSUT commanders build combat power for the Engineer Regiment and the Army to fight and win the wars of our Nation.

In TRADOC, exercising mission command to empower subordinate leaders to make sound decisions is absolutely essential. As taught during the Engineer Captains Career Course, the tasks of the commander include driving the operations process, developing teams, and informing and influencing Soldiers in the unit. The ability to execute these tasks daily directly impacts how drill sergeants operate and shape the command climate. Since drill sergeants are in a position of responsiblity, they must be empowered to make decisions that are consistent with the commander's training vision and philosophy without direct supervision. The commander must trust the cadre and certify that they are able to handle any issue with professionalism and excellence.

The commander must create a shared understanding and influence superiors on all levels because the OSUT company is on the tip of the training spear. While the commander is assessing and leading, he or she can provide candid feedback that may change how the TRADOC community implements critical training requirements. The company can influence training events to be more realistic, and the results can be eye-opening. Simply moving the judgment-based situational training event from the engagement skills trainer to military operations in urban training sites can provide valuable insight on how Soldiers communicate and react to different situations. It can also show the effectiveness of training and what areas may need improvement. Commanders must not allow hidebound tradition to be an excuse for not developing and enhancing training.

Trust and respect are fundamental in building and shaping teams. The commander must build teams by earning and giving trust and respect to Soldiers in the unit and maintaining good order and discipline. The same trust and respect will manifest throughout the company and into the platoons. OSUT companies are not only creating a TRADOC product; they are changing the lives of people. In some cases, cadre members inspire Soldiers to let go of misconceptions, join the Army team, and uphold the Army values. The commander holds cadre members and initial-entry training Soldiers accountable for their actions and punishes those who violate regulations or policies. The commander should use Uniform Code of Military Justice (UCMJ).[1] actions as a teaching point for young initial-entry training Soldiers since this may be the first time they have had to take full responsibility for their actions.

Since the cadre team is small, the command team will get to know them as fathers, mothers, husbands, and wives. It is imperative that the command team do whatever it takes to make sure that it is active in the Family role, not only because of the responsibility but because team members' Families are also the commander's extended Family. The command team should also work hard to develop the leadership potential of cadre members through counseling, coaching, and mentoring. The commander develops not only drill sergeants, but also a supply NCO, operations NCO, first sergeant, and executive officer.

Going to the field, throwing a grenade, conducting an obstacle course, rappelling down a tower, conducting live-fire assaults, and going through the gas chamber are examples of the training scenarios an OSUT company conducts in a few months. The Army profession starts in TRADOC, training and educating new recruits to become competent and committed Soldiers. Character, warrior ethos, and discipline are instilled in the new operational force. The training framework for OSUT is specifically outlined in a program of instruction, which is the framework for the way that basic combat training and advanced individual training are conducted. Initially, it may seem that the instructions to train new Soldiers are in place; however, they are not. The individual tasks are prescribed, but the way they are executed and assessed is completely up to the command team. This allows cadre to think critically and creatively about how and where to train in order to optimize and develop every Soldier. As the company trains and develops America's sons and daughters in the weeks ahead, the commander will see them transform into physically tough, disciplined, and proficient engineer warriors grounded in Army values and the profession of arms.

TRADOC is on the front lines of stewarding the profession of arms and building combat power. TRADOC cadre are leaders in the world's finest Army. They are completely committed and invested in everything they stand for, on and off duty. Therefore, the cadre must set the standards and enforce them for every Soldier. While it is the aim of the company to train to the standard, not all will succeed or possess the quality and character that are needed to become trusted Army professionals. The commander must take each advanced individual training Soldier and examine what is best for him or her, for the Engineer Regiment, and for the Army. It is an incredible responsibility to ensure that every engineer Soldier who pins on the castles is sent out to the force with the utmost competence, commitment, and character.

A mine detection dog handler runs a mine detection dog through training drills for scent and obedience.

Not everyone has what it takes to lead a TRADOC company. The environment has unique challenges that force leaders to learn and grow. The commander can be utterly frustrated and deeply satisfied. He or she will leave a lasting impact on hundreds of lives. It is humbling and rewarding to have parents and loved ones thank the team for making their boy a man or their daughter a woman. It is inspiring to see the team work together toward a common goal. The relationships that are built will last a lifetime. No one could ask for a better command. I only wish that I could take these outstanding NCOs with me on my next deployment. *ESSAYONS!*

Endnote:

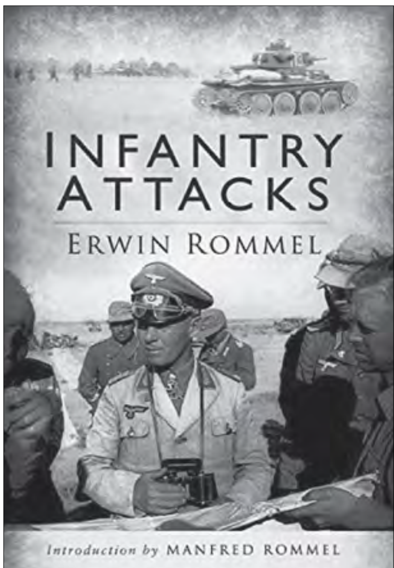
[1]Title 10, U.S. Code, Chapter 47, *UCMJ*.

Captain Munson serves as the commander of Company D, 35th Engineer Battalion, 1st Engineer Brigade, Fort Leonard Wood, Missouri. He is a graduate of the Engineer Basic Officer Leadership Course, Engineer Captains Career Course, Foundation Instructor Facilitator Course, and Airborne and Air Assault School. Captain Munson holds a bachelor's degree in general science–secondary education from the University of Dubuque, Iowa, and a master's degree in geological engineering from Missouri University of Science and Technology at Rolla.

Book Reviews

Self-development is a major pillar in the growth of Army leaders. One tool to aid in this is the "Engineer Commandant's Reading List" at <https://www.milsuite.mil/book/groups/usaes-commandant-resource-menu>. It includes a variety of books on history, politics, and culture that are appropriate for Soldiers and civilians in the Engineer Regiment. The list is not all-inclusive and will be updated over time.

Book reviews are a feature in each issue of *Engineer*. Authors of book reviews summarize the contents of books of interest and point out the key lessons to be learned from them. Readers who wish to submit book reviews may forward them to <usarmy.leonardwood.mscoe.mbx.engineer@mail.mil>. Books for review do not need to be selected from the reading list.



Infantry Attacks, by Field Marshall Erwin Rommel, Frontline Books, 30 May 2016.

Reviewed by Second Lieutenant Connor Wernecke

Though perhaps better known as a member of the Nazi high command and for his actions in the North African Campaign of World War II, Field Marshal Erwin Rommel first distinguished himself as a combat leader in World War I.[1] In his book, *Infantry Attacks*, Rommel presents a detailed narrative of his experience as a junior officer in the Imperial German Army and provides insight into the thought process of a small-unit commander. Although the events he describes occurred more than 100 years ago, many of his experiences and observations remain relevant to military leaders today. Rommel's decisive initiative, tempered by respect for the masterful employment of fundamental small-unit tasks, combined to make him a formidable leader and an example that modern military officers can still emulate.

The events in *Infantry Attacks* span the period of July 1914 to December 1917. During that time, Rommel's operations took him from France and Luxembourg on the Western front, to Romania and Italy on the Eastern and Italian fronts later in the war. Rommel was a platoon leader at the beginning of the war and quickly became company commander. The complex battlefields on which he fought often forced him to take responsibility for much larger forces. On one occasion, while conducting reconnaissance near Gesnes, France, he found himself in command of a battalion size element simply because he discovered a series of companies without officers that promptly attached themselves to his platoon.[2] Rommel's experiences in World War I were broad, from the bruising trench warfare of the Western front to the dynamic operating environments of Romania and Italy, which allowed him to use his talent for tactical surprise and deceit. Consistent throughout the experiences Rommel recounts, however, is his attitude toward combat and his approach to small-unit leadership.

Rommel's decisiveness and willingness to take initiative in difficult circumstances are key aspects of his leadership character. These traits became apparent when Rommel and three men in his platoon were scouting in the French countryside and came upon a group of 15 to 20 French soldiers on a coffee break.[3] Rather than retrieving the platoon's main body for an organized attack, Rommel seized the opportunity for a surprise attack with only his reconnaissance element. Although their four-man rush only scattered the Frenchmen, Rommel's small element achieved complete surprise and suffered no casualties in the encounter, ultimately regrouping with his platoon and attacking again, this time successfully. Although some may consider Rommel's initial attack rash, his ability to rapidly read a situation and take action is essential in military leaders. Recognizing and exploiting split-second opportunities on the battlefield was an area where Rommel excelled, and that ability has arguably become even more important today with the increasing pace and complexity of warfare.

The true hallmark of Rommel's success lies not in his resolute decision making in difficult situations nor in his pursuit of opportunities to attack, but rather in his adherence to, and mastery of, basic concepts of combat leadership. His disciplined approach to security, reconnaissance, and force protection highlights the importance he placed on his soldiers' welfare. Throughout his narrative, Rommel repeatedly references his meticulous use of scouting elements to learn as much about the enemy and the surrounding terrain as possible. He also emphasizes drilling into his soldiers the importance of simple tasks, like immediately digging fortified fighting positions upon first occupying a location because these simple actions save lives. While precisely the same tasks may no longer be as important in a modern wartime environment, the principal lesson remains the same: demanding discipline in the most fundamental tasks frees leaders to think more broadly and creatively about accomplishing their missions.

Similarly, Rommel's knowledge of the areas in which he operated, particularly his analysis and use of terrain to find and exploit enemy weaknesses, illustrates his ability to gather information from his environment and form actionable conclusions. In every engagement, he took great care to carefully analyze the surrounding terrain and determine how it would affect the battle outcome. In situations where his force was inferior, whether in manpower or equipment, Rommel planned his operations using the terrain that would provide his forces with the greatest advantage and surprise over the enemy. The results of his approach speak for themselves, as he repeatedly succeeded in overpowering or orchestrating the surrender of the enemy elements he engaged, many of which were better armed or better manned than his own force.

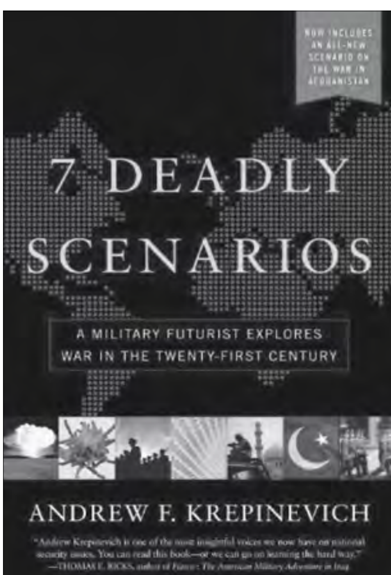
The aptly named *Infantry Attacks* details Field Marshal Erwin Rommel's simple but effective approach to small-unit tactical leadership. While some of his observations and conclusions are no longer applicable today, the essence of his leadership approach retains its utility. Discipline, decisiveness, and initiative are three qualities distinctly illustrated in *Infantry Attacks*, providing valuable firsthand evidence of their importance in combat.

[1]Major H.A. De Weerd, foreword to *Infantry Attacks*, by Marshal Erwin Rommel, Snowball Publishing, Lancaster, Texas, 2014, pp. ix-x.

[2]Major H.A. De Weerd, *Infantry Attacks*, by Marshal Erwin Rommel, Snowball Publishing, Lancaster, Texas, 2014, p. 22.

[3]Ibid, pp.7–8.

Second Lieutenant Wernecke is the executive officer at the 7th Engineer Dive Detachment at Joint Base Pearl Harbor–Hickam, Hawaii. He is a graduate of the U.S. Army Air Assault School, the Sapper Leader Course, the Engineer Basic Officer Leadership Course, and the U.S. Navy Joint Diving Officer Course. He holds a bachelor's degree in engineering psychology from the U.S. Military Academy–West Point, New York.



7 Deadly Scenarios: A Military Futurist Explores War in the Twenty-First Century, by Andrew F. Krepinevich, Bantam Press, 31 August 2010.

Reviewed by Second Lieutenant Caleb McNeill

Understanding and preparing for crisis level conflicts is a difficult and often daunting task for the U.S. Army and its sister Services. To react appropriately to a wide range of unprecedented political and military crises, the leaders of the U.S. government and military must possess the most up-to-date foresight the Nation's scholars have to offer. Andrew Krepinevich's *7 Deadly Scenarios: A Military Futurist Explores War in the Twenty-First Century* illustrates an assortment of complex situations that could bring the United States to the brink of a large-scale war. The book also gives insight into the actions that major players such as the President, the military, Congress, and other major government organizations may take to reach a critical decision point on whether to escalate the conflict to war.

Krepinevich's narrative details eight crisis scenarios ranging from the threat of nuclear war to international hostility amidst a global pandemic. Having worked with the Nation's leading minds in national security, Krepinevich imparts a wealth of knowledge and dissects each crisis in a format and writing style that are relatively easy to follow. First, he introduces the crisis, its initial damage toll, and global influence. Next, he outlines the ongoing effects and background of the crisis and the measures that the United States may take for damage control. Finally, Krepinevich describes the circumstances each organization must consider to thoughtfully and quickly reach a critical decision point.

7 Deadly Scenarios is an incredible collection of carefully orchestrated situations that seem all too likely through Krepinevich's logic. Topics discussed throughout the book include a war strategy of subversion by the Chinese, terrorist procurement of nuclear weapons, and a multifaction terrorist war on the global economy. Though Krepinevich takes the reader to the extremes of the international political spectrum, his methodical explanations of each scenario prevent his narrative from seeming out of place or far-fetched. He illustrates each vignette based on expert analysis, studies, and historical precedents that suggest likely paths that an actor or situation may follow. The scenarios probably would not progress exactly as described, but they may reflect a framework for future crises that could occur.

The author's focus on the development of each scenario, however, leaves the reader wondering about possible solutions to the crises. Although his purpose is only to discuss the scenario and not to provide solutions, explanations of a few probable responses and their consequences would be intriguing and helpful. Krepinevich elaborates well on the thought process of the President, the Service branch chiefs, and Congress leading up to a decision, but the omission of all postclimax action creates a void that could be filled with further insight on the capabilities and functions of these institutions and leaders. The author may not be able to predict and calculate the correct solution to each issue, but a description of the repercussions of government and military responses to the overall crises would not be beyond his expertise.

Understanding the operational environment is a major challenge facing the modern warfighters in the global political context. In a time when information travels faster and farther than ever and global issues are incredibly complex, it has become increasingly important for American Soldiers to educate themselves on how conflicts arise. This book provides an outstanding overview of potential modern conflicts, the interactions between America's essential leadership and defense institutions, and their combined approach to enacting the appropriate response. For the modern Soldier, this book can provide a basic understanding of the national and global implications of political and military crisis decisions. The scenarios provide an educated glimpse at the variety of global environments and conditions that the U.S. Army may soon face or is currently facing. In turn, this knowledge gives military leaders and subordinates a grasp of the overall flow of crisis decision making and an appreciation for the process.

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("Adopting the Chemical, Biological, Radiological, and Nuclear Reconnaissance Platoon," continued from page 25)

As a final note, there are different training efficiencies available within the BEB. Even though I don't envision the CBRN platoon (or the military intelligence company) reporting to the BEB staff during battle, that doesn't mean that integrating and building partnerships can't be practiced during the 90 percent of training that occurs without the brigade. For example, with input from the battalion intelligence staff, CBRN reconnaissance situational training exercises can include realistic reporting requirements that will exercise the BEB intelligence section. Better yet, the information collected can be used as input to the military intelligence gunnery process to exercise the information collection platoon across the full breadth of analysis. There may also be opportunities for the multifunction platoon to practice integrating with the CBRN reconnaissance element in the absence of maneuver units during the majority of the training. The efficiencies in conducting training in this manner come in the form of training value, realism, team building, and the establishment of cross-functional coalitions. As a community, we should seek out opportunities to create value for our Soldiers.

As with engineer reconnaissance, we are continually trying to enable maneuver commanders by providing intelligence to help them visualize, describe, and understand the common operating picture. In turn, this will allow commanders at all levels to make informed decisions. Adopting the CBRN reconnaissance platoon into the formation has been a learning experience and is an integral part of enabling the different warfighting functions. Engineer leaders should be excited to see what the future holds for the BEB and to be part of the Engineer Regiment's evolution.

Endnotes:

[1]Army Techniques Publication 3-11.37, *Multi-Service Tactics, Techniques, and Procedures for Chemical, Biological, Radiological, and Nuclear Reconnaissance and Surveillance*, 11 April 2017.

[2]Ibid.

[3]Army Techniques Publication 3-34.81, *Engineer Reconnaissance*, 1 March 2016.

[4]Army Doctrine Reference Publication 2-0, *Intelligence,* 31 August 2012.

Captain Swisher is a member of the Pennsylvania Army National Guard, serving as the assistant plans officer in the 103d BEB, 56th Stryker Brigade, 28th Infantry Division. He is a graduate of the Engineer Basic Officer Leader Course, the U.S. Army Airborne School, and the U.S. Army Mountain Warfare School. He works for the U.S. Army Corps of Engineers, Norfolk District, as a civil works plan formulator. At the time of this writing, he was deployed with the 71st Forward Engineer Support Team–Advanced. He holds a bachelor's degree in mechanical engineering from Drexel University, Philadelphia, Pennsylvania, and a master of business administration degree from York College of Pennsylvania at York.

THE ARMY SOLDIER ENHANCEMENT PROGRAM

By Sergeant Major Thomas B. House II (Retired)

The *National Defense Authorization Act for Fiscal Years 1990 and 1991* established the Army Soldier Enhancement Program (SEP) to enhance equipment used by dismounted Army Soldiers using commercial, off-the-shelf; government, off-the-shelf; and nondevelopmental item products.[1] SEP makes use of a "buy, try, and decide" methodology. If the review panel, which convenes twice a year, selects an item, SEP buys and evaluates the item in order to gain firsthand feedback from Soldiers. After evaluating an item for functionality, protection, and lethality, the Army considers issuing the product Army-wide.

With the Army immersed in conflicts around the world, Soldiers need equipment that reflects the best technology—and they need it fast. Before transformation was part of the Army lexicon, the SEP, within the Project Manager Soldier Warrior (a program that supported Soldiers through the acquisition of integrated Soldier systems), promoted transformation of Soldier systems with an accelerated acquisition process that issues better weapons and gear to Soldiers. SEP continues to play a key role in the effort to meet Soldiers' needs. The SEP panel reviews more than 100 proposals every 6 months, with the objective of identifying and obtaining items that a dismounted Soldier wears or carries in order to further enhance the effectiveness of the Soldier in a tactical environment.

Unlike many military acquisition programs, SEP represents an aggressive effort to identify and procure items that have already been developed and have the potential to substantially improve weapons and support equipment. SEP evaluates products from the warfighting functional areas: fires, mission command, movement and maneuver, sustainability, and protection. Previous SEP items include lighter and more-lethal weapons, weight-reduced and more-comfortable load-bearing equipment, field gear, survivability items, navigational aids, and training capabilities.

Soldier Needs

Soldiers serving in a dismounted role rely heavily on equipment and oftentimes have knowledge of commercial items that can better help them accomplish a mission. SEP provides Soldiers with an avenue to recommend those products directly to the acquisition community. SEP also makes use of themes to help industry leaders and Soldiers focus on items for which combat developers generate requirements. The current goal for SEP is to enhance Soldier mobility by reducing Soldier load. SEP reviews all products submitted, but products that reduce overall weight without increasing bulk or stiffness or compromising current capabilities receive higher priority for consideration and assessment within SEP.

The Program Executive Office Soldier, in coordination with the U.S. Army Training and Doctrine Command (TRADOC) Capability Manager–Soldier, reviews item submissions. A council of colonels meets each February and July to decide if an item is worth evaluating. If the item is approved, SEP funds the evaluation of the item and provides a final report with findings and recommendations. The recommendations could include adopting the item as an Army capability, not adopting the item as an Army capability, using the data/information gained during the evaluation to inform requirements generation, or assigning a National Stock Number (so that units can buy the item as-is).

Some past SEP successes include the M110 semiautomatic sniper system, clip-on sniper night sight, combat shotgun enhancement kit, squad common optic, extreme cold-weather socks, parachute electronic activation device, fuel handler coveralls and gloves, modular ghillie suit, ghillie suit accessory kit upgrade, individual combat shelter, PD-100 Black Hornet (nano unmanned aircraft system), Datron© Scout™ (unmanned aircraft system), InstantEye® (unmanned aircraft system), and Recon Scout® throwable robot. Current initiatives within SEP include fire control systems, weapons accessories and upgrades, cold-weather clothing and equipment, power charging and scavenger systems, Soldier-borne sensors, and 40-millimeter ammunition upgrades.

SEP Now

For more than 25 years, the SEP has been providing Soldiers with items that help them complete their missions more effectively. Many of these items were recommended to the SEP by Soldiers operating in a dismounted role. Anyone can submit suggestions, and all submissions are processed through the Program Executive Office Soldier Web site at <http://peosoldier.army.mil/SEP>. For more information about SEP, the process, or meeting dates, call (706) 626-8600 or send an e-mail to <thomas.b.house3.ctr@mail.mil>.

Endnote:

[1]House Resolution 2461, *National Defense Authorization Act for Fiscal Years 1990 and 1991*, <https://www.govtrack.us/congress/bills/101/hr2461/text>, accessed on 8 March 2018.

Sergeant Major House currently works with the SEP at Fort Benning, Georgia. He served in the Army for 29 years and retired in 2006 as the TRADOC Capabilities Manager–Soldier Sergeant Major. He is a graduate of the U.S. Army Sergeants Major Academy, Fort Bliss, Texas.

Shaping the Fight in Support of Operation Eagle Strike

By First Lieutenant Juliet Talavera

Army Techniques Publication (ATP) 3-37.10, *Base Camps*, states, "Base camp planning in general is a detailed and methodical process by which the necessary actions are developed to support the commander's base camp requirements in response to a mission need in light of specified constraints with available resources for a specific purpose."[1] In Iraq, with eastern Mosul cleared and units posturing for the western Mosul offensive, Task Force Eagle, 37th Brigade Engineer Battalion, 2d Brigade Combat Team, 82d Airborne Division, was tasked to support the master planning and construction of tactical assembly areas (TAAs) and position areas for artillery (PAAs). This task, assigned in support of the western Mosul offensive, was part of Operation Eagle Strike.

Shortly after arriving in theater, the 37th Brigade Engineer Battalion and the Combined Joint Forces Land Component Command approved the tactical basing plan for the western offensive. The plan included funding for a basic life support contract, a construction package consisting of Class IV materials, and material-handling equipment for the TAAs and PAAs. Maneuver task forces were tasked to occupy and conduct operations from their respective TAA and PAA. Each maneuver task force had a designated contracting officer representative (COR) and an engineer. Task force engineers served as key enablers for the maneuver task forces to advise the commanders across all lines of engineer support. The COR ensured that the contracted basic life support and construction packages were synchronized to meet the emerging mission requirements of the dynamic battlefield. The 37th Brigade Engineer Battalion construction cell served in an advisory capacity as the alternate COR for all TAAs and PAAs for the western Mosul offensive and the task force engineers. The construction cell, located at Qayarrah West Airbase, Iraq, was mission-essential to the master planning efforts for all TAAs and PAAs.

The base camp development planning process consists of the following steps:

- Initiate preliminary planning.
- Initiate land use planning, location selection, and facility development requirements.
- Initiate general site planning.
- Initiate designing, guiding, programming, and construction.
- Maintain and update plans.
- Maintain cleanup, closure, and archiving throughout the process.

Upon construction of the first PAA, it was apparent that there was a significant knowledge gap between the TAA and PAA establishment and master-planning efforts between the task force engineers and the task force COR. After construction of the first PAA, the construction cell determined that the steps were not reflexive or tailored to the mission. Task force engineers found the steps confusing and inapplicable to the battlefield. Based on these inputs, the construction cell arranged the steps captured in the base camp development planning process and nested them within the mission set, resulting in the following steps:

- Conducting reconnaissance.
- Occupying the site at the initial operating capability (IOC).
- Conducting operations at the IOC.
- Conducting operations at the final operating capability (FOC).
- Sustaining operations.

Master planning for the TAA or PAA occurs in the first two steps, while revision of that plan occurs in the last three steps. Figure 1 outlines this process.

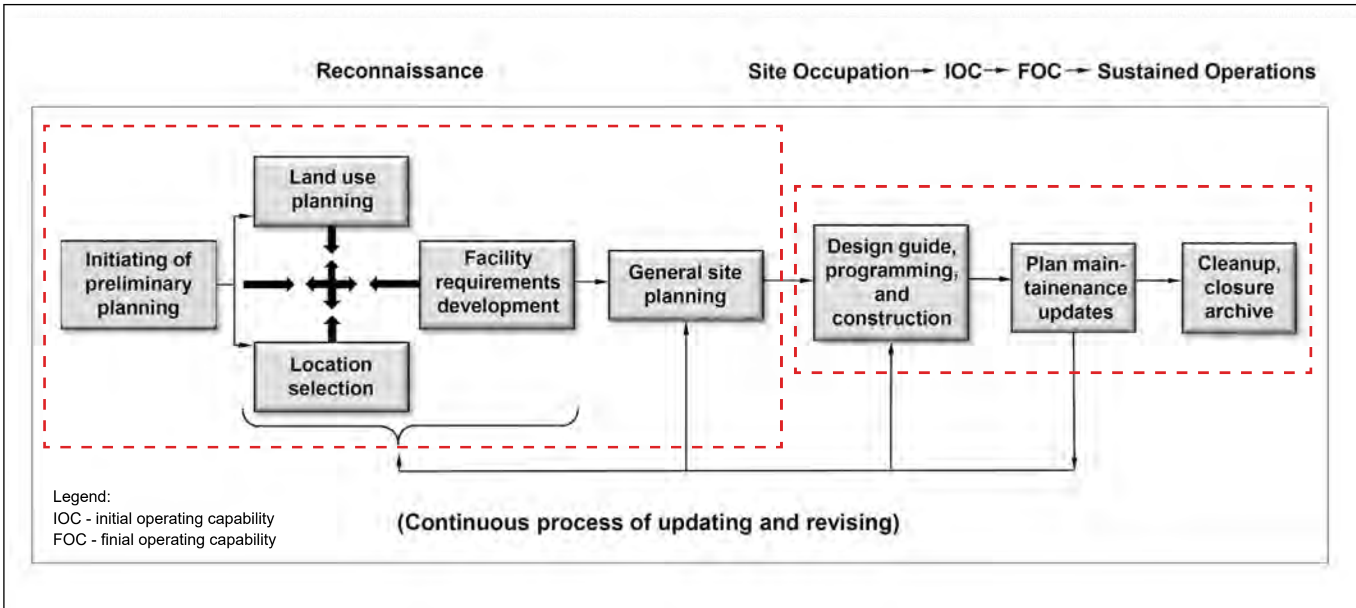

Figure 1. 37th Brigade Engineer Battalion base camp development process

The key planning considerations that the task force engineers communicated to the maneuver commanders related to mission requirements, site selection, facility requirements, expansion, and closure requirements. Land use agreements between Iraqi security forces and coalition forces dictated the selection of the site for the TAAs and PAAs. The primary role of the task force engineer was to define the operating capability of the mission set, which drove the master planning process. The construction cell followed guidance from the maneuver commander, task force engineer, and COR and created an initial master plan for the TAA or PAA. The terrain affected the master plan. Force protection and drainage were key considerations for the placement of life support areas, entry control points, dining facilities, Class IV storage yards, and guard towers. Another key component of the master plan was the designation of expansion areas in the event of a population surge and for the eventual closure of the TAAs and PAAs. From a contracting standpoint, the construction cell and the maneuver battalion COR coordinated contracted items to support the construction of the TAAs, PAAs, and Soldier billeting. Early in the deployment, the 37th Brigade Engineer Battalion had not yet received the organic engineer equipment. As a result, it had to rely heavily on contracted material-handling equipment for

Deliberate clearance operations conducted by combat engineers at a TAA in Mosul, Iraq. Before conducting any earthwork, combat engineers were required to deliberately clear the site.

Dozing operations conducted by equipment operators at a TAA in Mosul, Iraq. The equipment operators immediately began constructing the TAA once the area was deliberately cleared.

construction. The initial material-handling equipment package did not provide the flexibility or capability to construct the TAA and the PAA to IOC in 3 days. The construction cell and COR worked together to complete the material-handling equipment requests to provide the required engineer assets for the TAA and PAA. The basic material-handling equipment package used for the TAA and PAA consisted of the following vehicles: one grader, one 2.5-cubic-yard front-end loader, two bulldozers, one backhoe loader, one vibratory roller, one 10,000-pound forklift, one 10-ton dump truck, one skid steer, one water distributor, and one crane. Typically, two 4-person blade teams of horizontal engineers and a noncommissioned officer serving as the task force engineer supported the construction of the TAA and PAA. As a light airborne combat engineer unit, the 37th Brigade Engineer Battalion does not have organic crane operators. As a result, contracted crane operators conducted all crane operations in support of the construction of TAAs and PAAs.

Another planning consideration that task force engineers needed to communicate to the maneuver commanders involved facility requirements. These requirements are the planning factors used to determine the billeting standards for each TAA and PAA. The expected population size was used to predetermine the packages for basic life support. Before occupying the TAA and PAA, the construction cell worked with the COR to ensure that the basic life support packages would support the projected population in accordance with the facility requirements outlined in *The Sand Book.*[2]

The design of each TAA and PAA considered transient, surge, and contracted housing, allowing flexibility for expansion and closure to be factored into the base camp master plan. Moreover, a key part of the site selection process was the capability of the TAAs and PAAs to expand to accommodate the aforementioned additional personnel and equipment. These identified expansion areas became a helpful tool as TAAs and PAAs grew in population and capabilities. As a rule, each TAA and PAA planned would accommodate an additional 15 percent of the existing population in the event of personnel surges and expansion. Task force engineers kept closure in mind during the base camp master planning process. Although not part of Operation Eagle Strike, all base camp master plans outlined closure and retrograde requirements. Iraqi security forces were collocated with the majority of the TAAs and PAAs. The end state involved the transfer of the TAAs and PAAs to Iraqi security forces once mission requirements dictated the transition.

The importance of having the COR and task force engineer conduct the reconnaissance to understand the scope of work required to construct the TAA or PAA to IOC and FOC was a vital lesson learned. The COR and task force engineer acted as key enablers. Land use agreements between Iraqi security forces and coalition forces authorized the coalition construction and subsequent occupation of the TAA or PAA. Before construction of the TAA or PAA, maneuver commanders conducted reconnaissance. This reconnaissance answered key priority intelligence requirements, which drove the site selection for each TAA and PAA. These priority intelligence requirements were critical for setting conditions for site occupation at the IOC. Priority intelligence requirements, which were confirmed during the reconnaissance, included unexploded ordnance that was discovered on site, the number of buildings that were habitable, preexisting force protection measures, and the overall drainage of the site. The COR and task force engineer participating in the reconnaissance allowed for the identification of critical shortfalls and confirmation of priority intelligence requirements before occupation.

Horizontal-construction engineers can only be as effective as their equipment allows. After the construction of a TAA or PAA, the construction cell identified engineering support packages using contracted equipment, which was adapted to the mission. Redundancy in the engineer support package proved to be mission-essential due to the poor maintenance status of the contracted equipment. Based on the heavy reliance on contracted equipment, the mission timeline was in control of the maintenance contractor. This ultimately affected the horizontal-construction engineers' ability to operate and delayed the IOC and subsequent FOC in multiple TAAs and PAAs. Although the contractor is legally bound to provide mechanic support within 3 hours of notification, it soon became apparent that this timeline was not feasible. Since most of the contractors were required to navigate various checkpoints throughout northern Iraq, a more realistic timeline of 24 hours from initial notification to the receipt of mechanic support prevailed. Considering this factor, the recommended engineer support package incorporates redundancy in key assets because contracted equipment often proved to be unreliable.

Dozing operations were conducted by equipment operators at TAAs in Mosul, Iraq. The equipment operators relied heavily on contracted equipment to execute their missions.

Maneuver counterparts lacked the basic understanding of the synchronization of engineer efforts to get their TAAs and PAAs to IOC and FOC. There was a key knowledge gap between the maneuver commander and the task force engineer. To overcome this gap, the task force engineer established construction priorities between the reconnaissance and the initial site occupation to define the scope of work necessary to achieve IOC and FOC. The task force engineer conducted daily synchronization meetings with the maneuver battalion operations officer to ensure that engineer assets were appropriately used. The task force engineer was then able to provide the maneuver battalion with updates on the progress of the ongoing construction priorities and receive new guidance and changes related to the established scope of work. These daily synchronization meetings allowed a shared understanding of the progress and overall engineer support to the operation between the maneuver task force and the task force engineer.

By the end of the 9-month tour, Task Force Eagle, 37th Brigade Engineer Battalion, 2d Brigade Combat Team, 82d Airborne Division, provided master planning and construction support to establish four TAAs and three PAAs and expanded an existing TAA in support of Operation Eagle Strike and the clearance of west Mosul. On average, horizontal-construction engineers were able to establish a TAA or PAA at IOC in 48 hours and at FOC in 7 days. Through the application of doctrine, task force engineers were able to communicate with maneuver elements and meet all mission requirements through a shared understanding of base camp design.

Endnotes:

[1]ATP 3-37.10, *Base Camps,* 26 April 2013.

[2]Central Command Regulation 415-1, *Construction–Construction and Base Camp Development in the USCENTCOM Area of Responsibility (AOR), The Sand Book,* 15 April 2009.

First Lieutenant Talavera serves as the battalion construction officer with HHC, 37th BEB, 2d Brigade, 82d Airborne Division. She holds a bachelor's degree in psychology from the U.S. Military Academy–West Point, New York. She is a graduate of the Engineer Basic Officer Leadership Course and the U.S. Army Airborne School.

Engineer Doctrine Update

U.S. Army Maneuver Support Center of Excellence
Capabilities Development and Integration Directorate
Concepts, Organizations, and Doctrine Development Division

Publications Currently Being Updated

Publication Number	Title	Description	Tentative Publication Date
ATP 3-37.34	*Survivability Operations*	This publication will include updated terminology and survivability data in various tables.	3d quarter, fiscal year (FY) 2018
ATP 3-34.45	*Power Generation and Distribution*	This new publication will cover the power spectrum and transitions between voltage levels.	3d quarter, FY 18
ATP 3-34.56	*Waste Management for Deployed Forces*	This publication will be converted from a technical manual to an Army Techniques Publication (ATP).	4th quarter, FY 18
JP 3-34.56	*Waste Management for Deployed Forces*	This publication will be converted from a technical manual to an ATP.	4th quarter, FY 18
FM 3-34	*Engineer Operations*	This update will nest with and incorporate the updates from the new Field Manual (FM) 3-0, *Operations*.	1st quarter, FY 19

Over the last 16 years of combat operations in Iraq and Afghanistan, the military has predominately focused its efforts on counterinsurgency operations and stability tasks. However, today's operational environment presents threats that have adapted, modernized, and developed capabilities to counter U.S. advantages. Although the U.S. Army must be able to operate across the range of military operations, large-scale combat operations against a peer threat present the greatest challenge for Army forces. FM 3-0, *Operations*, which was published in October 2017, provides doctrine on how Army forces (corps, divisions, brigades) participate as part of a joint team, conducting large-scale combat operations against a peer threat using current force structure and capabilities. Future revisions of our engineer manuals, starting with FM 3-34, *Engineer Operations*, will be nested with FM 3-0 and will discuss engineer support during large-scale combat operations.

FM 3-0 is organized according to the Army's strategic roles to shape the operational environment, prevent conflict, conduct large-scale ground combat, and consolidate gains. It also addresses operations by echelon: theater army, corps, division, and brigade. The major discussion points in this manual include—

- The theater army is the senior Army headquarters in an area of responsibility. A corps headquarters may function as a tactical land headquarters under a joint or multinational land component command. A primary role of a division is as tactical headquarters—commanding brigades in decisive action. Theater armies, corps, and divisions may be task-organized with an assortment of multifunctional and functional units (theater engineer commands, engineer brigades) to support their operations.
- Modification of the operational framework allows adding the consolidation area to the deep, close, and support areas along with multiple domain considerations (physical, temporal, cognitive, and virtual). FM 3-0 discusses tactics to defeat peer threats that have capability advantages (integrated air defense systems, long-range fires) and accounts for an extended battlefield, including cyberspace, the electromagnetic spectrum, space, and the information environment across the range of military operations. Additionally, FM 3-0 designates corps and divisions as the lowest echelons that can typically orchestrate and synchronize multidomain capabilities during large-scale combat operations.

Engineer Doctrine Update

U.S. Army Maneuver Support Center of Excellence
Capabilities Development and Integration Directorate
Concepts, Organizations, and Doctrine Development Division

- Operations to shape, protect, and enhance national security interests ensure that regions remain stable and prevent a crisis from occurring. These operations consist of various long-term military engagements, security cooperation, intelligence, humanitarian efforts, information operations, and combined training and exercises.
- The intent of operations to prevent is to deter adversary actions and to de-escalate a situation. Operations to prevent are tailored in scope and scale in order to achieve a strategic or operational-level objective. Major activities during operations to prevent include executing flexible deterrent options and flexible response options, setting the theater, tailoring Army forces, and projecting the force. Corps headquarters may deploy into an operational area as a tactical headquarters with subordinate divisions and brigades as a show of force.
- Commanders direct tactical enabling tasks to support the performance of all offensive, defensive, and stability tasks. Tactical enabling tasks include reconnaissance, security, troop movement, relief in place, passage of lines, encirclement operations, mobility, and countermobility operations.
- In the defense, corps and divisions seek to gain the advantage in multiple domains and the information environment when the enemy initially has the initiative. There are three primary defensive tasks: area defense, mobile defense, and retrograde. Characteristics of the defense include disruption, flexibility, maneuver, mass and concentration, operations in depth, preparation, and security.
- The offense is the most direct and sure means of seizing, retaining, and exploiting the initiative to gain physical, temporal, and cognitive advantages. There are four primary offensive tasks: movement to contact, attack, exploitation, and pursuit. Commanders employ four defeat mechanisms: destroy, dislocate, disintegrate, and isolate. Characteristics of the offense include audacity, concentration, surprise, and tempo. There are six forms of Army maneuver: envelopment, flank attack, frontal attack, infiltration, penetration, and turning movement. Army units must be able to maneuver into the close fight to enable joint capabilities.
- Operations to consolidate gains exploit tactical and operational success by destroying or defeating enemy means for protracted resistance and denying the enemy operational purpose. Consolidation of gains is the follow-through to achieve the strategic purpose of large-scale ground combat. The pursuit of remaining enemy forces that resist below the threshold of large-scale combat begins in the consolidation area. The consolidation area is the portion of the commander's area of operations that is designated to facilitate the security and stability tasks necessary for freedom of action in the close area and to support the continuous consolidation of gains.

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"Doctrine is indispensable to an army. Doctrine provides a military organization with a common philosophy, a common language, a common purpose, and a unity of effort."

—General George H. Decker,
U.S. Army Chief of Staff, 1960–1962

Exercise Persistent Venture: Building Relationships With the Royal Engineers Elite Airborne Regiment

By Captain Justin M. Verde

American and British paratrooper forces have a longstanding partnership that dates back to World War II. Even today, the United States and the United Kingdom (U.K.) deploy personnel side by side in the fight against the Islamic State in Iraq and Syria, in counterterrorism efforts, and in foreign internal defense efforts. Indeed, the alliance and cultural similarities between the two nations help explain the parallels in lines of effort and methods of execution. Both nations have developed rapid-deployment forces that use airborne capabilities.

In recent years, airborne forces have struggled to remain relevant in modern combat, with dissenters suggesting that there are no clear necessities for an airborne operation to accomplish a particular mission. The United States and the United Kingdom have found their relevancy in their rapid-deployment forces—the U.S. Global Response Force (GRF) and the U.K. Air Assault Task Force (AATF). The purpose of the GRF and AATF is simple: stand ready to deploy globally on short notice. The two nations meet this requirement with the 82d Airborne Division and the 16 Air Assault Brigade, each serving as the largest airborne contingency force in its army.

Paratroopers assigned to the 23 Parachute Engineer Regiment rush to complete a medium girder bridge to allow friendly armored reinforcements access to the drop zone.

Modeled after existing U.K. exchanges with Australia and New Zealand, Exercise Persistent Venture created a personnel exchange between the 82d Airborne and the 16 Air Assault Brigade in order to develop closer ties between the United States and the United Kingdom and to foster future interoperability through staff relationships and a shared understanding of each organization. Exchanging officers or noncommissioned officers from the infantry, artillery, engineer, intelligence, logistics, and communications branches participated in this exercise for 3 months.

In July 2012, the U.K. Ministry of Defence published its Army 2020[1] concept and dictated that the 16 Air Assault Brigade be tasked to organize all combat support, and combat service support required to provide assured support in the event of the activation of the AATF. This essentially upgraded the brigade to a brigade combat team. The AATF is currently composed of a parachute regiment supported by units from the 23 Parachute Engineer Regiment; 2 Royal Ghurka Rifles; 7 Parachute Regiment Royal Horse Artillery; 13 Air Assault Support Regiment, Royal Logistics Corps; and 16 Medical Regiment. This combined arms structuring allows the parachute regiment to receive close support from the units organic to its task organization as part of the AATF, as opposed to requiring outside resourcing.

Officers of the 23 Parachute Engineer Regiment hold a quick huddle prior to a squad live fire to discuss safety and overwatch positions.

The 16 Air Assault Brigade mobilizes the AATF following the same *alert, marshal,* and *deploy* sequence as the American GRF. The core differences in its activation compared to the GRF lie in the availability of resources. During the alert phase, the 16 Air Assault Brigade paratroopers maintain a predetermined recall-to-station time that essentially limits them to mainland England. Upon alert, all AATF units establish accountability and the brigade begins the orders process, which continues throughout the activation sequence.

During the marshalling phase, subunits of the 16 Air Assault Brigade move to the Joint Air Mounting Centre at Brize Norton, the AATF staging area. Upon arrival, all personnel participating in the AATF in-process and the operations process continue as the commander evaluates new information and refines the plan.

During this period of refinement, paratroopers receive individual equipment and administrative supplies. Simultaneously, Royal Air Force personnel prepare large equipment for heavy drop or airlift. The principal difference between the Joint Air Mounting Centre and the arrival/departure airfield control group at Fort Bragg, North Carolina, is the immediacy with which paratroopers load aircraft. Unlike Fort Bragg, where the departure airfield is collocated with the arrival/departure airfield control group, Royal Air Force Brize Norton serves only as the AATF staging area, which delays the process.

Paratroopers assigned to the 23 Parachute Engineer Regiment utilize LARP assets to fill potholes in the runway.

A Soldier receives instruction on land procedures, while in the suspended harness trainer.

Once operations are complete, all using AATF personnel sign out, load equipment, and move to the designated airfield. There, paratroopers draw ammunition and rig personal equipment for airborne operations. As paratroopers prepare to conduct a joint forcible entry, they cross-load equipment and personnel as necessary, based on mission requirements.

Just as the GRF rotates readiness, the AATF rotates its infantry parachute regiments and support squadrons through high-readiness duty. Unlike the 82d Airborne Division, the 16 Air Assault Brigade has only two parachute regiments. For this reason, units are in either the high-readiness role or preparing to assume that role. The paratroopers of the 16 Air Assault Brigade focus solely on AATF readiness, while airmen from the Royal Air Force cover the nodes responsible for pushing the 16 Air Assault Brigade out the door and into its deployment. This is different from the 82d Airborne Division, where all nodes are covered by Army personnel, thus creating deep relationships so that infantry regiments and their support counterparts are well aware with whom they will be working and can train with them constantly.

While supporting the AATF, only one engineer squadron is on high-readiness duty with its assigned infantry regiment. This support typically consists of three parts: the attached battle group engineer, who serves as the subject matter expert and liaison to the parachute regiment commander; sapper sections attached to infantry platoons; and modifications to the task organization of the engineer squadron, under the squadron commanding officer, to better suit light-equipment mission requirements. The burden of relational responsibility falls on the battle group engineer and sapper sections, while the squadron commanding officer's responsibility is to use light-equipment assets to develop the survivability, countermobility, and mobility plans of the brigade.

The specific capabilities of the engineer regiment focus on airfield damage repair (ADR) and light airfield repair package (LARP) capabilities. The 23 Parachute Engineer Regiment provides mobility, countermobility, survivability, and general and geospatial engineering support, similar to an American brigade engineer battalion. The regiment accomplishes this by organizing each squadron into two field troops and a support troop. In this case, a field troop has a mission similar to that of a sapper platoon. A support troop more accurately models a light-equipment platoon. Geospatial engineering support, provided by way of the attachment of a two-man team to the squadron's battle group engineer, attaches to the infantry regiment's staff for battlefield area evaluation during the combat estimate or Seven Questions process.

During the activation of the rapid-reaction force, engineering specialties include ADR and LARP. One purpose of joint forcible entry is to seize a designated airhead or lodgment area. In doing so, the command allows for continuous air landing of troops and materials, while also providing a

Paratroopers assigned to the 16 Air Assault Brigade load a C-130K C1/C3 before conducting a mass airborne insertion into a brigade tactical exercise.

A platoon leader briefs paratroopers on the assembly plan on the drop zone prior to an airborne operation.

headquarters area for future operations. Engineers include LARP assets for conducting ADR to ensure that the airhead is prepared to receive follow-on air landings in the event of enemy countermobility efforts. In short, if the GRF or AATF seize an airfield containing holes, they need to be able to fix it.

While the 23 Parachute Engineer Regiment ADR kit delivers an acceptable mobility effort to the airhead, many of the vehicles cannot be airdropped due to airframe or vehicle restrictions. For this reason, it was necessary to develop a LARP, which consists of a small package of vehicles that can be airdropped in the first wave of an airborne assault to enable the rapid repair of runway damage. The 23 Parachute Engineer Regiment LARP assets include a multiterrain loader and an all-terrain vehicle with a trailer carrying a 5-gallon cement mixer and necessary Class IV construction materials. The purpose of the all-terrain vehicle is to bring in the remainder of the ADR kit and to offer spalling and small-crater repair.

From a tactical-engineer perspective, there are three potential issues with future parachute operations jointly conducted between the United States and the United Kingdom. First, U.K. heavy drop capabilities are extremely limited due to aircraft capabilities. This directly correlates to the second potential issue: The amount of heavy engineer equipment inserted in the first wave of an airborne assault is dependent on available aircraft; and thus, a limitation on aircraft capabilities corresponds with a reduction in engineering capability of the assaulting force. Finally, the inconsistency of analog and digital tracking mechanisms in U.S. and U.K. forces opens the door for communication issues at the tactical and operational levels.

In 2016 alone, the United States tallied more than $611 billion on defense expenditures, compared to $48 billion spent by the United Kingdom.[2] Given such a massive margin, it should be clear that with the inherently smaller air force of the United Kingdom comes reduced airlift capabilities. This is especially important to engineers since many of their mission-essential tasks involve heavy equipment. The problem is particularly conspicuous with the immense loss of capability between the complete U.K. ADR kit and LARP assets. While the ADR kit includes the necessary resources to adequately prepare lodgment for air landings, the LARP fails to provide the same resources or capabilities in a timely manner.

"While the forces of the United States and the United Kingdom differ greatly, there are lessons to learn on both sides . . ."

The U.K. LARP equipment limits the entire support troop to one operator moving dirt and obstacles at a time, without compaction capability. The inclusion of a cement mixer compounds the issue. While spalling repair is important, the ability of the support troop to compact the dirt below the cement is insufficient for it to be usable. Additionally, with only a 5-gallon mixer available, significant holes are not repairable. A second multiterrain loader or other attachments should be included in the LARP.

In the event of a joint forcible-entry and airfield seizure, the 23 Parachute Engineer Regiment LARP would not be sufficient to meet the time requirement imposed by U.S. forces. This would be the case if joint forces were to seize the same airfield or if two airfields were seized simultaneously, such that timelines may differ greatly and the reallocation of resources across a theater may be required.

Paratroopers assigned to the 23 Parachute Engineer Regiment clear obstacles from the airfield after an airborne operation to allow follow-on landings to bring in much-needed supplies and reinforcements.

There are three potential solutions to this issue. First, 82d Airborne Division engineers could provide all LARP equipment during an operation. However, this is not feasible since it could fail to make use of the additional manpower and capabilities provided by U.K. forces. The second option would be to simultaneously provide U.S. and U.K. LARP equipment through organic airframes. However, this solution would not adequately nest personnel or allow for the most efficient use of the equipment. The most practical solution would be for the United States to provide additional heavy drop platforms for delivery of U.K. ADR equipment. This would allow the United Kingdom to maximize the amount of heavy equipment in the initial wave of the airborne assault, minimize the time for airfield repair, and fully exploit the potential of the 23 Parachute Engineer Regiment. Despite these obstacles, the United Kingdom has mastered the ability to get the most out of its expenditures.

Through incorporation and incentivizing of the private sector in the Ministry of Defence, the United Kingdom has been able to minimize the cost of operations and maintenance while maintaining the level necessary for military readiness.[3] Interestingly, this has been visible at all levels of command. The United Kingdom's use of analog-tracking mechanisms and communication systems is particularly helpful. From their company outposts to the brigade tactical-operation center, U.K. forces have far more terrain models and maps than their equivalent units in the United States. Moreover, the United Kingdom uses varying radio frequencies. This creates an adaptive and accurate environment in which a common operational picture can be quickly developed, relocated, and reset with relatively no problems.

The United States and the United Kingdom have very different tracking mechanisms, but neither is "wrong." The issues that arise are the difficulty of cross-talk and the tracking of subordinate units in joint operations. Fortunately, systems that are in place with U.K. forces are not necessarily foreign to U.S. forces; rather, they are underutilized. The solution to this problem is to master the basics. The 82d Airborne Division must be prepared to conduct battle-tracking operations in a truly light-equipment environment in the event that significant heavy-equipment drops are not available, as the majority of its training focuses on digital tracking mechanisms.

Despite any potential interoperability issues, Exercise Persistent Venture was a resounding success. While the forces of the United States and the United Kingdom differ greatly, there are lessons to learn on both sides and these lessons can lead to an eventual happy medium. Ultimately, the 3-month exchange was long enough to provide an excellent view of the societal and military culture of the allies, but short enough that it allowed the exchanging units to receive valuable insight. The exchange also developed lasting personal and professional relationships for the paratroopers and the units. These relationships proved invaluable when the units met again during All-American Week and the Warfighter Exercise and will no doubt assist in lengthening further interoperability experiences.

Endnotes:

[1]British Army Headquarters, "Transforming the British Army: An Update," July 2013, <http://www.army.mod.uk/documents/general/Army2020_Report_v2.pdf/>, accessed on 8 March 2018.

[2] Niall McCarthy, "The Top 15 Countries for Military Expenditure in 2016," *Forbes Magazine*, 24 April 2017, <www.forbes.com/sites/niallmccarthy/2017/04/24/the-top-15-countries-for-military-expenditure-in-2016-infographic/#6f1acc0243f3> accessed on 8 March 2018.

[3] P. D. Gouré, *"British MoD Again Shows Our DOD How to Transform Defense Procurement*," 20 February 2015, <http://www.lexingtoninstitute.org/>, accessed on 8 March 2018.

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Managed Aquifer Recharge:

An Approach to Foster Stability in Arid Regions Through Water Security

By Captain Erik Patton and Dr. Saugata Datta

The scarcity of fresh water, like other basic resources, can be a cause of conflict in semiarid and arid regions. Managed aquifer recharge (MAR) techniques provide a local, low-cost and low-infrastructure approach to addressing water scarcity. In water-scarce locations with favorable geology, engineers should consider constructing MAR infrastructure during transformation or stability operations as a reconstruction project with long-term benefits. The numerical computer model MODFLOW-2005 demonstrates water storage benefits of a MAR project using a check dam structure across a wadi. A second form of MAR structure, the infiltration basin, should also be considered.

Water conflict can destabilize governments, foster extremism, and create hostility between upstream and downstream users. Food and water security are linked, with an average of 70 percent of global fresh water being used for agriculture, increasing to 90 percent in water-scarce countries such as Yemen.[1] According to forecasts, by 2040, the most water-stressed countries will include some countries whose stability has strategic implications for the United States; Palestine shares the No. 1 spot, while the top 25 include Oman (No. 10), Libya (No. 15), Yemen (No. 16), Iraq (No. 21), and Pakistan (No. 23).[2]

Army Doctrine Reference Publication (ADRP) 3-07, *Stability,*[3] discusses how military forces build host nation capacity to operate and maintain essential civil services during transformation, when military forces may be tasked to implement public works projects. These transformation tasks are defined by lines of effort and often include a water line of effort as the "W" in the acronym SWEAT-MSO (sewage, water, electricity, academics, trash–medical, safety, and other considerations). One means of addressing water insecurity is the construction of MAR projects. MAR involves storing water in the local aquifer for use during the dry season or droughts. Compared to infrastructure projects like dams or trans-watershed diversions, MAR is far less expensive and potentially yields more water because there are negligible evaporation losses compared to surface impoundments. Additionally, the water is naturally filtered by percolation, frequently becoming safer through removal of pathogens and organics.[4, 5]

Low-Cost MAR Methods

A simple method of MAR enhances recharge by slowing ephemeral streamflow through wadis using check dams. This method can be successful in regions of infrequent but high-intensity rainfall. Monsoons cause such conditions over parts of Africa, the Arabian peninsula, and the American Southwest.

A second method of MAR makes use of infiltration basins to pond water over highly permeable soil. The top layers of soil are removed to create a pit to bypass low-permeability layers, ensuring that water flows vertically to the aquifer. This form of infiltration is suited to locations where a known water source is diverted into the basin. Wastewater treatment plants are an example of this type of supply. Treated wastewater is indirectly reused by recharging the aquifer for later extraction, avoiding the stigma associated with direct reuse (known as toilet to tap). Active infiltration basins are in use near Fort Bliss, Texas. Figure 1 shows a basin 36 hours after continuously receiving inflow at a rate of

Figure 1. A 0.3-acre infiltration basin in El Paso, Texas, where a continuous inflow of 300 gallons per minute was observed for 36 hours in June 2017.

300 gallons per minute. Without infiltration, the water would be more than 2 meters deep; however high-permeability soils at the bottom of the basin resulted in only one-third of the basin floor being wetted.

Both forms of MAR require periodic maintenance, as siltation clogs pore spaces. Clogging is usually limited to the top several inches of soil, and removal of the clogged soil restores infiltration efficiency.

Case Study: Yemen

Yemen is a mountainous country that critically lacks water. Overshadowed by conflict and epidemics, a solution to Yemen's problem of decreasing water availability must be solved in order to achieve long-term stability. Check dams provide part of the solution. Several such structures existed in the Bahman Wadi northeast of the capital city Sana'a prior to the current conflict.

A hydraulic simulation running MODFLOW-2005 demonstrates water volume gains anticipated when check dams are placed along wadi channels. Inspired by existing check dams in the Bahman Wadi in Yemen, simulation inputs represented the geology and hydrology of the Sana'a Basin, with simplifications made to better demonstrate MAR principles. The simulation setup included—

- A catchment measuring 1,000 by 300 meters, oriented east-west.
- A trapezoidal wadi channel of varying width and a maximum depth of 10 meters.
- A 3- by 110-meter check dam, perpendicular to the wadi channel.
- Simulated gravel and sand over permeable sandstone bedrock in the wadi.
- Twelve 150-meter-deep pumping wells.
- Two storm and flooding events, on Day 1 and Day 180.
- Ponding in the simulation reservoir of the check dam simulation after Day 180.

With each well initially pumping 30 cubic meters per day, steady-state conditions and a water table that was 30 meters below ground surface at the west end of the model were achieved. Well production increased to 35 cubic meters per day for 1 year (starting Day 1), inducing additional drawdown and creating an unsteady flow state. A 2013 International Monetary Fund report estimates that the average Yemeni has access to 86 cubic meters of water per year, 2 percent of the world's average.[6] The well field in this simulation would support fewer than 1,800 people. For comparison, California's new standard for kitchen faucets limits flow rate to around 10 cubic meters a day; each of the simulated wells produces less water than is required to run four ultraefficient faucets.[7]

Two recharge scenarios were simulated: natural flow plus wadi recharge and natural flow plus wadi recharge and induced recharge from a 3-meter-high check dam (Figure 2). The results of the simulation with a 3-meter-high check dam indicated that 150.33 cubic meters of water infiltrated, compared to 70.33 cubic meters infiltrated without the structure. The simulation models include only a small stretch of wadi. Infiltration across the entire wadi would be much higher. Four to six storms can be expected annually at Bahman Wadi, and up to 33 check dams could be efficiently used along the wadi length.[8]

Prior to Yemen's current conflict, Sana'a University research corroborated the effects of check dams on wadi recharge.[9, 10] A 2011 study of the Bahman Wadi area estimated the natural recharge in the catchment to be 44,541 cubic meters and induced recharge from existing structures to be 78,160 cubic meters. Compared to Sana'a University's numbers, the percent of recharge induced by the simulated check dam is overestimated (53 percent versus Sana'a University's 43 percent estimate), however this is reasonable considering the assumptions made to meet the intent of demonstrating the potential of MAR.

Water table levels also indicate the effectiveness of MAR. After pumping was increased to 35 cubic meters a day, the water table was not at steady state and

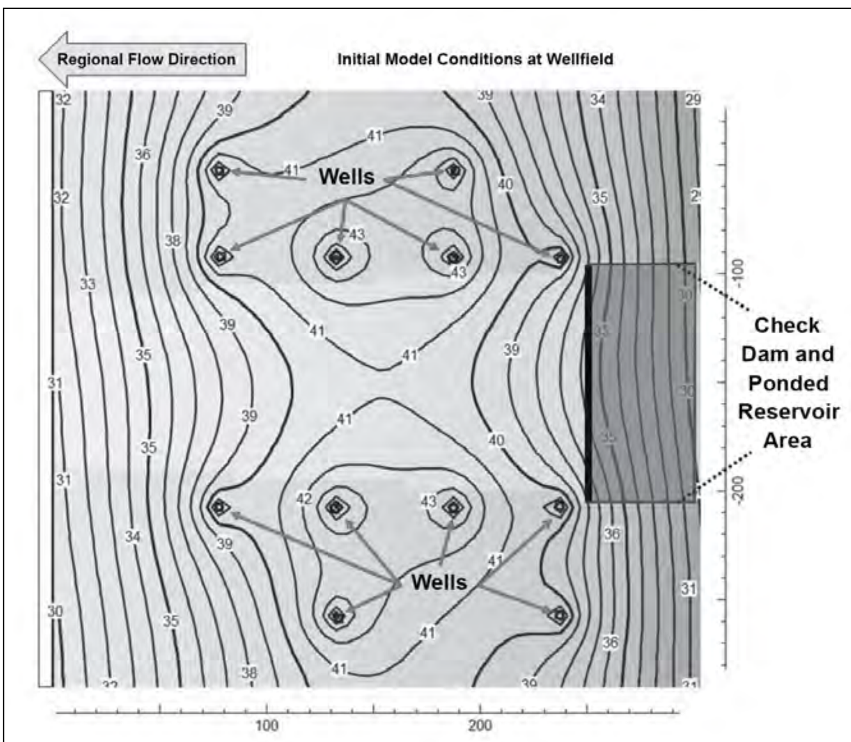

Figure 2. Steady-state water table at model wellfield prior to increased pumping or groundwater recharge. Scale is in meters; contours represent water table level in meters below ground surface.

began to decline. The simulated average decline in well water levels over a year is 4.9 meters, within the typical range of 2- to 6-meter declines observed in the Yemen highlands.

Comparing results from the check dam simulation to the simulation without a check dam, a temporary maximum water table rise of 29 centimeters was recorded at the well closest to the check dam. After 180 days of no additional recharge, the average water level in the check dam simulation was slightly less than 4 centimeters higher than the simulation without a check dam.

Discussion and Recommendations for Implementation

While the lack of water is not the proximate cause of conflicts, it is increasingly one of the ultimate causes. According to ADRP 3-07, "When the host nation cannot perform its roles (in providing essential services), military forces often execute these tasks directly."[11] U.S. military intervention could be ordered in the case of a failed state experiencing drought and famine. When engineers are assigned transformation tasks to establish long-term development, they should consider MAR as a project with long-term stability benefits. The relatively simple infrastructure requirements for check dams and infiltration basins allow local, unskilled labor to assist in construction; benefit the local economy during construction; and alleviate the initiation of large-scale projects that require dedicated, technical host nation support. MAR projects provide a positive example of U.S. and host nation government cooperation for citizens who may otherwise have little reason to believe in the good will of the relationship.

MAR projects establish and strengthen local infrastructure. Check dams require occasional repair, while check dams and infiltration basins require periodic removal of silt layers to restore infiltration rates. Like other types of water infrastructure, MAR projects serve a common good. Stakeholders and local government should be encouraged to form a mutual agreement for maintenance, creating a starting point for trust and strengthening the role of governmental institutions. MAR projects like those discussed are sustainable in that local labor can maintain and use the project after military intervention ceases. Examples of how institutional issues should be addressed are concisely stated in United Nations educational, scientific and cultural organization publications like "Strategies for Managed Aquifer Recharge (MAR) in Semi-Arid Areas". [12]

Conclusion

MAR projects should be considered when military engineers plan reconstruction programs. MAR promotes water security, which acts as a stabilizing force—especially in semiarid and arid regions. Benefits of MAR projects include—

- Creation or enhancement of the underground volume of water, which can be extracted during droughts or dry seasons.
- Low-cost infiltration basins and check dams and minimal infrastructure requirements with designs tailored to local conditions.
- Increased aquifer recharge, demonstrated here with an approximate doubling of groundwater recharge (from 70.33 cubic meters to 150.33 cubic meters per storm event) in modeling simulation.
- Project sustainment by local populations, without continual outside assistance.

The U.S. Army Corps of Engineers has the required skills to assist with reachback requests to determine groundwater flow, including questions about the development of the Department of Defense Groundwater Modeling System.

Endnotes

[1]Christopher Ward et al., "Water Resources Management in Yemen: Contribution to the CDR Yemen," *World Bank Archives,* 2000.

[2]Andrew Maddocks et al., "Ranking the World's Most Water-Stressed Countries in 2040," *World Resources Institute*, 2015.

[3]ADRP 3-07, *Stability,* 31 August 2012.

[4]Ian Gale (editor), "Strategies for Managed Aquifer Recharge (MAR) in Semi-Arid Areas," United Nations Educational, Scientific, and Cultural Organization, International Hydrological Programme, 2005.

[5]M. B. Pescod, "Wastewater Treatment and Use in Agriculture (FAO Irrigation and Drainage Paper 47)," Food and Agriculture Organization of the United Nations, 1992.

[6]International Monetary Fund, "International Monetary Fund Annual Report 2013," 1 October 2013.

[7]California Code of Regulations, Title 20, Sections 1601–1608, *Toilets, Urinals, and Faucets Regulations,* 2016.

[8]Stanley Consultants, *"Bahman Check Dams Design Report,"* Sana'a Basin Water Management Project, Sana'a, Republic of Yemen, 2006.

[9]Ahmed Alderwish, "Induced Recharge at New Dam Sites-Sana'a Basin, Yemen," *Arabian Journal of Geosciences*, 2010, pp. 283–293.

[10]Ahmed Alderwish, "Integrated Water Management for Small Catchments in Arid Mountainous Region–Yemen," *International Journal of Energy, Environment, and Economics*, Vol. 19, No. 6, 2011.

[11]ADRP 3-07.

[12]Gale.

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The Military Microgrid:

Today and Tomorrow

By Colonel Lisa Shay and Major Nicholas G. Barry

The U.S. Army needs to capitalize on the advantages of the microgrid-capable generation equipment already fielded to support sustained security force assistance operations and multidomain battles. Many users are unaware of the advantages of microgrids or how to use existing systems to form them. Establishing microgrids reduces fuel consumption up to 50 percent while simultaneously reducing maintenance requirements. Microgrids increase the resiliency of mission-essential systems by automatically responding to outages. The control systems required for microgrids easily integrate renewable energy sources and batteries, further reducing logistical requirements. The fielding of microgrid-capable generators reduces logistical requirements and allows the integration of diverse silent and fuelless energy sources.

In support of security force assistance operations, the U.S. Army runs several hundred small military outposts throughout Africa, Europe, and the Middle East. These facilities provide essential life support and force protection but cannot function without reliable electrical power. Commercial or tactical low-voltage diesel generators almost exclusively provide this electrical power. Even when available, local electrical grids tend to suffer from unreliability and poor power quality. Thus, most of these small bases are electrical islands (not connected to a local power grid on a consistent basis)—commonly referred to as microgrids.

However, the current electrical islands found on most Army outposts fall short of being true microgrids. The U.S. Department of Energy defines a microgrid as an autonomously functioning local energy grid with control capacity. Some microgrids have the capability to connect and disconnect from larger electrical grids. Creating a microgrid is not as simple as connecting two generators to be simultaneous contributors to the same load. Generator sets have two points of control: the governor and the exciter. The exciter regulates the generator's output voltage; the governor controls the speed of the engine (and real power output) to regulate frequency. A simple parallel connection of two generators causes immediate conflict between the two governors. The generators damage themselves as each attempts to regulate frequency. Each grid should have only one device attempting to regulate frequency. This is why true microgrids require centralized control.

International Organization for Standards (ISO) 8528-1: 2005, *Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets—Part 1: Application, Ratings and Performance,* provides guidelines for generator application, ratings, and performance. This standard recommends that diesel generators operate at 70 to 100 percent of their prime power rating.[1] For the long term, it is critical to keep the operating percentage above 40 percent of the prime power rating.[2] A recent study at the Massachusetts Institute of Technology Lincoln Laboratory found that most military generators operated at just 10 to 20 percent of their rated prime power load.[3] This low-percentage utilization leads to the incomplete combustion of fuel in diesel engines, known as *wet stacking*. Wet stacking causes increased fuel consumption, increased maintenance costs, increased emissions, and a significant reduction in fuel efficiency. Microgrids control functions can be used to minimize wet stacking, thus reducing fuel expenses, logistical force requirements, and maintenance requirements. Microgrids also reduce generator maintenance requirements by operating at higher load factors. This reduces service interruptions, the number of maintenance personnel needed, and the expense of repair parts.

Most military outposts tend to create isolated grids within the base, each connected to its own generator. This is partially a function of poor base planning, a general lack of knowledge about generators and power systems, an apprehension about affecting functioning systems, a lack of concern for fuel efficiency, and the urgency to maintain mission-essential services. Newer generation systems have the capabilities to form rudimentary microgrids, but Soldiers and leaders often lack the knowledge to properly set up and run these systems. A study of Cooperative Security Location (CSL) Garoua in Africa provides an excellent example of the need for a microgrid. In a July 2016 site survey, the CSL used nine generators that each averaged between 19 and 57 percent load and consumed a total of 425 gallons of fuel per day.

Fortunately, CSL Garoua has the latest force provider kit, which includes Advanced Medium Mobile Power Source (AMMPS) generator sets. Unlike the Army tactical generators, the AMMPS sets can work cooperatively by having one or more of the generators set to produce constant current (and thus constant power, given a constant voltage) and having only one generator regulating frequency with the governor. Two AMMPS generators can power a CSL microgrid. One AMMPS generator would be set to its maximum rated current output (its most efficient operating point), and the other would maintain frequency by using its governor to regulate the real power in response to changes in demand.

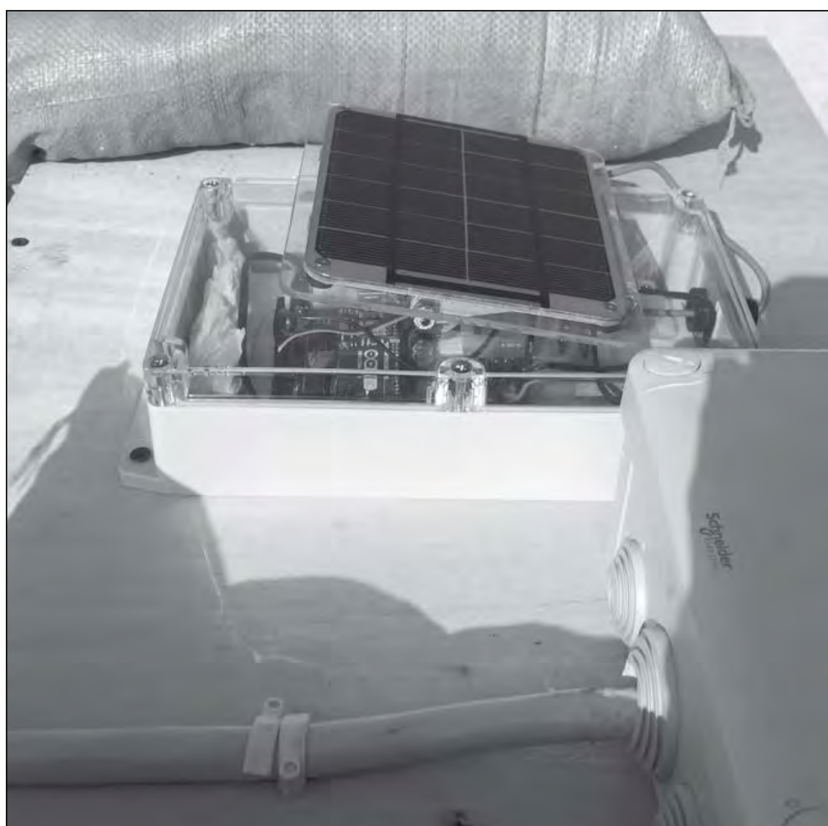
The formation of a microgrid could reduce yearly fuel consumption cost by more than 50 percent, or $315,000. When mission accomplishment is paramount, cost reductions and other monetary concerns rarely drive military missions. For CSL Garoua, a microgrid could reduce fuel deliveries by 32 yearly 2,500-gallon truck missions, a 50 percent reduction. An impact of that scale results in reduced requirements for logistical personnel and equipment, which in turn saves the Army even more money. In combat environments, there is also the opportunity for cost savings of security forces that are no longer needed to support the eliminated fuel delivery missions. In force cap-constrained theaters, this allows room for more combat Soldiers. Microgrids also increase redundancy for mission-essential systems. If a generator goes offline for any reason, another generator connected to the grid quickly activates to take over, which is an improvement on current setups that require human intervention.

The integration of photovoltaic (PV) generation using solar panels is another significant benefit of forming microgrids. Connecting solar panels to small loads and having generators sprinkled throughout the base (as done currently) would exacerbate system fuel inefficiency and possibly increase fuel consumption. However, a microgrid can shut down generators as necessary during peak solar generation hours so that they always operate in an efficient region and meet demand. While CSL Garoua's location near the equator makes it an ideal candidate for PV generation, solar radiation varies with the seasons, weather, and other factors. CSL Garoua could install a 300-panel, 100-kilowatt solar array in an area of only 6,500 square feet. Analysis of data collected from 2016 to 2017 indicates that such a system would create an average yearly fuel cost reduction of $45,600, or five additional 2,500-gallon fuel trucks. While a PV system requires an initial investment of capital, the pay-off period is estimated to be just 2 years. Establishing a microgrid with existing equipment produces a cost reduction six times higher than PV generation and requires significantly less capital investment and transportation assets.

While the AMMPS generators provide excellent capabilities to help establish microgrids and realize efficiency and redundancy improvements, they are not a complete solution. The requirement for trained users to frequently provide human intervention contributes to the limited formation of microgrids with AMMPS generators. The system requires a more sophisticated and networkable control system to capitalize on the benefits of microgrids. The AMMPS generators have extremely limited remote operation capabilities and cannot work autonomously to start up, operate in parallel, and shut down to meet demand. The lack of automation requires action by trained Soldiers and makes PV integration more complicated. Additionally, the AMMPS generators do not contain the robust cyber protections necessary for any potentially networked military device.

Also, the AMMPS generators do not have provisions to integrate batteries. In time, battery technology will progress to the point where it will be advantageous for the military to invest in it. However, weight, volatility, and short life cycles do not currently make microgrid scale batteries advantageous for large-scale deployment. Future batteries promise silent, emission-free, and highly portable energy sources perfect for high-demand, short-duration applications such as communication or directed-energy weapons.

(continued on page 54)



Solar radiation meter

Strategic Broadening: The Berkeley Experience

By Captain Robert B. Howell and Captain Collin R. Jones

"We come from a society of improvisers—a society of innovators, tinkerers, problem solvers, techno-savvy at an early age; and independence of action comes natural to all Americans. Army training and professional education need to foster this initiative, not suppress it," said General Mark A. Milley, Army Chief of Staff, speaking at the Association of the U.S. Army Eisenhower Luncheon on 4 October 2016.[1]

The annual University of California Berkeley Strategic Broadening Seminar addresses General Milley's concern by educating selected Army leaders in an immersive experience. The unique, 12-day program takes place in the San Francisco Bay Area, the global epicenter for entrepreneurship and innovation. Former Army Chief of Staff General Raymond T. Odierno initiated the program to prepare Soldiers and Department of Defense civilians for future leadership roles in a variety of organizations. Several seminars ranging from 2 to 6 weeks in length are conducted annually across the globe. This article describes the authors' experiences at the Berkeley Strategic Broadening Seminar.

This seminar introduces commissioned, warrant, and senior noncommissioned officers and Department of Defense civilians to decentralized organizations; exposes them to the San Francisco technology ecosystem; and encourages interactions with the esteemed Berkeley faculty. Leaders learn how organizations thrive by remaining decentralized and empowering their members at all levels. Visits with numerous technology campuses and industry leaders give participants insight to different environments and leadership techniques that foster innovation. Discussions and practical exercises with Berkeley faculty members reinforce concepts and their application in military organizations. This unique opportunity provides a diverse program that lets graduates have an immediate impact on developing agile and adaptive leaders and organizations.

Decentralized Organizations and Mission Command

Ori Brafman, best-selling author of the books *Sway*[2] and *The Starfish and the Spider*,[3] is a principal facilitator of the program; he led several discussions about centralized and decentralized organizations. Brafman likened these types of organizations to starfish and spiders.

Starfish, like decentralized organizations, can lose a major portion of their bodies and still thrive.[4] The starfish body functions without a head like a group with no formal hierarchy. Decentralized organizations have no headquarters and lack a clear leader. There is no delineation of responsibility in a starfish organization; members do not report to a department head, but choose to accomplish any activity they deem relevant without approval.[5]

In centralized organizations, much like a spider, members rely on a head to provide orders and divide responsibility. Knowledge and power tend to concentrate at the headquarters; thus, the head makes decisions for the group.[6] Knowledge from the edge of a network, usually at the participant level, tends to accumulate "where the action is." U.S. Army doctrine addresses the need to use knowledge at the edge through effective mission command. According to Army Doctrine Reference Publication 5-0, *The Operations Process*, "mission command requires a command climate in which commanders encourage subordinates to accept prudent risk and exercise disciplined initiative to seize opportunities and counter threats within the commander's intent."[7] General Martin E. Dempsey, a Starfish Leadership Senior Fellow and former chairman of the Joint Chiefs of Staff, summarized the importance of starfish organizations best when he stated in 2010, "The past 8 plus years of war . . . taught us many things as an Army. One particular lesson we've learned is that decentralized threats are best countered by also decentralizing our own capabilities."[8]

Silicon Valley and the Technology Industry

The San Francisco Bay Area boasts several qualities, including having the Nation's largest concentration of research institutions, the highest density of venture capital firms in the world, the highest concentration of Fortune 500 companies in the country, and the highest level of patent generation in the Nation. It also holds the position as the world's top innovation center. Most of the industries in San Francisco and Silicon Valley are just minutes away from the Berkeley campus and provide an excellent opportunity for site visits. All the visits included a discussion about what the firms provide and their unique perspective on organization leadership.

The first visit of the seminar was to the offices of Andreessen Horowitz, a venture capital firm that provides funding and training to help companies grow and improve. The firm hosts companies like Airbnb©, BuzzFeed©, Facebook©, Lyft©, and Pinterest© in its venture and growth portfolio. The seminar continued to the campuses of Stanford University and Facebook. NetApp©, a data storage and management company, hosted seminar participants for lunch and was the site of the next visit. The first day of visits concluded with a tour of the Google campus and a discussion of some of the projects of the Alphabet, Inc.® X Program.[9]

The second day of visits began with a trip to downtown San Francisco to the offices of the NASDAQ© Entrepreneurial Center, a "nonprofit organization designed to educate, innovate, and connect aspiring and current entrepreneurs."[110] After a short walk, the group stopped at the offices of Salesforce©, a firm that offers customer relationship management applications for business.[11]

The seminar continued through downtown to the offices of LinkedIn© for lunch. LinkedIn manages the world's largest professional network on the Internet, hosting more than 500 million members.[12] The second day of visits concluded with discussions with leaders from the companies Reflektive© and Harmless Harvest©.

The Department of Defense realized the value of innovation in Silicon Valley and developed its own version of a start-up in the Bay Area. The Defense Innovation Unit–Experimental hosts a portfolio that includes projects in artificial intelligence, autonomy, information technology, and space.[13] Discussions with leaders from these organizations offered seminar participants valuable insights.

Seminar Curriculum

The seminar curriculum integrated Starfish Leadership and lessons learned from exposure to industry. It included lessons on—

- Developing design thinking.
- Building trust-based relationships.
- Practicing improvisational leadership. Design thinking shares similarities with the military decision-making process and emphasizes team collaboration. With regard to design thinking, Berkeley professor Dr. Clark Kellogg states: "The alternative to a linear thinking process that is taught in analytic business systems is one in which we are using simultaneous thinking and more broadly based thinking, generating many more alternative solutions for evaluation."[14] The design thinking process values diversity and multiple perspectives to extract insights, generate ideas, and design solutions and products. The process is valuable because of its inclusive approach that leverages the creativity of all team members while mitigating bias.

The lessons in building trust-based relationships included several activities and discussions that increased leader ability to enhance team cohesion and establish mutual trust. A common theme throughout these lessons was the emphasis on being consciously aware through active listening and valuing others.

Practicing improvisational leadership enhanced leader communication skills when dealing with unexpected and dynamic situations by demonstrating ways to seize the opportunities presented. Improvisational leadership is a flexible mindset that allows leaders to listen to what others say and to build upon their ideas to foster an environment of innovation and creativity.[15] An improvisational tool known as *Yes, and* can be used to accept the ideas of others while following up with an appropriate level of decisiveness.

The curriculum stayed true to the principles it taught by remaining flexible. A daily schedule was provided, but it was not rigid. This allowed leaders to spend more time on lessons and topics they found most interesting. The schedule's flexibility also enabled unexpected guests to insert themselves in the curriculum and offer their insight on the various leadership and innovation discussions and exercises.

Conclusion

The 2-week University of California Berkeley Strategic Broadening Seminar addresses General Milley's concern for fostering innovation through its immersive introduction to Starfish Leadership, visits to industry innovators, and a diverse curriculum. Army leaders must implement the principles of the starfish philosophy in their organizations to empower members and remain agile. Interactions with numerous Silicon Valley companies and leaders provided insight on the characteristics of an innovative environment. The seminar curriculum is full of lessons and activities delivered by accomplished faculty members who empower participants with unique tools and ideas to improve their organizations and leaders. We recommend that leaders continue to attend this annual seminar to learn the ideology and become a driving force for innovation in the Army.

Endnotes:

[1]Mark A. Milley, "Dwight David Eisenhower Luncheon," 4 October 2016, <https://www.ausa.org/events/ausa-annual-meeting-exposition/sessions/dwight-david-eisenhower-luncheon>, accessed on 8 March 2018.

[2]Ori Brafman and Rom Brafman, *Sway: The Irresistible Pull of Irrational Behavior,* Crown Business, New York, New York, 3 June 2008.

[3]Ori Brafman and Rod A. Beckstrom, *The Starfish and the Spider: The Unstoppable Power of Leaderless Organizations*, Portfolio, New York, New York, 5 October 2006.

[4]Ibid., p. 35.

[5]Ibid., p. 48.

[6]Ibid., p. 49.

[7]Army Doctrine Reference Publication 5-0*, The Operations Process,* 17 May 2012.

[8]Martin Dempsey, "The Army's Starfish Program and an Emphasis on Decentralization," 19 April 2010, <http://smallwarsjournal.com/blog/the-armys-starfish-program-and-an-emphasis-on-decentralization>, accessed on 8 March 2018.

[9]"What We Do," <https://x.company/about/>, accessed on 8 March 2018.

[10]"NASDAQ Entrepreneurial Center," <http://thecenter.nasdaq.org/about-us/>, accessed on 27 October 2017.

[11]"What is *Salesforce*?" <https://www.salesforce.com/products/what-is-salesforce/>, accessed on 8 March 2018.

[12]"About LinkedIn," <https://press.linkedin.com/about-linkedin?trk=uno-reg-guest-home-about>, accessed on 8 March 2018.

[13]"Defense Innovation Unit Experimental," <https://www.diux.mil/portfolio>, accessed on 8 March 2018.

[14]Neelima Mahajan, "Design Thinking Demystified: An Interview with Clark Kellogg," 26 September 2013, <http://knowledge.ckgsb.edu.cn/2013/09/26/management/design-thinking-clark-kellogg/>, accessed on 8 March 2018.

[15]"Leadership Communication," <http://haas.berkeley.edu/CTE/documents/instructional-support/Redacted%20Sample%20Syllabus%20Leadership%20Communication_Fall %202014.pdf>, accessed on 8 March 2018.

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("Military Microgrid," continued from page 51)

The emergence of multidomain battle likely means that future battlefields will look nothing like the system of combat outposts that now litter Iraq and Afghanistan. However, many of those outposts will remain an essential part of security force assistance and other partnership operations throughout the world. Microgrids can significantly reduce fuel and maintenance requirements for these bases. They can take on a diverse array of power sources such as battery systems, which operate silently and provide an uninterrupted power supply, or PV systems, which produce electricity without any fuel requirements. These generators create more resilient power networks that will suffer fewer outages to mission-essential equipment. The AMMPS generators are a step in the right direction but are not a complete solution. The system lacks an automated control system to leverage the full benefits for microgrid formation.

Microgrids are also relevant for multidomain battle. Small, dispersed units must coalesce for large operations. The formation of microgrids during these times, no matter how brief, can create significant fuel consumption reductions. Reduced fuel consumption extends operational range and reduces logistics support requirements. The Army should develop true microgrids to reduce fuel consumption and maintenance requirements, integrate diverse energy sources, and increase resiliency for mission-essential systems.

Endnotes:

[1]ISO 8528-1: 2005, *Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets—Part 1: Application, Ratings and Performance,* 23 August 2007.

[2]Ibid.

[3]S.V.T. Nguyen et al., "Tactical Power Systems Study," Technical Report 1181, Massachusetts Institute of Technology Lincoln Laboratories, Lexington, Massachusetts, 19 May 2014.

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ENGINEER WRITER'S GUIDE

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Articles should be concise, straightforward, and in the active voice. Avoid using acronyms when possible. When used, acronyms must be spelled out and identified at the first use. Avoid the use of bureaucratic jargon and military buzzwords. Text length should not exceed 2,000 words (about eight double-spaced pages).

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Include photographs and/or graphics that illustrate information in the article. Graphics must be accompanied by captions or descriptions; photographs should also be identified with the date, location, unit/personnel, and activity, as applicable. Do not embed photographs in Microsoft® PowerPoint or Word or include photographs or illustrations in the text; instead, send each of them as a separate file. If illustrations are created in PowerPoint, avoid the excessive use of color and shading. Save digital images at a resolution no lower than 200 dpi. Please see the photo guide at <http://www.wood.army.mil/engrmag/Photograph%20Illustration%20Guide.htm> for more information.

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Provide a short paragraph that summarizes the content of the article. Also include a short biography, including full name, rank, current unit, job title, and education; U.S. Postal Service mailing address; and a commercial daytime telephone number.

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Property Accountability Virtual Playbook: The Right Tool at the Right Time

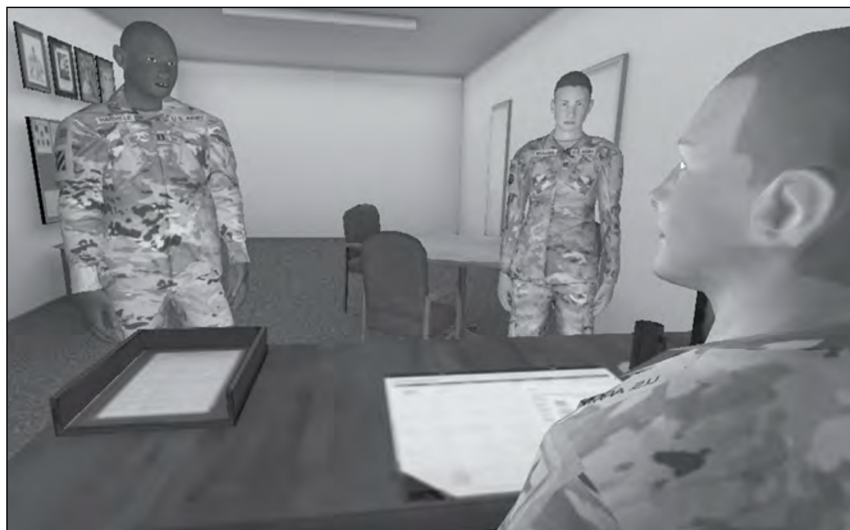
By Captain Matthew J. Johnson

Improving Property Accountability

In January 2017, the Logistics Training Department, U.S. Army Quartermaster School, Fort Lee, Virginia, began an initiative to create a Property Accountability Virtual Playbook (PAVPB). The playbook is an online, computer-based training resource that promotes property accountability and improves Army readiness.

Army leaders have the responsibility to achieve and sustain Army readiness, ensuring that Soldiers have the right types and quantities of equipment needed to "fight tonight." Department of the Army investigations of excess equipment and financial liability of property loss derived from inventories indicate that the Army is attacking the problem but that challenges remain with Soldier knowledge of property accountability principles.

To address the knowledge gap, the U.S. Army Combined Arms Support Command (CASCOM), Fort Lee, and the Quartermaster School assembled a team of experts spanning several different organizations to design and develop the interactive training product with an overall objective of improving property accountability across the Army. "CASCOM is here to help our units in the field," the Quartermaster General, Brigadier General Rodney D. Fogg, stated. "The Property Accountability Virtual Playbook is the right tool at the right time to help our junior leaders succeed," he added.



PAVPB briefing

PAVPB bay

Interactive Training

PAVPB is an interactive, virtual, 3D training resource that teaches users about property accountability by demonstrating the proper way to conduct a change-of-command inventory. The target audience for PAVPB is nonlogistician leaders across the Army, from commanders to sub-hand receipt holders.

Strykers in the desert

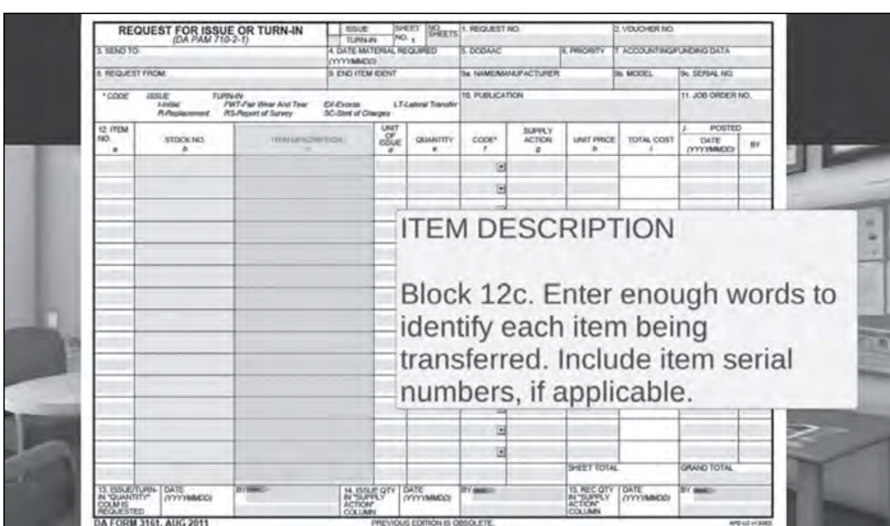
PAVPB focuses on the change-of-command inventory (a vital inventory that is conducted at the tactical level) to demonstrate proper property accountability techniques. A company commander is fully dedicated to property accountability for all equipment in the unit at the time of the inventory. The change-of-command inventory forms the baseline inventory process for inventory types, to include cyclic and sensitive-item inventories. The PAVPB user learns about the people, property, and processes that are encountered during the preinventory, inventory, and postinventory phases of a change-of-command inventory.

Relevant Resources

According to Chief Warrant Officer Five Jonathan O. Yerby, Quartermaster School Regimental Chief Warrant Officer, “Interactive digital media is a force multiplier, and it is how young people learn.” PAVPB is a digital training enabler that allows users to participate in interactive inventories of a Stryker armored vehicle, Abrams tank, and three different weapon systems. PAVPB also includes tactics, techniques, and procedures and best practices that have been collected from units and subject matter experts across the Army. It explains the roles of officers, warrant officers, and noncommissioned officers who are involved in the change-of-command process, ensuring property accountability. With the Army transition from the Property Book Unit Supply Enhanced System to the Global Combat Support System–Army (GCSS–Army), PAVPB familiarizes the user with the new GCSS–Army terminology. It also links users to valuable property accountability and Command Supply Discipline Program resources and references to assist those with property responsibility across the Army.

Teamwork and Collaboration

The collective efforts of numerous organizations, including the Maneuver Center of Excellence, Fort Benning, Georgia; the U.S. Army Ordnance School, Fort Lee, Virginia; and the GCSS–Army developers, Midlothian, Virginia, yielded impressive results toward the creation of a final product. Great care was taken to ensure that PAVPB is user-friendly and does not require a common access card. The end product is also intended to be adaptable for mobile versions and touch screen deployment in the future. PAVPB will be published on multiple platforms, including Sustainment One Stop, Army Training Network, and additional public Web sites. After receiving feedback from the field and incorporating the beta testing results, PAVPB was made available across the Army. PAVPB provides Soldiers with a valuable resource that delivers training on property accountability and promotes Army readiness. It can be accessed at <http://www.cascom.army.mil/index.htm>.



Sample PAVPB turn in form

Captain Johnson is the operations officer for the 262d Quartermaster Battalion, U.S. Army Quartermaster School. He holds a bachelor’s degree in political science from Norwich University, Northfield, Vermont.

Horizontally and Vertically
Developing Engineer Leaders:
Increasing the Size of the Toolkit and Improving the Craftsmanship of the Engineer

By Captain Guillermo J. Guandique and Captain David G. Weart

The engineer carpenter squad toolkit provides the tools necessary to construct and rebuild facilities. The carpenter's mind is part of that toolkit. The mind is the repository for the knowledge gained through the commissioning source and the Engineer Basic Officer Leadership Course. These are the tools used to construct solutions and rehabilitate organizations. Attending training, participating in job rotation, and completing professional development are ways to add to the toolkit. The ability to solve complex problems in the operating environment increases as the size of the toolkit grows. When a leader develops horizontally, the number and type of tools available increase. Subsequently, vertical development increases the size of the toolkit and refines the quality and effectiveness of the leader. The intentional integration of horizontal and vertical development of engineer leaders can accelerate the capacity to lead effectively in volatile, uncertain, complex, and ambiguous environments.

Engineer leaders expand their toolkits and refine their skills through intentional activities in a conducive setting that fosters horizontal and vertical development. For this article, vertical development is defined as an engineer leader's increased capacity to think, solve problems, and lead in strategic and interdependent ways. Job progression and additional professional military education are critical elements in building leaders in the Engineer Regiment but are not the primary vehicles for vertical development. Research on the topic by the Center for Creative Leadership concludes that leadership programs focused on vertical development increase self-awareness, the ability to solve complex problems, and critical thinking skills.[1]

When considering leader development, the default vehicles for growth include additional schooling, job rotations, and professional development opportunities. These myriad experiences provide new tools to add to the toolkit and provide different approaches to solve problems and help develop organizations. As the problems they encounter grow in complexity throughout their professional careers, engineers acquire more tools. The refined ability to be successful in a job is often learned from experience. As the operating environment evolves, the engineer Soldier must realize that the ways of problem solving must evolve concurrently. The capacity to solve complex problems must be greater than the tendency to create them.[2] Engineers possess the necessary knowledge, skills, and abilities; however, some problems require a greater perspective and a better way to use the available skills. When knowledge, skills, and abilities are learned, the engineer Soldier develops horizontally, across the domain of the current way of thinking.[3] Vertical development occurs when the "ability to think in more complex, systemic, strategic, and interdependent ways" is learned.[4] In other words, developing vertically offers a greater, more sophisticated use of tools in the toolkit. The impetus to grow vertically comes when the current way of thinking is insufficient to solve the problems faced.

Captain Weart administers the commissioning oath to a newly commissioned second lieutenant.

Horizontal and vertical development are not mutually exclusive—they complement each other. When a new lieutenant goes to a training course, new information is learned, new skills are acquired, and new competencies are brought back to the unit. How the new knowledge is applied ultimately determines the effectiveness of the time invested in training and growth. Leaders must recognize that a subordinate's acquisition of new skills and competencies may not always be as obvious as a tab or skill badge. Otherwise, the potential for more effective use is left behind. The goal is to challenge leaders to solve problems using new skills, competencies, and information that requires a more sophisticated way of thinking. Challenging leaders just outside of their current capacity and capability stimulates growth and development.

A U.S. Military Academy tactical noncommissioned officer facilitates a discussion on the principles of counseling to a group of cadets.

Vertical development requires the suspension of a performance-oriented mindset and the adoption of a learning-oriented posture. Leaders must be willing to accept risk and allow subordinates to explore innovative solutions. A learning orientation promotes accelerated development by allowing individuals to explore unique and interdependent ways to solve problems. The lessons and competencies that a leader learns through vertical development may not surface until transition to a new duty assignment. Vertical development ensures that the Army as an enterprise maintains a competitive advantage by developing and retaining quality leaders.

Increasing the capability of an engineer leader to learn new skills and competencies increases the size of a leader's toolkit. Adopting a variety of problem-solving skills such as strategic thinking and critical reflection refine a leader's craftsmanship. In order to operationalize vertical development at the unit level, we propose a practical model. The techniques that we routinely use in our own practice of developing leaders include—

- Challenging assignments that are just beyond one's ability to complete.
- Engaging coaching relationships.
- Structured reflection.

Vertical development occurs when we engage in an experience that challenges the current way of thinking. The engineer encounters different perspectives and engages in coaching to help adapt to new ways of thinking. Army doctrine publications address all three techniques as the ways and means for developing leaders; implementation requires intentional and tactical patience by the leadership.

Tactical officers at the U.S. Military Academy are the integrators of West Point's four developmental programs—academic, character, military, and physical. Teaching these developmental programs is not always operationalized by introducing new material to cadets, but rather by coaching them through the complex problems they face by using the skills and abilities taught at the academy. Assigning the best cadet to the most challenging position or task may not always be what is most beneficial to the Army as an organization and to the individual as a growing leader. Deliberate pairing of cadets to positions that will challenge them just beyond their current abilities can be the impetus for development. The challenge for leaders and leader developers goes beyond assigning positions. It involves the deliberate coaching relationship in which we engage to help cadets through the challenge and the structured reflection that we facilitate to solidify growth. In the operational Army, leader developers can engage in the same practice by assigning challenging jobs and tasks that are just beyond the capacity of an individual. These stretch assignments create a stimulus for growth within the individual, providing him or her with the opportunity to be successful.

An example that is relevant to the Engineer Regiment might be the assignment of a newly tabbed "sapper-qualified" second lieutenant with the task of developing and validating a sapper train-up program for the entire battalion. Fresh out of the course, the newly tabbed sapper will have the technical and tactical expertise necessary, but may need to develop the interpersonal and critical-thinking skills required of staff officers. This project will require engaging multiple stakeholders, determining requirements, monitoring training, and certifying leaders. Without proper support from seasoned leader developers, junior engineer lieutenants may not have the capacity or wisdom to develop an entire training program for a battalion size element. The leader developer's role in this process is to provide support as the individual is exposed to different perspectives and adapts to his or her own internal change. In order to catalyze horizontal and vertical growth, leader developers assume a coaching position to guide developing leaders through their problem-solving efforts.

Developmental coaching helps leaders through tasks and improves personal qualities. Research on expert performance indicates that coaching relationships that provide truly candid feedback on leader behavior can accelerate learning and growth to higher levels of performance.[5] Coaching relationships internal to an organization should take place outside of the chain of command to avoid the perception of interference with a leader's evaluation report. A unit-sponsored coaching program aligns leaders outside of their organic chains of command and ideally assigns junior leaders with more senior leaders as coaches. Referring to

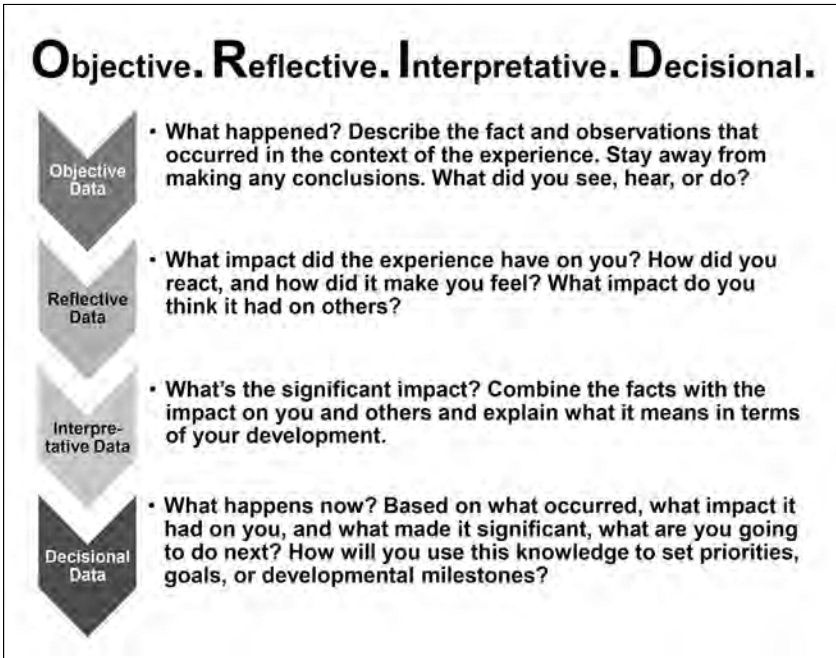


Figure 1. Four-part framework guideline

the earlier example, the lead of the sapper program project would receive coaching from a senior officer outside of the direct chain of command. Underpinned by a relationship of trust and mutual respect, the goal of the coach would be to facilitate learning and methods of thinking and to provide feedback related to the approach in developing the train-up program. When we are coaching cadets, using open-ended questions facilitates discovery and provides subtle suggestions about how they might approach a challenge differently. The benefits of coaching to the individual and the organization are endless. Successful coaching relationships help break down organizational barricades, share best practices for leader development, and provide additional repetitions for leaders to develop their interpersonal skills. As the coach provides a thought partner for the young leader, engaging in a structured reflection practice promotes meaning and making and gaining self-awareness.

In his classic work, *On Becoming a Leader*, Warren Bennis writes that "In order for leaders to look forward with acuity, one must first look back with honesty."[6] Bennis stresses that the true understanding of one's actions is garnered through structured reflection and a Socratic internal dialogue. Solitude is not necessarily synonymous with the operational tempo and the demands placed on Army leaders. Finding quiet time to record in a journal may be a luxury that some do not have. Recognizing the constraints of time (adopting the four-part objective, reflective, interpretive, decisional questioning framework) is a time-effective technique when guiding a subordinate through a personal coaching or structured reflection session. When reflecting on an experience, objective questions help determine what actually happened and define the role that the leader had in the outcome. Reflective elements focus on the leader's emotional response to an event and help the leader recall what he or she was feeling during the experience. Interpretive analysis requires critical thinking to determine the value, meaning, and lessons learned. Decisional inquiries are action-oriented and focus on the next steps the leader must take in applying the lessons learned and new levels of thinking. In the previously mentioned scenario, the second lieutenant would conduct a personal reflection session using the objective, reflective, interpretive, decisional framework following his or her final briefing to the battalion commander and after the program's first iterations. Figure 1 illustrates the four-part framework.

Intentional leader development is strategic and imperative for the growth of each individual engineer leader and the health of each organization in the Regiment. Leader development of every engineer, officer, noncommissioned officer, enlisted Soldier, and Department of the Army civilian, helps ensure our competitive edge as the Army's tool for delivering unique effects on battlefields and construction sites. When designing the organization's leader development plans, engineer leaders must combine the elements of horizontal and vertical development. Doing so unleashes the leadership potential from every team member and increases the capacity of the Engineer Regiment to accomplish its diverse set of missions in a dynamic operating environment.

Endnotes:

[1]Nick Petrie, *Vertical Leadership Development—Part 1, Developing Leaders for a Complex World*, Center for Creative Leadership, 2014.

[2]Ibid.

[3]Ibid.

[4]Ibid.

[5]A. Ericsson, "The Making of an Expert," *Harvard Business Review*, July 2007.

[6]Warren Bennis, *On Becoming a Leader*, Perseus Books Group, New York, New York, 2009.

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