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Front cover: South Dakota Army National Guard engineers construct a Heavy Dry-Span Bridge (HDSB) during a 3-day training exercise.

Back cover: Best Sapper Competition 2015 held at Fort Leonard Wood, Missouri. Photos by Melissa Buckley.

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Clear the Way

Brigadier General Anthony C. Funkhouser
Commandant, U.S. Army Engineer School



This is the last time I'll write this Clear the Way column from the commandant's office. I am writing this at the conclusion of the 2015 Senior Engineer Leader Conference; and I want to thank everyone who put the event together, including senior leaders from across the Engineer Regiment, the alumni, the Gold Star Families, and the Best Sapper competitors who made it a first-class event.

I have been honored to have served as your 95th commandant for the past 2 years. Michelle and I are grateful for the opportunity you gave us to serve. But it's time to go and relinquish responsibility to Colonel James and Elizabeth Raymer, who will most assuredly take the U.S. Army Engineer School and the Engineer Regiment to the next level.

Someone asked me recently what I enjoyed the most as commandant. I answered that it was engaging with young engineers and leaders and hearing their feedback, their opinions, their stories, and their optimism for the future. In addition, seeing our team working initiatives and actions across the Army and having a real impact has been a pleasure.

If I had to assess where we are, I would say that the Engineer Regiment remains healthy across all three components, with transitioning to the brigade engineer battalions, establishing the geospatial intelligence cells, finishing the echelons-above-brigade construction company force design update, and starting the combat engineer company redesign. We transitioned from Operation Desert Storm-era Bradley systems to the M2SA/M2A3 Bradley fighting vehicles in the armored brigade combat teams. We are replacing the M113 armored personnel carrier and fielding Volcano mine delivery systems back to the armored brigade combat teams in the short term while we work the larger family of scatterable mine replacement over the next decade. We have also received Army level guidance on the way ahead with the armored combat excavator and its replacement system.

What does the future hold for our Regiment? I see a continual transition toward the Army Operating Concept. We will focus on leader development, with emphasis on credentialing, education, certification, and licensing to raise technical competence. I anticipate that our broadening opportunities will remain and be a critical part of career development. I see these factors keeping our military occupational specialty fill strong across the force. People will want to be part of this and to challenge themselves. I see an ever-increasing level of technical competency and qualifications for our commissioned and noncommissioned officers that will serve them well in uniform and when they depart. I think that we will be completely gender-integrated—with a common physical standard—in the next year and that we will continue to deliver on all of our missions. We are driving toward more instructor and leader exchanges with joint, interagency, and coalition partners across the training base and in the operational force. I think that we will see continued demand for engineers in the operational force, which could impact our structure within the divisions again. I see engineer mission sets expanding as we have to support decisive action, provide domestic support, and conduct search-and-rescue operations within our unified land operations. I expect that we will replace our current terrain-shaping capabilities with network munition initiatives. We will see smart munitions employed differently, and we will need to develop new concepts. We will see more robotically operated equipment to increase the safety of our Soldiers. We will also see continued improvements to our detection, reconnaissance, and communications capabilities. All of these efforts will make engineers more indispensable than ever on the battlefield.

(Continued on page 4)

"I see engineer mission sets expanding as we have to support decisive action, provide domestic support, and conduct search-and-rescue operations within our unified land operations."

Lead the Way

Command Sergeant Major Butler J. Kendrick, Jr.
Regimental Command Sergeant Major



Hail to the Engineer Regiment! First, let me say how fortunate I have been to serve in this assignment with you—the Soldiers, Civilians, and Families of this awesome organization—and engage with you across all components (Regular Army, Army National Guard, U.S. Army Reserve) and the U.S Army Corps of Engineers.

Unfortunately for me, this is my last article as 17th regimental command sergeant major and I want to thank every junior enlisted Soldier and all junior and senior leaders for what you do every day to lead your units and support the Engineer Regiment and the U.S. Army.

As we continue to transition after 13 years of continuous combat, please ensure that recovery and refit are your top priorities so that we remain ready for our critical role in supporting the Nation. As leaders, we owe our formations the diligence to protect them from undue uncertainty in their lives. We must protect Soldiers and Families to safeguard the human dimension of our forces.

Some of our Soldiers, including leaders, are dealing with battlefield wounds and other issues that threaten our level of performance, professionalism, and duty if they are not addressed. The challenges I see are recruitment, retention, suicide prevention, safety, training, and sexual harassment and rape prevention. Leaders have to work to communicate across the ranks today more than ever. There are many leaders who are not taking the time to talk to their Soldiers to make sure that the message is propagated throughout the chain of command. As word of the new Army Operating Concept (U.S. Army Training and Doctrine Command Pamphlet 525-3-1, *The U.S. Army Operating Concept*)[1] continues to spread through our ranks, let's take this message away from it: To prepare and win in a complex and uncertain world, the most important factor is the Soldier. I encourage you to make sure you read and know the human dimension concept (U.S. Army Training and Doctrine Command Pamphlet 525-3-7, *The U.S. Army Concept for the Human Dimension in Full Spectrum Operations*)[2] and continue to develop our leaders.

Stay adaptive and agile, and innovate and develop our leaders to remain the best the Army has to offer. Remember these points and employ them to develop your subordinate leaders to the next level:

- Lead by example.
- Develop leaders.
- Set the environment.
- Establish critical and creative leaders.
- Be an agile leader.
- Learn the art and science of mission command.
- Develop subordinates two levels down.

I couldn't have imagined a better way to end my journey as your regimental command sergeant major than the Senior Engineer Leader Conference here at Fort Leonard Wood, Missouri. Leaders from across the Engineer Regiment collaborated on critical topics, including combined talent management, capturing lessons learned, and regimental history. Additionally, the Army Engineer Association vendor display was an important opportunity for Soldiers to interface with the newest battlefield technologies. I would be remiss if I did not mention the 1st Engineer Brigade and the U.S. Army Engineer School for paying final honors to Major General Harold J. Greene, Sergeant First Class Ramon S. Morris, and Specialist Wyatt J. Martin during a moving ceremony as their names were added to the Engineer Memorial Wall. The Best Sapper Competition was extraordinary and rivaled all previous years in scale and execution. The 2015 Best Sapper Competition winners are First Lieutenant Daniel L. Foky and Sergeant Brandon Loeder from the 127th Engineer Battalion, Fort Bragg, North Carolina. Let me thank all leaders for the support of their units and their participation from across the globe. With 46 teams competing, this was the best turnout in the event's history.

Let me also welcome Command Sergeant Major Bradley J. Houston, your 18th regimental command sergeant major. I know you will provide him the same type of professionalism, commitment, and genuine support you have given me for the past 2 years.

Command Sergeant Major Houston, you will do great things for our Soldiers and for the betterment of the Engineer Regiment. In addition to the 95 former commandants and 17 regimental command sergeants major watching you

from somewhere, there are approximately 95,000 Soldiers. No pressure! On a more serious note, I have the utmost confidence in your capabilities and am sure you will do an extraordinary job.

Teammates, Sapper 7 fading out. Thanks for letting me serve this superb team. *Essayons*, Army Strong!

Endnotes:

[1]U.S. Army Training and Doctrine Command Pamphlet 525-3-1, *The U.S. Army Operating Concept: Win in a Complex World*, 31 October 2014.

[2]U.S. Army Training and Doctrine Command Pamphlet 525-3-7, *The U.S. Army Concept for the Human Dimension in Full Spectrum Operations,* 11 June 2008.

("Clear the Way," continued from page 2)

And all the while, engineers will help lead the way and solve the Army's challenges now and into the future. The future of the Engineer Regiment is bright, and we remain a regiment of opportunities. I challenge you to take advantage of them as you move along this profession of arms. Realistically, the Army will face some very challenging times as our leaders balance personnel, readiness, and modernization accounts. I urge you to trust our leaders to make the best possible decisions and to focus on ensuring that your personnel and organizations are trained and ready to provide engineer support to the Army, the joint force, and the Nation when called upon to do so.

I want to conclude by thanking a number of team members because we all know it's a team effort. Our regimental network is a strength, and I've been impressed at our ability to share information and awareness across the force.

To the U.S. Army Engineer School, 1st Engineer Brigade, Office of the Chief of Engineers, and Maneuver Support Center of Excellence team, thank you for your leadership and professionalism. You are the few but the mighty who help drive so many topics. Thanks to all the senior engineers across the force from the Department of the Army, U.S. Army Forces Command, U.S. Army Training and Doctrine Command, U.S. Army Human Resources Command, U.S. Army Cadet Command, the Army National Guard, the U.S. Army Reserve, the U.S. Army Corps of Engineers, and the combatant commands; you are the best of our Army, and you are making a positive difference for our Soldiers across the Army. Thanks to our Army civilian workforce, alumni, contractors, the Army Engineer Association, and the Society of American Military Engineers for your partnerships and selfless commitment to excellence. Thanks to our Honorary Colonel, Major General Randal R. Castro (Retired); Honorary Command Sergeant Major, Command Sergeant Major Robert M. Dils (Retired); and Honorary Chief Warrant Officer, Chief Warrant Officer Five Michael A. Harper (Retired).

Special thanks go to our managing editor, Ms. Diane E. Eidson, who will retire after this issue with 41 years of service to the Engineer Regiment. We will miss you.

I would like to add a final word of personal thanks to my current lineup: Command Sergeant Major Butler J. Kendrick, Jr., Chief Warrant Officer Five Scott R. Owens, Colonel Glenn A. Kiesewetter, Colonel David T. Theisen, Colonel Heather J. Warden, Lieutenant Colonel Adam M. Calderon, Lieutenant Colonel Lars N. Zetterstrom, Mr. James R. Rowan, and the entire U.S. Army Engineer School team. The Regiment is forever better for your leadership and collaboration. Thank you for allowing me to serve as your commandant.

Essayons!



Show the Way

Chief Warrant Officer Five Scott R. Owens
Regimental Chief Warrant Officer



As I write this, it is April 2015 and the Engineer Regiment has just concluded the Senior Engineer Leader Conference and the Engineer Regimental Ball. The conference was a great success, and leaders participated in person and via Defense Connect Online. The theme for this year, "Shaping Engineers to Win in a Complex World," was designed to show how the Engineer Regiment is transforming to support the Army Operating Concept—Win in a Complex World.

If you haven't read U.S. Army Training and Doctrine Command Pamphlet 525-3-1, *The U.S. Army Operating Concept*, I encourage you and your Soldiers to do so.[1] It's a candid acknowledgement that the future is unpredictable and unknowable and that the operational environment will be complex. The Army cannot restrict itself by trying to predict the adversary and nature of the next conflict and then design a force to meet that predicted threat. Instead, it needs a force that is able to conduct joint, combined arms operations with Soldiers, leaders, and teams that thrive in environments of uncertainty and danger. In short, the Soldier is the weapons system in which the Army is investing.

The Army Operating Concept describes how emerging technologies promise to improve future force combat effectiveness. It discusses the need to identify, develop, and integrate technological improvements to contribute to the Army's differential advantage over potential adversaries. However, it also warns of challenges in overcoming enemy efforts to copy or counter our technological edge. Warrant officers, by the nature of their role as technical experts, will be a major weapon in the Army arsenal to address these challenges. Warrant officers are the experts in integrating technology within the operational and institutional forces. The Army is working on several fronts to develop its warrant officer cohort so that it will be ready to adapt to the changing, challenging, and complex environment that will be the norm.

The Army Senior Warrant Officer Council (of which I am a voting member) has drafted a document entitled "Warrant Officer 2025." It is a concept document that reinforces the themes identified in the Army Operating Concept and is intended to illustrate the vision for accessing, training, equipping, and developing Army warrant officers to thrive in the future. The School of Advanced Leadership and Tactics at the U.S. Army Combined Arms Center, Fort Leavenworth, Kansas, is leading collaborative work between training developers at centers and schools across the U.S. Army Training and Doctrine Command. It is developing common core content to give Army warrant officers a common baseline of tactical, operational, and strategic knowledge and skills. The Engineer School is redesigning its Warrant Officer Advanced Course and Warrant Officer Intermediate Level Education technical follow-on courses to keep pace with emerging technologies and concepts. A key step to enabling this is warrant officer participation in the Training With Industry Program. Geospatial engineering technicians (Military Occupational Specialty 125D) were the first to take part; Engineer School leaders are in discussions with potential industry partners to let construction engineering technicians (Military Occupational Specialty 120A) participate.

National, joint, and Army leaders will face unforeseeable and complex situations in the future, as they have in the past. The difference now, besides the technological landscape of the modern world, is that Army leaders are not designing the force to meet a threat that it is comfortable with, and which can be countered by, traditional weapons systems. Instead, the Army has taken the realistic approach that the future is truly unknowable, but that it will be complex and unpredictable. Therefore, we must develop leaders with the mental agility and capacity to quickly assess situations, decide, and act.

My message to engineer warrant officers is to—

- Take every opportunity to develop technically, tactically, operationally, and strategically.
- Become an expert in emerging technological advancements; but also be flexible, innovative, and creative.
- Broaden your thought processes.
- Seek a variety of assignments, especially those that might be out of your comfort zone.
- Understand the immediate environment and the strategic environment.

- Be able to interact with leaders and speak a common language, including doctrinal warfighter terminology and concepts.
- Know where to interject your advice to leaders before they make decisions.

A warrant office that I once worked for when I was a private instilled a concept in me that has been instrumental to my success as a warrant officer. He said, "Flexibility equals survivability." I often hear those words in my memories and have found a profound truth in them.

By the time this column is printed, I will have retired from the Army after more than 31 years of service. I have been accepted for a geographer position with the U.S. Geological Survey at the National Geospatial Technical Operations Center in Rolla, Missouri. I'm excited about the opportunity, but I know that it will be bittersweet. I will miss serving in the Army and miss working with all of you—the commissioned officers, warrant officers, noncommissioned officers, junior enlisted Soldiers, and Civilians who serve the Nation, the Army, and the Engineer Regiment. But after witnessing the sheer energy and professionalism exhibited by Army engineers every day, I know that the Engineer Regiment is in good hands. We are living up to the legacy of those who went before us. Now it is my turn to leave. I wish you all safety, good health, happiness, love, and a successful career. And if you need anything from the U.S. Geological Survey, you know where to find me!

For information about how to become an engineer warrant officer, log on to the U.S. Army recruiting Web site at <http://www.usarec.army.mil/hq/warrant>.

Endnote:

[1]U.S. Army Training and Doctrine Command Pamphlet 525-3-1, *The U.S. Army Operating Concept*, 31 October 2014.



CONDUCTING THE COMBINED ARMS BREACH IN A MULTINATIONAL ENVIRONMENT:

Observations From an Engineer Company Observer-Coach Trainer

By Captain Christopher G. Loschiavo

Throughout the last 13 years of the War on Terrorism, the combined arms breach has become a lost art for engineer and maneuver elements. While deficiencies in training, planning, and execution have been observed from brigade to platoon levels, this article focuses primarily on the company and platoon. The following are some of the most common problems observed at the Joint Multinational Readiness Center (JMRC) in Hohenfels, Germany:

- Lack of synchronization between the engineer company commander or platoon leader and the maneuver company commander.
- Poor capabilities briefings by the engineer company commander or platoon leader to the maneuver company commander.
- Lack of combined arms breach rehearsals.
- Failure to incorporate multinational engineers and other assets into the planning process and execution.

The first three problems highlight the lack of familiarity and experience with the combined arms breach among company leaders today. They simply have not conducted this type of operation and have received little or no training on it at home station before arriving at JMRC. The results have been—

- Desynchronized operations at the breach site.
- Delayed breaching operations due to a lack of adherence to breaching tenets and fundamentals.
- Avoidable casualties in and around the breach site and engagement area.

Also, the lack of multinational integration by U.S. commanders in multinational decisive action training environments (DATEs) has created a reduced level of partnership, understanding, and cooperation; failed to maximize available resources; and failed to fully achieve the interoperability training objective. During the three DATE rotations



A U.S. engineer platoon receives an operation order from a Czech infantry company.



U.S. and Czech engineers conduct combined planning and establish an SOP for vehicle lane marking.

in the last 6 months at JMRC, there has been no multinational integration into a combined arms breach.

Obstacle breaching is the use of several tactics and techniques to advance an attacking force to the far side of an obstacle that is covered by fire. It is one of the most difficult combat tasks that a force can encounter. Also, breaching is a synchronized combined arms operation under the control of a maneuver commander.[1] To effectively execute a combined arms breach, precise synchronization must be achieved between the engineer and maneuver forces. The commander ensures synchronization through proper planning and preparation by using the following key fundamentals:

- Detailed reverse planning.
- Clear subunit instructions.
- Effective command and control.
- Well-rehearsed forces.

The failure to synchronize effective suppression and obscuration with obstacle reduction and assault, for example, can lead to swift, overwhelming losses of friendly forces at the obstacle or within the enemy engagement area. During numerous training rotations at JMRC, observers-coaches have observed a lack of thorough planning and preparation from the engineer and maneuver elements. Some of the failures observed include—

- Delayed task organization of engineers to maneuver commanders, resulting in extremely compressed planning timelines.
- Poor enemy obstacle intelligence, resulting in the mismanagement of reduction assets.
- Lack of understanding engineer capabilities by the maneuver commanders and platoon leaders.

One method to avoid desynchronization is a detailed and well-articulated capabilities briefing by the engineer company commander or platoon leader to the maneuver company commander immediately upon linkup or notification of task organization. At a minimum, this capabilities briefing should include the following:

- Number of engineers available.
- Type and quantity of vehicles and weapons systems.
- Breaching methods.
- Type and quantity of reduction, proofing, and marking assets available.
- Quantity, length, and width of lanes (vehicle or footpath) that can be achieved through various obstacles.
- Unit standard operating procedure (SOP) for lane marking.
- Procedures for passage of lines.



U.S. engineers breach a vehicle lane through an obstacle in support of a U.S. maneuver company.



U.S. engineers conduct a manual breach through a mine obstacle in support of a Czech maneuver company.

With a capabilities briefing, the engineer company commander or platoon leader can paint a detailed picture for the maneuver company commander of what can be accomplished with the forces and resources available, thus enabling detailed reverse planning that leads to clear orders, thorough rehearsals, and effective command and control. However, engineer commanders and platoon leaders frequently fail to achieve this level of shared understanding with their maneuver counterparts. The level of understanding that is achieved typically amounts to something like "I've got two mine-clearing line charges," or "I can breach one lane." Whether it is due to poor communication skills or limited experience, these engineers do not effectively communicate the necessary information to maneuver commanders.

Conducting rehearsals with all appropriate forces is key to planning and preparing for any military operation. Conducting several methodical rehearsals for a combined arms breach is no exception. The combined arms unit (brigade, battalion, or company) should meticulously plan and control the rehearsals. The terrain model at the rehearsal site needs to reflect the actual obstacle system (zone, belt, or group) in as much detail as possible. The terrain chosen for the rehearsal should be as similar as possible to that of the operational area, and a practice obstacle system based on obstacle intelligence should be constructed. Rehearsals should include a leader and key personnel walk-through and individual rehearsals by support, breach, and assault forces. These rehearsals should also include contingency plans to account for possible enemy counterattacks; indirect fire; and chemical, biological, radiological, and nuclear attacks.

During the past three DATE rotations at JMRC, the rotational training units planned multiple combined arms breaches at the brigade and battalion levels during force-on-force operations, yet they executed no company level combined arms breach rehearsals. Combined arms breach rehearsals were integrated into the overall brigade level combined arms rehearsals, but the elements that would execute the breaches never conducted such rehearsals. There was usually just a discussion of the combined arms breach between the engineer and maneuver leaders. This lack of a leader and key personnel walk-through and individual rehearsals by support, breach, and assault forces resulted in desynchronized operations at the enemy obstacle, delayed breaching execution due to a lack of adherence to breaching tenets and fundamentals, and avoidable friendly casualties in and around the engagement area.

These observations describe U.S. Army units and their abilities to execute the combined arms breach according to U.S. doctrine. However, the integration of America's multinational counterparts into the equation is missing. In a July 2014 interview at the Aspen Security Forum, Army Chief of Staff General Raymond T. Odierno said that U.S. forces must conduct more exercises featuring more interoperability. "Our NATO partners have significantly decreased their spending on security, so we have to better understand what all our capabilities are. We have to understand what our strengths and weaknesses are. We have to work together to build multinational capability to solve these problems," he said.[2]

Interoperability can be defined as the degree to which various organizations or individuals are able to operate together to achieve a common goal. Its purpose is to satisfy the Nation's strategic objectives while operating within a constrained environment to maximize efficiency and economy of force. To achieve these goals at the tactical level in the combined arms breach, U.S. units must integrate multinational engineer and maneuver units into planning and execution. This has not been successfully achieved during a DATE rotation. The brigade level concept of the operation has integrated multinational battalions and companies into the overall scheme of maneuver, but multinational units

(continued on page 19)



The Assault Breacher Vehicle in the Multinational Brigade: The Explosive Dynamic of Interoperability

By Captain James D. Walton

In the face of aggression from the East, tensions grow among America's European allies, resulting in the need for North Atlantic Treaty Organization (NATO) allies and partners to "shift from meeting operational demand to meeting operational preparedness."[1] The recent ideological change in operational readiness is most evident at the Joint Multinational Readiness Center (JMRC), Hohenfels, Germany, one of three combat training centers that the U.S. Army maintains. Located in the heart of Europe, the JMRC serves as the proving ground for joint and multinational forces to train in the decisive-action training environment, which features a hybrid and near-peer threat for rotational training units to fight within the scenario. The JMRC is the catalyst for this increased need to provide interoperable multinational brigades, which the deputy commanding general of U.S. Army Europe recently referred to as a "proof of principle."[2]

While training unified land operations at the JMRC, multinational brigades typically execute combined arms mobility operations or breaching operations, one of "the single most difficult combat task a unit can perform."[3] A recent JMRC training rotation saw the introduction of the first assault breacher vehicles (ABVs) into a multinational brigade. The ABV is a tracked, joint (U.S. Army and U.S. Marine Corps) combat engineer vehicle designed to conduct deliberate and hasty breaching of minefields and complex obstacles. It was fielded by the U.S. Army in 2011 to provide a combat engineer platform that is more capable than previous equipment sets for supporting mobility operations at the tactical level, increasing the explosive and mechanical breach capability for the armored brigade combat team, and providing additional protection for combat engineers conducting the breach. The ABV has been used overseas in contingency operations but is now being integrated into multinational brigades training in Europe.

Integrating the ABV into multinational brigades for mobility support is the ultimate test of interoperability. "Interoperability-associated costs at the operational and tactical level tend to result from inefficiencies caused by a number of possible factors," to include strategy, doctrine,

and systems capabilities.[4] So, how does an ad hoc multinational brigade integrate the ABV to achieve interoperability, ensuring that the multinational combined arms breach is a success? The answer is simple: ensure that maneuver commanders, engineer leaders, and staff members have a shared understanding of the system capabilities, NATO and U.S. engineer doctrine, and established standard operating procedures for breach operations.

This shared understanding can be achieved in the following ways:

- Capabilities briefings.
- Engineer working groups.
  - ❑ Engineer network.
  - ❑ NATO-U.S. doctrine crosswalk.
  - ❑ Standard operating procedures.
- Combined arms rehearsals (CARs).

Capabilities briefings. Observations from JMRC rotations indicate that the U.S. Army maintains a more robust explosive breach package at the tactical level than its NATO allies and partners. During the formation of a multinational brigade that includes ABVs, these capabilities must be conveyed to maneuver commanders and engineer staffs at all echelons. The understanding gained from a thorough capabilities briefing will influence future task organizations and courses of action. The engineer company commander or senior representative should deliver this briefing, which is the beginning of building networks and critical relationships across the formation.

The information requirements for a proper capabilities briefing include—

- Explosive and mechanical breach.
- Lane marking and proofing.
- Sustainment requirements.

While these topics may seem elementary, the importance of knowing these facts cannot be overstated. For example, a well-developed capabilities briefing would highlight the fact that each "ABV can reduce an obstacle with its linear demolition charge, proof a lane with its mine plow, and mark lanes while the other ABVs provide redundancy and alternatives for the combat formation."[5] Also, the overall capabilities for lane reduction must be articulated in numbers, to include the number of vehicle lanes through reinforcing tactical obstacles at varying depths and complexity.

"Integrating the ABV into multinational brigades for mobility support is the ultimate test of interoperability."

Engineer working groups. As multinational brigades are established, the engineer coordinator must develop routine and battle rhythm engineer working groups. Foremost on the agenda should be establishing the engineer network within the brigade, which consists of the following:

- Brigade engineer.
- Task force and battle group engineers.
- Brigade engineer battalion leaders and staff.

The fires community in the U.S. Army does extremely well at establishing and maintaining its own network of artillery commissioned and noncommissioned officers within a brigade combat team. This often proves difficult for engineers since the brigade engineer battalion is relatively new to the Army. The difficulty in establishing and maintaining this network is amplified in a multinational unit due to language, cultural, doctrinal, and technical barriers.

The engineer working group must clearly establish methods to implement the breach tenets and apply the breach fundamentals while using the ABV as the primary platform for explosive and mechanical reduction. To do this, however, there must be a clear understanding of NATO and U.S. Army engineer doctrine, as outlined in Standardization Agreement (STANAG) 2485, *Countermine Operations in Land Warfare*; STANAG 2036, *Land Mine Laying,*



A multinational armored vehicle strikes a minefield.



An M1 Abrams tank assaults through a vehicle lane that was reduced by an ABV.

Marking, Recording, and Reporting Procedures; and Army Tactics, Techniques, and Procedures 3-90.4, *Combined Arms Mobility Operations.*[6, 7, 8]

It is important to note that the types of breach operations, methods of breaching, and lane-marking standards vary slightly between NATO and U.S. doctrines. Specifically, the ABV automated lane-marking system would be superseded by manual lane-marking performed by dismounted Soldiers in accordance with NATO standards.

CARs. Arguably the most critical step in integrating the ABV into a multinational brigade that is preparing to conduct combined arms mobility operations is executing a CAR. The rehearsal serves as a coordination event in which "subordinate units synchronize their plans with each other" and ensure that "their plans achieve the higher commander's intent."[9, 10]

Best practices indicate that successful CARs focus two echelons down. For example, a brigade CAR would review down to company level tasks, purposes, and scheme of maneuver. It is essential that the company and task force commanders who have ABVs task-organized to them synchronize the ABV employment by rehearsing, in detail, the timing and locations for lane reduction, reduction and proofing methods, marking standards, and reporting requirements. The detail required in the CAR is significant; the topics described here only highlight several key areas of emphasis. The ABV is a key component to combined arms mobility operations. The platform must be synchronized within the context of the larger operation, ensuring that all multinational partners understand the ABV techniques and procedures and where they fit into the fight.

The ABV will provide the multinational brigade with a significant capability to conduct combined arms breaching but will prove challenging to integrate unless engineer leaders and staff members can interoperate. The steps outlined in this article serve as a baseline for newly formed multinational brigades to follow when integrating ABVs, based on lessons learned and best practices at the JMRC.

Endnotes:

[1]Speech by Major General Walter E. Piatt, quoted by Jim Garamone, "Reassurance, Interoperability Key for U.S. Army in Europe," *DoD News,* 16 October 2014, accessed on 15 January 2015, <http://www.defense.gov/news/newsarticle.aspx?id=123432>.

[2]Ibid.

[3]STANAG 2485, Ed. 2, *Countermine Operations in Land Warfare*, 21 November 2003.

[4]Rand Corporation, "Interoperability," *A Broad Definition of Interoperability*, Chapter 2, accessed on 15 January 2015, <http://www.rand.org/pubs/monograph_reports/MR1235.html>.

[5]Lieutenant Colonel Jason A. Kirk and Captain Clint W. Brown, "Combined Arms Breaching in the Decisive Action Training Environment: Welcome Back to the Dance Floor," *Engineer Magazine*, September–December 2012.

[6]Ibid.

[7]STANAG 2485.

[8]STANAG 2036, Ed. 6, *Land Mine Laying, Marking, Recording, and Reporting Procedures*, 27 January 2005.

[9]Army Tactics, Techniques, and Procedures 3-90.4, *Combined Arms Mobility Operations*, 10 August 2011.

[10]Field Manual 6-0, *Commanders and Staff Organization and Operations*, 5 May 2014.

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The First Army Route Clearance Academy

By Captain Benjamin R. Ritzema and Mr. Adam R. Robinson

Before deploying to Afghanistan, route clearance platoons in the 2d Armored Brigade Combat Team, 4th Infantry Division, faced many of the same training and readiness challenges faced by Regular Army and Reserve Component (RC) units. The brigade conducted its final culminating training event (CTE) at the Joint Readiness Training Center, Fort Polk, Louisiana. Sapper platoons trained as route clearance platoons using nonstandard route clearance equipment that consisted of an RG-33 mine-resistant, ambush-protected (MRAP) vehicle; three International® MaxxPro® MRAP vehicles; and a simulated Buffalo (a 5-ton truck converted for training purposes into an MRAP vehicle). The Soldiers learned movement techniques, proper radio procedures, and the correct security postures to use during their rotation; but the Joint Readiness Training Center identified gaps in their route clearance training.

When the Soldiers deployed in May 2011, they finally got standard route clearance equipment (a Husky vehicle-mounted mine detection system, a Buffalo, and an RG-31 MRAP vehicle) and spent a few weeks training at Kandahar Airfield before moving to their final location to begin conducting route clearance. It was 3 weeks before they assumed the route clearance mission. Many units have experienced the same frustrations over the lack of training time on proper route clearance equipment before deployment. Route clearance units, regardless of component, face significant challenges maintaining readiness due to a lack of equipment, training areas, and training on the wide variety of specialized route clearance tasks. The



Civilian role-players interact with engineers at the Route Clearance Academy.

First Army Route Clearance Academy at McGregor Range, New Mexico, is the solution to this problem for RC route clearance units.

McGregor Range

After many years of overseas contingency operations, the U.S. Army learned that it faces significant challenges maintaining readiness. The challenges are not limited to the Regular Army but extend to the RC. These challenges increase when readiness involves unique, theater-specific equipment, large training areas, and route clearance tasks. To achieve readiness, First Army partners with RC engineer leaders to advise, assist, and train RC formations before and after mobilization, allowing U.S. Army Forces Command to provide combatant commanders with trained and ready route clearance forces.

To train RC engineer units, First Army established the First Army Route Clearance Academy at McGregor Range, which is adjacent to Fort Bliss, Texas. Here, the 3d Engineer Battalion, 364th Regiment (Task Force Rampant), 5th Armored Brigade, Division West, First Army, trains engineer units to conduct route clearance operations to meet the global threat of improvised explosive devices (IEDs).

Training Location

In fiscal year 2008, First Army established McGregor Range as a mobilization force generation installation to train and prepare RC Soldiers for combat. Today, the former air defense artillery facility has counterimprovised explosive device (C-IED) lanes consisting of classrooms, storage facilities, mounted and dismounted IED static display areas, handheld detector lanes, robotic lanes, and improved roads. McGregor Range is the premier training venue for RC route clearance units. The 400-square-kilometer Task Force Rampant area of operation contains two mountain villages and three lower elevation villages, ranging from 10 to 18 structures each. Veterans of deployments often comment that the 4,000-foot elevation and sweltering summer heat of the area strikingly resemble conditions in southern Afghanistan.

Academy Training Beginnings

The Route Clearance Academy began with predeployment route clearance training for RC units. During training assessments, observers noted that Soldiers lacked task familiarity and proficiency due to inadequate training. Once First Army identified training gaps over the course of multiple CTEs, the need for a specific training academy began to take shape. The academy taught the fundamentals of route clearance to close the individual and crew training gaps identified when route clearance vehicles and C-IED enablers were not available to RC units at home station.

What started as an exercise-focused mobilization training and validation process turned into hands-on, professionally executed route clearance training that decreased the individual and crew task learning curve and allowed units to focus their efforts on improving platoon and company collective task proficiency during training.



Soldiers of the 950th Engineer Company, Wisconsin Army National Guard, conduct an after action review at McGregor Range.

Training Equipment

Before honing Soldier skills on vehicles and equipment, members of each route clearance patrol (RCP) spend an entire day on the McGregor Range virtual clearance training suite. They conduct virtual missions to sharpen internal crew and patrol communications skills and tactics, techniques, and procedures. Task Force Rampant provides and maintains three full sets of route clearance vehicles, including Huskies with mounted detection systems (commonly known as ground-penetrating radar), Buffalos, and RG-31s. Ancillary equipment such as searchlights, light interrogation arms, rollers, vehicle optics sensor systems, handheld detectors, and robotic platforms are also available. Contracted civilian maintenance teams provide support for the vehicles, and the only robotics repair facility for Fort Bliss is at McGregor Range.



Soldiers from the 411th Engineer Brigade, U.S. Army Reserve, conduct an interrogation with a Buffalo at McGregor Range.

Training Concept

The Task Force Rampant training concept is based on traditional crawl-walk-run methodology, but the in-depth attention to individual and crew tasks makes the training unlike any other.

Crawl phase. The time devoted to the fundamentals of route clearance provides rigorous, hands-on, round-robin style training events that give Soldiers equal opportunity to train on route clearance equipment and C-IED enablers. Specified tasks include mounting and removing the mine rollers from the RG-31; using robotic devices, handheld detectors, and the route clearance optics suite; and performing recovery training with an actual RG-31 hull that the training unit can flip on its side to add complexity. For some Soldiers, this training is their first exposure to critical tasks that a combatant commander might expect them to perform in theater.

Walk phase. Situational training exercise lanes propel an engineer company into executing RCP missions and require the company command post to participate in operations. This training is a *walk* for the command post because leaders are only required to focus on current operations and to battletrack their active patrols. Task Force Rampant personnel act as the higher headquarters while simultaneously operating their own 24-hour tactical operations center (TOC) at another location. During this 3-day phase, the company is provided an assured mobility matrix outlining the routes that they will clear within the time allotted and in order of precedence. Task Force Rampant observers-controllers continuously gauge the performance of the command post and adjust the level of training difficulty accordingly. If the unit demonstrates proficiency early on, it may be tasked to produce company intelligence support team products, perform targeting, plan missions, or build assured mobility matrices during the exercise.

Each RCP must conduct three missions that increase in difficulty. In the crawl and walk phases, the unit clears a 28- to 44-kilometer route led by an observer-controller. In the run phase, the unit clears a 47- to 54-kilometer route and the mission is unit-led. Observers-controllers add 10 injections into the missions, including a sniper, an IED triggerman, a near ambush, civilian traffic, IED blasts, and recovery scenarios. Because unit proficiency varies, the training concept allows trainers to tailor the curriculum to the needs of the unit.

Run phase. The CTE is a company's capstone exercise, with Task Force Rampant staff analyzing the tasks in detail to create the most realistic and challenging training available. Maneuver boxes replicate a division area of operations that forces a patrol leader to cross multiple brigade boundaries and adjust communications appropriately. Similar to situational training exercise lanes, Task Force Rampant serves as the company's battalion TOC and requires the same reporting requirements that a real in-theater higher headquarters would demand. The TOC also



The 388th Route Clearance Company, U.S. Army Reserve, patrols Wagali Village at McGregor Range.

provides a continuous link to the patrols, allowing them to request assets such as medevacs, close air support, or indirect fire. Task Force Rampant can add yet another layer of authenticity to the exercise by providing civilian role-players and foreign language speakers to create realistic key leader engagements. Fort Bliss units often provide real-world or notional unmanned aerial vehicle support.

The routes for each CTE mission mimic real-world scenarios. The distances, terrain, road types, injections, villages, and duration can all provide formidable challenges for an RCP to negotiate. Some missions may last more than 12 hours as units work through tactical dilemmas and taxing scenarios. The patrols include day and night operations to test unit planning, preparation, and execution abilities. The final mission of the CTE pushes the company command post and RCP to their limits as they must plan and prepare for a large, named operation to support a notional maneuver unit while still performing their scheduled daily missions. This complexity challenges the company as a whole, usually requiring the delegation of tasks at all levels. A rest overnight may be added to challenge proficient units before the operation, forcing the RCP to assume an overnight vehicular patrol base posture in an unsecure location. Establishing a guard force and a less-than-ideal rest plan severely complicates the planning and preparation for the next day's mission.

Intangible Benefits

The personalized training experience that an engineer company can expect sets the Route Clearance Academy apart from other major training venues. From the moment a company arrives at McGregor Range, its members realize that it is all about Soldier and unit training. Task Force Rampant maintains a cadre of observers-controllers who understand the challenges of route clearance and know how to train and mentor Soldiers appropriately. Many observers-controllers wish that they had gone through this training before their own deployments.

Route clearance training will remain a challenge due to the specialized equipment, large maneuver areas, and number of injections required. The First Army Route Clearance Academy is the solution to the readiness challenge that Reserve Component route clearance units face. It will continue to produce fully trained route clearance units that combatant commanders can leverage to ensure secure routes in the operational environments of today and tomorrow. For more information, visit the First Army Web site at <www.first.army.mil>.

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Tactics, Techniques, and Procedures for the Assistant Brigade Engineer

By Captain Neal A. Stainbrook

A recent graduate of the Engineer Captains Career Course heading to a brigade combat team (BCT) with an organic brigade engineer battalion (BEB) would be well armed with the two-part *Engineer* article by Colonel Jason L. Smallfield entitled, "Employment of Brigade and Task Force Engineers."[1] The purpose of this article is to further prepare recent graduates and current assistant brigade engineers (ABEs) for their role at combat training centers (CTCs), particularly the National Training Center, Fort Irwin, California, by discussing tactics, techniques, and procedures (TTP) for the ABE section and how it interacts with the BEB.

Establish a Baseline

The first step for the recent graduate is to read and understand Army Techniques Publication 3-34.22, *Engineer Operations–Brigade Combat Team and Below*.[2] This publication is a great baseline to help ABE sections establish their relationship with the BEB. It outlines the roles and responsibilities of the ABE and the BEB staff and addresses the duties of the ABE section through the activities of planning, preparing, executing, and assessing.[3] It also provides a helpful battle-tracking list for engineers. Identifying which echelon has the primary responsibility over which processes or engineering lines of effort is important to avoid tasking or planning overkill. These TTP could also help junior engineer officers attending the Basic Officer Leader Course understand their roles as future platoon leaders.

Attend a Leader Training Class

ABEs should attend the leader training class hosted by the CTC. The engineer major on the brigade staff may inherit the role of chief of operations during the rotation, so the recent graduate must be prepared to assume the role of officer-in-charge of the ABE section. Taking the lead engineer staff officer role in brigade command post exercises or in military decisionmaking process training events at the brigade level would also be beneficial before a CTC rotation. Opening a communication channel with the engineer observer-controller is also important. The observer-controller may provide a trends briefing for the protection warfighting function, which can serve as a catalyst for conversation with the BEB staff and commander. Early communication with the engineer observer-controller will help identify shortfalls in training or standard operating procedures in time to remedy them before the start of the rotation.

Conduct Rehearsals

The recent graduate should develop a maneuver support or protection warfighting function working group and conduct rehearsals at battalion and brigade field training exercises before the CTC rotation. This working group could include representatives from the following sections:

- ABE.
- Military police.
- Military intelligence.
- Route clearance.
- Electronic warfare.
- Nonlethal effects.
- Explosive ordnance disposal.
- Others.

The working group should strive to approach improvised explosive device hot spots from the engagement area

development framework of the enemy. A product of this working group should be a route clearance schedule focused on targeted areas of enemy improvised explosive device activities.

Create a Common Operational Picture

Create a shared engineer common operational picture for the ABE section and BEB current operations section. Include permissions shared between the two entities within the Army Mission Command System, including Command Post of the Future. The displayed common operational picture on Command Post of the Future can include engineer equipment readiness, route clearance schedules, the current task organization of engineer units, construction materials on hand, and the status of listed items at present and those projected 24 or 48 hours in the future. This will enable consistency in providing running estimates with real-time updates, create shared understanding between the ABE and BEB, and allow parallel planning early in the operations process. The right operator should be identified for the ABE and BEB to manage this common operational picture so that it remains current and relevant.

Establish a Construction Materials Plan

Establish a plan for construction materials for reception, staging, onward movement, and integration. Present the plan during predeployment briefings, and apply the operations process to ensure that combat-configured loads are built and ready for use during the emplacement of tactical obstacles. A competent manager or owner of the resource must be identified to ensure that the combat load packages are built to standard and staged appropriately for the operating environment. Moving the combat loads and planning their dump sites could take place more rapidly, maximizing the time available for obstacle emplacement in the critical transition from offense to defense. The battalion should identify its internal requirements for construction materials; the brigade may choose to segregate protection construction materials from the stockpile designated for tactical obstacles and engagement area development. During the predeployment site survey or leader training program, the ABE should talk to the managers of the construction material yard and identify unit construction material areas.

Act as Liaison Officer

The ABE must prepare to be the de facto BEB liaison officer. Other BCT battalions may maintain a constant presence at the brigade, but the BEB may not have the resources to provide the same amount of coverage. (If the BEB is colocated with the brigade, such a position may not be required.) A lack of liaison could prevent nonengineer facets of the BEB (such as military intelligence and signal capabilities) from full integration into the common operational picture. Effective time management and the use of the limited ABE section personnel will become critical if the ABE serves as the BEB liaison officer. Sharing permissions with the ABE to the BEB common operational picture via Command Post of the Future will enable situational awareness for the ABE in place of a BEB liaison officer in the tactical operations center.



An engineer interrogates an improvised explosive device with the claw of a Buffalo mine-resistant, ambush-protected vehicle.

Develop Effective Knowledge Management

Effective knowledge management in the ABE section is essential in garrison and deployed environments. If the staff or unit already has an effective system, the recent graduate should mirror it and stay within its confines. If no system exists, one should be developed with the principles of Army Techniques Publication 6-01.1, *Techniques for Effective Knowledge Management*, in mind: "Knowledge management enables the mission command warfighting function by . . . helping the staff provide timely and relevant information and knowledge."[4] At a minimum, appropriate levels of access

and content management should be included in the knowledge management plan. Paragraph 3-48 of Army Techniques Publication 6-01.1 lists the minimum requirements for a content management plan, including—

- File-naming standards.
- Standardized procedures for collecting, storing, or sharing content.
- Common acronym list.
- Document tagging to ease searching contents.
- Archiving procedures for obsolete or historical examples.
- Standardized templates.
- Permissions and access policies.
- Considerations for personally identifiable information.[5]

Knowledge management is important for engineers, especially when viewed through the lens of active minefields and the status of current routes; whereas, version control and correct information are vital to protecting friendly forces. Knowledge management does not end with redeployment from the CTC rotation. The ABE must capture lessons learned and have strategies to improve weaknesses and reinforce strengths. The ABE section should attend the BEB after action reviews, including those conducted at the end of rotation, if possible.

These TTP were developed during a National Training Center rotation of the 1st Stryker Brigade Combat Team, 25th Infantry Division, with the organic 70th Brigade Engineer Battalion standing up several months earlier. With many BEBs scheduled to activate in coming years, recent Engineer Captains Career Course graduates need to prepare for the ABE role and command time. Whether at the ABE, BEB staff, or company command, engineer captains need to understand their roles and how they ultimately support their brigades.

Endnotes:

[1]Jason L. Smallfield, "Employment of Brigade and Task Force Engineers: Part I," *Engineer*, May–August 2014, pp. 9–14; "Employment of Brigade and Task Force Engineers: Part II—Tactics, Techniques, and Procedures," *Engineer*, September–December 2014, pp. 7–9.

[2]Army Techniques Publication 3-34.22, *Engineer Operations–Brigade Combat Teams and Below*, 5 December 2014.

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

[4]Army Techniques Publication 6-01.1, *Techniques for Effective Knowledge Management*, 6 March 2015.

[5]Ibid.

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("Combined Arms Breach," continued from page 9)

have not been included in plans or task-organized to conduct a combined arms breach with U.S. forces. The default plan seems to be to task-organize U.S. engineers to conduct combined arms breaching primarily using U.S. maneuver forces. However, U.S. Army engineers have operated with multinational task forces. In the past two DATE rotations, they have supported Lithuanian, Slovenian, Czech, Romanian, Danish, and Bulgarian maneuver units. Conversely, French engineers supported a U.S. mechanized infantry company.

Even though some interoperability has been achieved at the tactical level, the lack of combined arms breaching interoperability has created a reduced level of cross-army understanding and cooperation, a failure to maximize available resources, and a failure to fully achieve General Odierno's vision of understanding our strengths, weaknesses, and capabilities.

What is the way ahead? How do we get better? The answer is simple: training. U.S. forces need to train and rehearse the combined arms breach at their home stations before deploying to a combat training center. Engineer and maneuver companies need to incorporate combined arms breaching into their annual training plans at the individual and collective training levels and have the time and resources to train on this task at home station. By working and training with each other, engineer and maneuver units can develop integrated tactics, techniques, and procedures and establish SOPs that they can share with their training counterparts on arrival at a combat training center. This will enable a faster and more efficient synchronization of effort for executing a combined arms breach. Because U.S. units can rarely train with multinational counterparts at home station, they need to prioritize coordination with them as soon as possible when arriving at a combat training center. This makes it critical to receive a thorough capabilities brief from the multinational units and develop a combined SOP for operations. Then units should dedicate time to rehearsals for all stages of the combined arms breach, which will allow a shared understanding of each phase of the operation and an understanding of each unit's capabilities. This will ultimately enable a more successful combined arms breach and enhance interoperability.

Endnotes:

[1]Army Techniques Publication 3-34.22, *Engineer Operations—Brigade Combat Team and Below*, 5 December 2014.

[2]Claudette Roulo, "Army Needs Balance, Interoperability, Odierno Says," 24 July 2014, <http://www.defense.gov/news/newsarticle.aspx?id=122741>, accessed on 17 March 2015.

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True Sons of Freedom:

African-American Military Engineers of World War I

By Staff Sergeant William W. Greer

When the Great War erupted in 1914, few Americans believed that the United States should become involved in what seemed to be an exclusively European conflict. However, by 1917 the mood changed. In January, the Germans resumed unrestricted submarine warfare and tried to lure Mexico into attacking the United States. When the Zimmerman Telegram making that proposal was intercepted, the American public was outraged. On 2 April 1917, President Woodrow Wilson appealed to Congress and war was declared on Germany. A draft was instituted, in which all Americans were expected to do their part, African-Americans included. The black experience in the Great War is an incredible chapter in our legacy as engineers. Army policies, reflecting the institutional and informal discrimination that characterized American society at the time, relegated most African-Americans to labor-intensive jobs such as stevedore or laborer. Most of the officers appointed over the black units of the segregated Army were white, bringing their own prejudices. Military engineering tasks fell to formal engineer units and the support units that had been formed from the stevedores. Although they did not all bear the title of engineer, their missions and accomplishments were those we recognize today as belonging to the Army engineers.

Early in the War

When the first American troop convoy sailed for France in June 1917, no black Soldiers were aboard. The 400–500 uniformed black stevedores aboard were technically civilians but were still subject to

military rules and regulations. They were assigned the worst berthing and mess facilities aboard ship. Many preferred sleeping on deck, regardless of weather, rather than in the stuffy lower decks where they were assigned. The black officers assigned to supervise them were not allowed to dine in the white officers' mess, but black men were assigned there to serve as mess boys and stewards.[1] Stevedores were often disdained because of the common belief among white officers and Soldiers that they were physically or mentally inferior and unfit for combat.



Black Soldiers return to America from France.

Toward the end of the war, civilian laborers were replaced by the Services of Supply. The black Soldiers who made up one-third of that group were organized into 46 engineer service battalions, 44 labor battalions, 24 labor companies, and more than a dozen pioneer infantry regiments. These units built base camps, docks and piers, supply sheds, storage areas near ports and railroad facilities, and barracks and temporary housing for troops who were pushed from the ports to the front lines. Some Soldiers became forestry engineers, felling trees and operating sawmills for fuel and construction projects. In 20 days, the 335th Labor Battalion cut more than 1,000 cubic meters of wood and 250,000 poles and then dragged the results out of the forest with sling ropes. The 331st Labor Battalion cut more than 40,000 cubic meters of wood in 108 days. While performing these duties, the men generally slept in floorless tents and ate outside in the rain and mud. Other black laborers quarried rock and stone for road and building repair and construction. Other laborers built or repaired damaged rail lines.



The 369th Infantry Regiment "Harlem Hellfighters" band prepares for a parade.

Pioneer infantry regiments fared better than stevedores and black labor units because they received infantry training in case they needed to fight on the front lines. Formed to support engineer regiments or provide engineer support to infantry and artillery units, pioneer infantry units usually had numerous mechanics, blacksmiths and farriers (important to an army still dependent on horses), and carpenters, plus a mixture of Soldiers with technical training from civilian schools. Many of the black pioneer infantry units worked close to the front lines and very often

came under fire, accomplishing whatever missions they were assigned. They were engaged in road construction, trench construction and reinforcement, demolition work, and ammunition holding area construction. Before the armistice, several regiments were employed just behind the front lines at the Argonne Forest and Saint-Mihiel, where they constructed macadam roads and narrow- and wide-gauge railroads to transport artillery, supplies, and munitions. The 805th Pioneer Infantry Regiment was rushed in to repair a road near Varenne, which had been heavily damaged by German artillery fire. Without its repair, no ammunition could be transported forward to continue the American effort, nor could the wounded be evacuated for medical care. It is reported that this unit sang as it worked through the night with enemy artillery shells falling nearby to make the road passable. Seven of the black pioneer infantry regiments were authorized to wear the combat ribbon at war's end.[2] Many of the Soldiers of the pioneer infantry regiments, however, were disappointed in how their units were employed. As one officer lamented, "They did everything the infantry was too proud to do and the engineers too lazy to do."[3]

Under Fire

The 317th Engineer Regiment was formed on 24 October 1917 at Camp Sherman, Ohio. It would provide the combat engineering support for the all-black 92d Infantry Division. After careful consideration, the War Department inducted the 1,490 men into the regiment. It was composed of many men with experience in the construction trades and training at technical schools. There was much debate in the War Department about the officers who would command the unit. African-American officers who had graduated infantry training were suggested, but the Engineer Corps opposed this proposal because the officers lacked specific engineer training. In the end, 30 black infantry officers were assigned to the unit, three of whom had engineering experience and education. After arriving in France, the black captains (except the chaplain, two line officers, and those in the medical detachment) were replaced by white officers, but the black lieutenants were retained.

The unit sailed for France on 8 June and reached Brest on 19 June. The Soldiers were immediately put to work loading baggage headed for the front and working on roads and barracks. At the port of Saint-Nazaire, the regiment almost single-handedly built a pier that stretched a mile offshore. It was very dangerous work since the Soldiers had to work standing on slippery boards. On June 27, the regiment arrived in the Bourbonne-les-Bains for 4 weeks of intensive training and work on projects such as building mess halls, shower facilities, barracks, stables, warehouses, and railroad yards. The regiment became the first element of the 92d Division to enter the war, relieving the 7th Engineers, 5th Infantry Division, in late August. They constructed dugouts, repaired and extended trenches, and mined bridges that were in danger of falling into enemy hands. They also engaged in lumber and sawmill operations, providing firewood and lumber for construction projects. In one mission, 25 enlisted men performed especially courageously under fire for 3 days and nights, gas-proofing dugouts as enemy artillery fired phosgene and mustard gas on their positions.



Some Soldiers from the 369th Infantry Regiment served in French units and wore French helmets.

"The men salvaged rocks and timbers from abandoned and mined enemy positions and used them to reinforce trenches for the Americans. They also built light-gauge railroads to supply forces at the front lines and heavy-gauge railroads for the rear areas."

From the time the U.S. Army launched its greatest attack of the war in the Argonne Forest on 26 September 1918 until the conclusion of hostilities on 11 November, the regiment worked tirelessly to open major roads to support the effort. In many places, the roads had been destroyed by enemy fire and required massive amounts of labor and materials to repair. Often, the roads had to be rerouted at night through less-than-ideal terrain and reinforced with logs to evacuate casualties and to ensure that supplies and ammunition reached the front lines. The men salvaged rocks and timbers from abandoned and mined enemy positions and used them to reinforce trenches for the Americans. They also built light-gauge railroads to supply forces at the front lines and heavy-gauge railroads to move troops and supplies in the rear areas. They worked day and night throughout the offensive, often under enemy fire, earning unit campaign streamers for the Meusse-Argonne and Lorraine Campaigns. After the war, the 317th was demobilized on 31 March 1919.

After the Armistice

Despite their distinguished service, other slights awaited African-American Soldiers after the armistice of 11 November 1918. They were excluded from many victory parades, including the main parade in Paris, despite the fact that black troops from England and France were included. The huge French war painting, "Le Pantheon de la Guerre," by Pierre Carrier-Belleuse and Auguste Francois Gorguet, pictured those who had contributed to the final victory, including black soldiers of the Allied nations—except the Americans. It was as if the Army was unwilling to recognize the sacrifices and triumphs of its black warriors.[4]

After the fighting, much work remained and much of it fell to the African-American Soldiers and engineers. Some of the work was labor-intensive, such as constructing the Pershing Stadium near Paris, providing firewood, salvaging equipment and materials from the battlefields, removing barbed wire entanglements, detonating unexploded ordnance, and filling trenches. American cemeteries had to be constructed, the largest of which (Argonne National Cemetery) was established at Romagne. The task of retrieving decomposing bodies for burial in the cemeteries fell to the men of the black 814th, 815th, and 816th Pioneer Infantry Regiments. They retrieved and buried fallen Americans within a 50-kilometer radius of the cemetery. No doubt, the taboos associated with handling the dead added to their feelings of isolation, discrimination, and humiliation.

After the war, most Soldiers simply wished to put this chapter behind them and pick up with their civilian lives. However, many desired to continue their military service. As the Army drew down after the war, examining boards determined who would be retained on active duty. It seemed that the Army was intent on restricting the number of black officers and Soldiers allowed to continue military service. The few black officers who were retained found themselves restricted to infantry and cavalry units despite good performance as artillery and engineer officers. Black enlisted Soldiers could only reenlist in traditionally black regiments.[5] Interestingly, the 77th Engineer Combat Company was the last all-black unit to engage an enemy, some 30 years later in the Korean War. The Army was to remain segregated for many years, until Executive Order 9981 was signed by President Harry S. Truman in July 1948. The last surviving black World War I veteran, Mr. Moses Hardy, 805th Pioneer Infantry Regiment, died on 7 December 2006. With him passed the last opportunity to hear the story of the black engineers of the Great War from one who lived it. Although resources exist detailing the African-American experience in World War I, relatively few are dedicated to the engineers and the units that were assigned engineer roles.

Endnotes:

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[2]Ibid., pp. 105–106.

[3]Charles H. Williams, *Negro Soldiers in World War I: The Human Side,* (formerly titled *Sidelights on Negro Soldiers*), AMS Press, Inc., New York, New York, 1970, p. 155.

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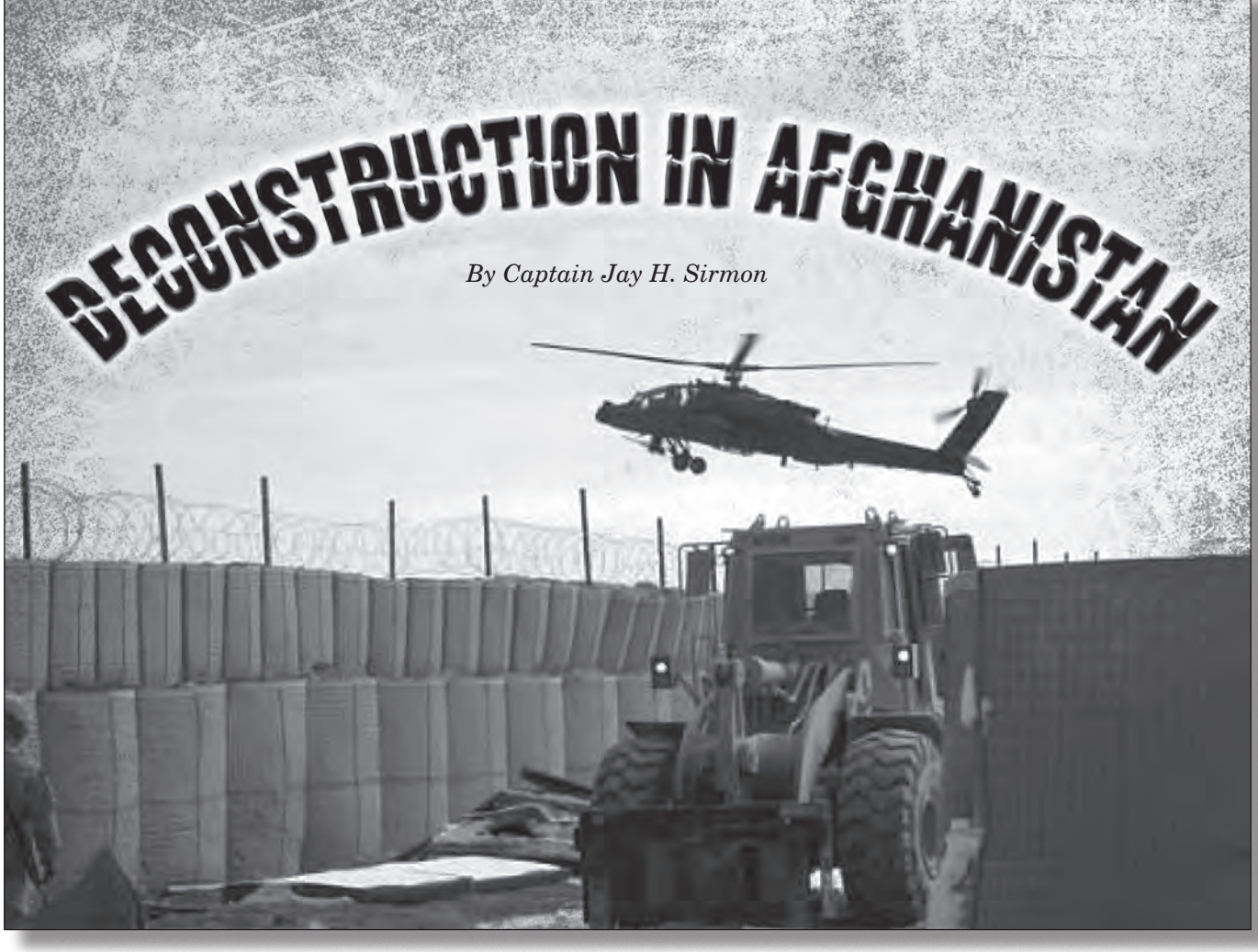
Photos courtesy of the National Archives and Records Administration.

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DECONSTRUCTION IN AFGHANISTAN

By Captain Jay H. Sirmon



The 1223d Engineer Company, South Carolina Army National Guard, has varying degrees of experience and education in its ranks. As with most construction effects units in the Army National Guard, rank is not necessarily an indicator of technical skill. More than 75 percent of the Soldiers in the company have civilian careers that match or complement their military occupational specialties. When the unit received the alert that it would deploy to Afghanistan to tear down forward operating bases (FOBs) instead of build them, there were expectations that very little of the tremendous amount of engineering talent in the company would be used. Those expectations were wrong.



A Soldier from the 1223d Engineer Company attaches a harness to a concrete T-wall to remove it from the base perimeter wall.

The company arrived in Kandahar, Afghanistan, in August 2013 with responsibilities throughout Regional Command (South) and Regional Command (Southwest). A lesson that was learned quickly was that structure teardown involves much more than bulldozers and dump trucks. To ensure mission success, the following factors were addressed:

- Utilities.
- Location.
- Debris disposal.

Utilities. Electrical utilities are especially important. Most of the bases that the 1223d Engineers deconstructed were not slated for total closure but had sections that remained operational after the unit completed its mission. After more than 13 years of adding to and reorganizing FOBs, the electrical lines were difficult to trace and even more difficult to safely

disconnect. One of the unit warrant officers, a master electrician in civilian life, and the company interior electricians adapted quickly to the task. Since plans or drawings rarely existed, they began by locating the generators in use and then tracing the service cables to the panel boxes. As safety was paramount, guards were posted at the generators when service cables were disconnected to avoid inadvertent start-ups. Standard lockout/tag-out procedures were performed at the same time. Once the deconstruction was complete, the electricians reenergized the system to provide power to the remaining structures. This was a lengthy process; the electricians were included in the advance team, allowing minimal downtime for users who were waiting for utilities to be sanitized.



Soldiers reinforce a perimeter wall.



Soldiers use a boom lift to dismantle aluminum tent frames.

Location. The location of the FOB and the equipment available there were major planning factors. On most projects, the 1223d Engineer Company had operational control of a horizontal engineer platoon. Much of the mission success depended on the availability of heavy equipment. Bulldozers, graders, cranes, forklifts, loaders, and dump trucks were used in most deconstruction missions. Heavy equipment was brought in quickly to bases that were relatively close to Kandahar, but this was not possible for some locations. Company leaders became creative at working around shortages of personnel and equipment. Relationships were established with local civilian contractors for access to equipment and with other on-base units for extra personnel. Company commissioned and noncommissioned officers became very good at substituting equipment, planning for shortages, and developing mutual aid relationships with residents on the FOBs.

Debris disposal. The disposition of material and debris was a critical factor when planning the deconstruction missions. Concrete T-walls and metals such as copper were always recovered for recycling. Fiber was usually recovered; and sometimes plywood had to be reclaimed, tripling the time needed to destroy a wood structure. Perhaps the most difficult material to reclaim was gravel. Some jobs required the engineers to leave the land in the same condition it was in 13 years earlier when it was essentially farmland. Years of adding gravel resulted in levels up to 30 inches deep, which had to be removed. This painstaking operation was usually reserved for the horizontal platoon, which worked with bulldozers, graders, hydraulic excavators, and dump trucks to accomplish the mission.

The Soldiers of the 1223d Engineer Company reduced FOBs for 9 months. Most of them now joke that they cannot look at a building without contemplating the procedures that would be needed to destroy it. The mission that the company performed in Afghanistan was much more than it originally anticipated, providing a challenge to its leaders and making its members better Soldiers and civilians.

Captain Sirmon is the commander of the 1223d Engineer Company, Summerville, South Carolina. He works for the construction and facilities management office of the South Carolina Army National Guard. He is a graduate of The Citadel and is pursuing a master's degree in engineering management from Missouri University of Science and Technology at Rolla.

ENGINEER WEEK 2015

















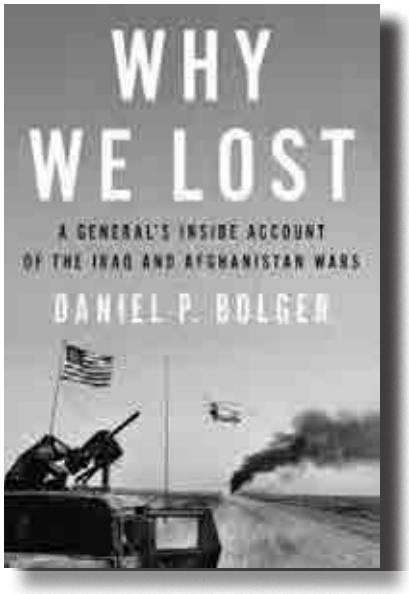


Photos by Fort Leonard Wood Visual Information Center

Book Review

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 <http://www.wood.army.mil/usaes/library/documents/ENGR_CMDT_READING_LIST_2012.pdf>. 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 will be a feature in each issue of *Engineer*. Authors will summarize the contents of books of interest and will 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>.



Why We Lost: A General's Inside Account of the Iraq and Afghanistan Wars, by Lieutenant General Daniel P. Bolger (Retired), Eamon Dolan/Houghton Mifflin Harcourt, 11 November 2014, ASIN 978-05443704

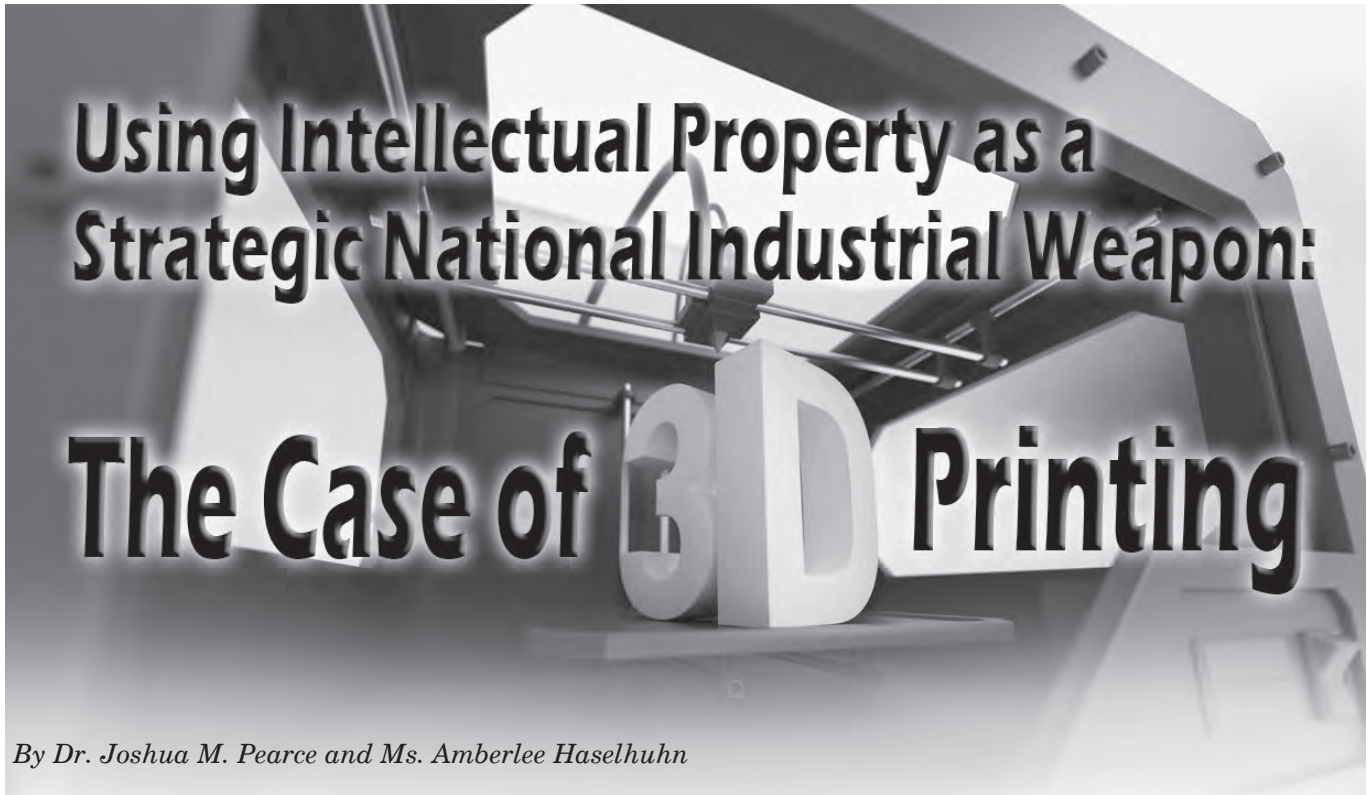
Reviewed by Colonel Jason A. Kirk

Engineers and all members of the profession of arms should read this book. Yes, it will frustrate and upset you. Yes, the declaration that we "lost" in Iraq and Afghanistan is somewhat premature, especially in light of our extended commitments to Afghanistan's security after 2014 and the new commitments of the United States and its allies to help Iraq confront Islamic State of Iraq and the Levant terrorist threats. But in reading this book, you will be reminded of many universal truths applicable to engineers and Army professionals engaged in current and future conflicts. The book will contribute to the reader's professional self-development and aid in the personal reflections that everyone engaged in these conflicts would be well advised to ponder.

What happened? What was supposed to happen? How can we fix it? Just as you will find at the Army's combat training centers, the best after action reviews (AARs) do not focus on the good things that you and your unit accomplished. Rather, they focus on the shortfalls which, through analysis, you can improve in the future. Lieutenant General Bolger offers this book as that kind of AAR. His driving thesis is that the fundamental reason we "lost" is that a succession of senior leaders—Generals John P. Abizaid, George W. Casey, David H. Petraeus, Raymond T. Odierno, Stanley A. McChrystal, John R. Allen, and Joseph F. Dunford, Jr.—worked with the flawed assumption that President George W. Bush and President Barack H. Obama would support the long-term troop presence necessary for the eventual success of our counterinsurgency strategies in Iraq and Afghanistan. Absent the long-term troop commitment, Bolger says, the counterinsurgency strategies were doomed to fail. "Sergeants and captains, not to mention our fellow citizens, count on generals to sort out such fundamental strategy. We didn't," he concludes in this 544-page mea culpa.

Though the target of this fundamental lesson learned is a group of 3- and 4-star general officers, all military professionals (including those few readers who are destined for future service as 3- or 4-star general officers) will find important takeaways in this book. The author makes the point several times that leaders must get on the ground to "see the elephant" so that they can gauge progress and then make necessary adjustments in mission scope or resource application. He gives himself and a few other leaders, such as General McChrystal, credit for doing this time-intensive, personally hazardous fact-finding. He also points out that many of his peers did not take the time to do it. Taking a page from Sun Tzu and others writers, Bolger emphasizes the universal importance of knowing the enemy you are fighting. He asserts that we failed to do this in many ways, including not understanding the depth of the Sunni-Shiite strife in Iraq or the age-old disdain for external forces that the Afghans exhibited toward British and Russian invaders in the not-too-distant past.

(Continued on page 31)



Using Intellectual Property as a Strategic National Industrial Weapon: The Case of 3D Printing

By Dr. Joshua M. Pearce and Ms. Amberlee Haselhuhn

Will the American patent system cripple U.S. military applications of 3-D printing? There is some consensus that 3-D printing represents the "next industrial revolution." It is a form of additive manufacturing for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of a material. It can be used to make everything from expensive scientific and engineering tools to novel biotechnologies. The U.S. military has already determined that 3-D printing represents a strategic advantage on the battlefield. It is now clear that 3-D printing will affect every industry, and there is currently considerable debate on its intellectual property implications. There is some evidence that intellectual property strategies can be used as a strategic national weapon. This articles reviews the U.S. policies relating to 3-D printing in that context and finds evidence that China is strategically using U.S. patent law to ensure its own national interests for the next industrial revolution.

Background

As with many great inventions, a powerful strategic national intellectual property weapon was discovered by accident. The German patent system before World War I restricted patents to processes and did not allow product patents. Chemicals and chemical products, for which the Germans became well known, were not patentable until much later. With no intellectual property protection, German chemical companies were under enormous pressure to innovate—companies had to innovate and strike first or die. The German companies that survived such a fight (BASF, Bayer, Hoechst, and others) were strong and efficient and innovated constantly to stay that way. They were not philosophically opposed to intellectual property. They aggressively patented abroad, leading to a dominant stance in chemical patents in the United States and in the resultant international chemical market. In 1936, for example, IG Farben held 4,000 patents in the United States and was receiving new patents at a rate of almost one per day.[1]

"The U.S. military has already determined that 3-D printing represents a strategic advantage on the battlefield. . . . There is some evidence that intellectual property strategies can be used as a strategic national weapon."

Although those actions were not part of formal industrial warfare (that we are aware of), they worked as an intellectual property weapon that hobbled fledgling U.S. companies which hoped to compete against the onslaught of broad, overlapping claims that were forged in the innovative fires of the German homeland. To understand how pathetic the U.S. chemical industry was after such an attack, consider that before U.S. entry into World War I, U.S. industries had

to smuggle dyes from Germany via submarine to bypass the British blockade. To this day, American chemistry professors recommend that students learn German as their second language because of the German dominance in chemistry-related fields.

General Requirements for an Intellectual Property Weapon

The German experience reveals the following generalized requirements for a nation to wield a strategic national industrial weapon using intellectual property law:

1. Possess weak or nonexistent patent protection within the homeland for a specific industrial class.

2. Target an enemy industrial country possessing strong intellectual property protection in the same industrial class.

3. Aggressively patent in the target country to slow innovation in that industry.

To detect the intellectual property weapon, it must be determined from published literature if Requirement 3 is present and from investigation of laws and enforcement if the country has also fulfilled Requirements 1 and 2.

A Case Study of Modern 3-D Printing

A 3-D printer constructs 3-D objects from a digital design by adding successive layers of material. Watching an employee at an ice cream shop build a soft serve ice cream cone would illustrate the basic process. While 3-D printers have been around since the 1970s, the technology did not gain continuous media attention until recently. The historic 3-D printers, although commercialized, never diffused very widely, to the chagrin of the engineers toiling on them in the research and development departments of a small group of companies. The 3-D printers improved over time, but were so costly that they were generally used only for rapid prototyping by major industrial players such as the Ford Motor Company℠ and General Electric™. Prices for commercial plastic 3-D printers started at $20,000, and metal 3-D printers from Europe cost more than $500,000.

When the core U.S. patent protection expired on one of the simplest 3-D printing techniques, a British engineering professor used a 3-D printer to print another 3-D printer, thus developing the RepRap© (replicating rapid prototyper).[2] Current versions of the open-source RepRap can print about 50 percent of their own parts. These two developments caused an explosion of small 3-D printer companies, a dramatic reduction in 3-D printing costs, and the concomitant 3-D printer media frenzy.

Beyond the mainstream media's watchful gaze, another frenzy is taking place in the world's patent offices: the number of patents to control the 3-D printing space is exploding. While only 487 patents related to 3-D printing were filed in 2002, this number has increased almost 40 percent to 680 patents filed per year since 2007.[3] Gridlogics™ reports that the two leading 3-D printing firms in the United States filed 76 patents between 1999 and 2013.[4] Over the same period, a group of Chinese companies gained 452 additive manufacturing patents.

It appears that China meets Requirement 3 of aggressive patenting in the target country. Requirement 2 is also met since the United States has some of the strongest and farthest-reaching patent laws in the world. The U.S. Patent and Trademark Office reports that there is an army of 32,328 active patent lawyers and 10,811 active patent agents in the United States.[5] These patent specialists operate in a relatively litigious culture, ensuring that laws are enforced. These numbers approximately equal the active duty manpower of the U.S. Coast Guard.

On the other hand, the Chinese have a much different view of intellectual property. Consider the rapid innovation and diverse products made possible in the Chinese smartphone market, enabling Chinese firms to offer highly sophisticated smart phones to their domestic customers at unprecedented low costs years ahead of Western markets. They also sell humorously infringing mash-ups, such as the so-called Voda-Pod-Berry.[6] Although patents were only adopted in China in 1984, their aggressive patenting in the 3-D printing arena shows that the Chinese have quickly grasped the concept of intellectual property. However, China is well known for ignoring intellectual property rights in essentially every industry. Imagine how many lawsuits would be filed against the Voda-Pod-Berry if it were sold in America. Many authors have similarly concluded what Bryan Mercurio forcefully summarizes: "China is without a doubt the world's leading infringer of intellectual property rights."[7] This appears to satisfy Requirement 1.

External observation indicates that China believes in the promise of 3-D printing. Wohlers Associates, Incorporated, reports that the Chinese government invested nearly $245 million in a 7-year project to boost the development of additive manufacturing. Meanwhile, the United States struggles to keep up. Five of the most powerful U.S. federal agencies—Department of Defense, Department of Energy, Department of Commerce, National Science Foundation, and National Aeronautics and Space Administration—jointly invested $45 million in the National Additive Manufacturing Innovation Institute. Known as "America Makes," it supports American companies and universities eager to recapture manufacturing jobs lost to low-wage countries like China.[8]

But America will not be making much in the future if the Chinese invest a small amount of the capital they have earmarked for 3-D printing to hire patent lawyers to lay out an impenetrable patent minefield (or what lawyers refer to as a patent thicket). It is clear that China is in a position to use the U.S. patent system as a weapon to incapacitate the United States for the next industrial revolution and weaken the use of 3-D printing applications in the U.S. military. Whether the use of a strategic national intellectual property weapon was part of a conspiracy to bury U.S. manufacturing or, more innocently, one of the steps in a Chinese 7-year plan

for domestic industrial growth is beside the point. To avoid industrial irrelevancy, the United States must institute a method of defense. Perhaps the only way to ensure that U.S. industry remains relevant after the next industrial revolution is to significantly modify or possibly abolish the intellectual property system that made the first industrial revolution possible.

Endnotes:

[1]J.K. Smith, "National Goals, Industry Structure, and Corporate Strategies: Chemical Cartels Between the Wars," In Akiro Kudo and Terushi Hara (Eds.), International Cartels in Business History, University of Tokyo Press, Tokyo, 1992.

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[3]Heesun Wee, "The 'Gold Rush' for 3-D Printing Patents," 15 August 2013, <http://www.cnbc.com/id/100942655>, accessed on 1 April 2015.

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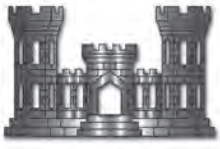
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WANG Fei-yue, "The Coming Revolution in National Defense Weaponry and Systems: From 3-D Printing to Parallel Military Systems," *National Defense Science and Technology,* Issue 3, 2013, pp. 1–9.

Dr. Pearce is an associate professor who is cross-appointed in the Department of Materials Science and Engineering and the Department of Electrical and Computer Engineering at the Michigan Technological University, Houghton, Michigan, where he directs the 3-D printing labs. His group developed the first low-cost, 3-D printer capable of printing steel.

Ms. Haselhuhn is a Ph.D. candidate in materials science and engineering at Michigan Technological University and is developing new aluminum alloys for 3-D printing.



(Book Review, continued from page 28)

As a professional historian, Lieutenant General Bolger's book is a tribute to the dedicated Soldiers, Marines, Sailors, and Airmen who have fought in Afghanistan and Iraq since 2001. Engineer Regiment readers will appreciate the details of two Army heroes who paid the ultimate sacrifice: Medal of Honor winner Sergeant First Class Paul R. Smith, a platoon sergeant with Company B, 11th Engineer Battalion, 3d Infantry Division; and Captain Eric T. Paliwoda, commander of Company B, 4th Engineer Battalion, 4th Infantry Division (Mechanized). He provides several accounts of Army engineers fighting as infantry and serves up a primer on the use of combined arms breaching tools such as the antipersonnel obstacle breaching system and the mine-clearing line charge. Addressing the importance of getting the "Afghans in the lead," the author describes the fearless—often extremely risky—efforts of Afghan explosive ordnance disposal troops. Discussing the tactical competency of our force that he has seen during his 35 years in service, Lieutenant General Bolger appears to be a fan of Army engineers and their flexibility as the "Swiss army knife of the U.S. Army."

In addressing the gap between what happened and what was supposed to happen, the author gives clear reminders that good order and discipline are paramount on the battlefield. He smacks the reader in the face with reminders of deviations from these standards with descriptions of the detainee killings by U.S. troops in Iraq in 2005; his detailed account of the slaughter of Afghan civilians by Staff Sergeant Robert Bales in Kandahar Province in 2012; and his recounting of the severe hazing abuse and 2012 death of Private Danny Chen in Kandahar Province. One possible preventive measure suggested is for junior leaders to talk with subordinates and understand their stresses and emotional state. It is never foolproof, but vigilant leader presence can certainly help prevent the indiscipline that naturally develops when troops operate at small garrisons and other hazardous and remote locations.

This book, deliberately released for sale on Veteran's Day 2014, will cause readers to reflect on the tireless, dedicated efforts of our engineer brothers and sisters, critical civilian interagency development partners, coalition partners, and Iraqi and Afghan counterparts. Lieutenant General Bolger makes it clear that one conclusion of this AAR is that what went right involved the men and women who fought. We can all take pride in that. But, as in any good AAR at one of our combat training centers or the local "Back 40" training area, taking ownership of the lesson learned will be necessary to win the next engagement in which we are called to serve.

Essayons!

Colonel Kirk served two tours in support of Operation Iraqi Freedom and is currently attending the U.S. Army War College. He is slated to take command of the U.S. Army Corps of Engineers, Jacksonville District, in July.

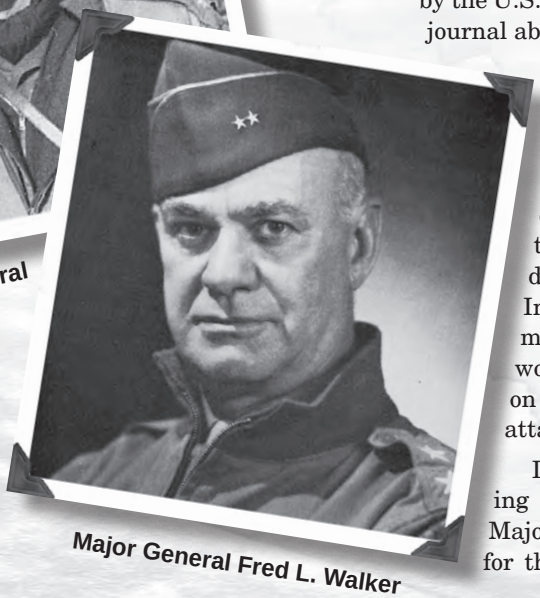
Crossing the Rapido: A Mission Command Study

By Captain Robert F. Gold

The campaign to liberate Italy during World War II was a brutal struggle where offensive gains were sometimes measured in yards. During the winter of 1943–1944, the U.S. Fifth Army offensive stalled along the formidable Gustav Line (a string of fortified positions occupied by Axis forces) that stretched from the Adriatic Sea to the Tyrrhenian Sea. The line tied together the daunting terrain feaures of the Italian peninsula with countless protective obstacles. With the aim of seizing Rome, Lieutenant General Mark W. Clark, commander of the U.S. Fifth Army, ordered Major General Fred L. Walker, commander of the 36th Infantry Division, to penetrate the Gustav Line by crossing the Rapido River in the vicinity of San Angelo on 20 January 1944. The purpose of the operation was to seize a bridgehead that armored forces could use to exploit the breach and to attack up the Liri Vallery toward Rome. This battle is important for military professionals to study because it compares two different command philosophies: mission command versus detailed command.



Lieutenant General Mark W. Clark



Major General Fred L. Walker

The philosophy of mission command, as outlined in Army Doctrine Reference Publication 6-0, *Mission Command*, helps the commander balance the art of command with the science of control.[1] Detailed command is the opposite, requiring commanders to provide subordinates with highly detailed mission orders outlining every step of an operation. Mission command is exercised through the operations process, which is driven by the following activities:

- Understand.
- Visualize.
- Describe.
- Direct.
- Lead.
- Assess.

During the attempt to cross the Rapido, Major General Walker displayed the traits of mission command and detailed command philosophies as current Army doctrine recognizes them.

Understanding is knowledge that has been synthesized and had judgment applied to it by commanders and staffs to develop meaning. Using this definition, Major General Walker had a firm understanding of the situation leading up to the river crossing, identifying it as a potential mission for his division several weeks before it was assigned to him by the U.S. Fifth Army. He wrote extensively in his personal journal about the conditions of the approaches and exits at potential crossing sites along the Rapido and included information about the high quality of the German troops occupying the Gustav Line. He used this information about the terrain and enemy to create shared understanding with subordinate commanders during staff planning for the river crossing. The strength of the German defenses was evident to the leaders in the 36th Infantry Division, with one of the deputy regimental commanders commenting, ". . . the division would fail to cross the Rapido because the defenses on the far side were too strong for infantrymen to attack and stay alive."[2]

In addition to creating shared understanding among the staff and regimental commanders, Major General Walker drove the operations process for the Rapido River crossing by conceptualizing an

operational approach. Despite being pessimistic about the outcome of the mission, he spent considerable time in his personal journal outlining his thought process on how to successfully cross the river. He balanced his understanding of the operational environment with the constraints imposed on him by Lieutenant General Clark's staff. The U.S. Fifth Army had decided many of the details for the 36th Infantry Division, such as the operation timeline, crossing sites, and far side objectives. Given the quality of the enemy and his orders from the U.S. Fifth Army, Major General Walker decided to keep the plan as simple as possible. The 36th Division had no experience conducting a wet-gap crossing under fire and there was no time to rehearse with the crossing equipment.

After visualizing an operation, commanders then describe it to the staff and subordinates, facilitating shared understanding of the situation, mission, and intent. On 17 January 1944, Major General Walker issued Field Order No. 42 regarding the Rapido River crossing. According to Fred Majdalany in his book, *The Battle of Cassino*—

> For the Rapido operation the regimental commanders were told by Division exactly how they were to handle their regiments—what battalions to employ, where their assembly positions were to be, their routes to the river and their start lines . . . the two regimental commanders who bore the burden of this operation could not help themselves. Their thinking had been done for them. They had merely to carry out an extremely difficult assignment, with little scope to influence the proceedings themselves. . . .[3]

The amount of detail in the mission orders from Major General Walker seem to lean toward detailed command rather than mission command. However, since most of the regiment, battalion, and company leaders in the 36th Infantry Division were new replacements with little time for rehearsal, it can be reasoned that Field Order No. 42 provided so much detail because mutual trust had not been established among commanders, which is a key ingredient to successfully implementing the mission command philosophy. Conversely, the order that the division staff produced laid out Major General Walker's intent to the commanders as a clear and concise expression of the purpose of the operation and the desired end state.

A major flaw of Field Order No. 42 was that it detailed how units would maneuver to the Rapido, but gave no timeline to synchronize the division efforts to cross the river. This specifically applies to the engineer support for the crossing. The order laid out numerous engineering tasks, but they were not synchronized with the infantry that would make the assault. This led to confusion during the movement to the river, such as troops wandering into minefields that had not been cleared and engineer guides failing to link up with the infantry.

Ultimately, this led to infantrymen moving the 412-pound assault boats over the 1-mile approach to the Rapido through mud flats that were strewn with antipersonnel mines and were under artillery observation and interlocking machine gun fire. Once troops made it to the river, the assault boats were quickly destroyed. However, replacement boats were not arriving due to a lack of coordination. As the assault was reaching a culminating point, an entire infantry company was ordered out of the assault and used to bring boats to the river to keep up the attack. The boat depot was located 1 mile behind the forward line of troops, effectively taking those infantrymen out of the battle for quite some time. The lack of synchronization for these engineering efforts in the mission orders was critical to the outcome of the battle. However, leaders and Soldiers still understood the commander's intent and, through the initiative of junior leaders, penetrated up to 1,000 yards in some places along the front before stopping because of heavy German fire and local counterattacks. The bridges constructed by the engineers were destroyed or swept away in the strong river current, so many Soldiers were trapped on the far side and the operation ultimately failed to achieve any of its objectives.



Medics evacuate casualties from the Rapido River area.

Commanders direct all aspects of operations by establishing the commander's intent, setting achievable objectives, and issuing



Mud deep enough to bog down this Sherman tank illustrates conditions faced by the 36th Infantry Division.

clear tasks to subordinate units. While Major General Walker did some of this, there were times when he failed to direct division efforts at the Rapido. An example of this was establishing the command post 6 miles to the rear of the forward line of troops. In his book, *Bloody River: The Real Tragedy of the Rapido*, Martin Blumenson states that Major General Walker sat at the telephone during the battle, personally answering telephone calls from his commanders, engineer officers, and others who were providing situational update reports. He saw his primary responsibility as preventing the immediate higher headquarters, II Corps, from interfering with subordinate operations during the battle. Major General Walker failed to use his staff to synthesize information into knowledge and never left his command post to see the crossing effort himself.[4]

The U.S. Army framework for exercising mission command is the operations process. Major General Walker did drive the operations process during the crossing attempt by understanding the situation, conceptualizing the means to accomplish the mission, communicating his concept, and directing his staff and subordinate commanders throughout the operations process. However, despite employing some elements of mission command, the attempt to cross the Rapido River in January 1944 was an absolute disaster. This was mainly due to the fact that the operation details were developed at the theater army level with no input from the 36th Infantry Division staff. This rigidity in mission orders ultimately led to more than 1,600 division casualties in just 2 days of fighting. It is essential that military professionals study this action because it illustrates the importance of shared understanding among commanders and staffs, the significance of a clear commander's intent, the use of mission orders to coordinate and synchronize warfighting functions, and the disadvantage of inflexible mission orders from leaders who do not have a full understanding of the situation facing their subordinates. Finally, it must be emphasized that the Rapido River crossing attempt reveals that commanders cannot rely on mission orders alone to direct subordinates to mission accomplishment. Sometimes, they must place themselves at the critical point to guide the actions of their subordinates.

Endnotes:

[1]Army Doctrine Reference Publication 6-0, *Mission Command,* 17 May 2012.

[2]Duane Schultz, *Crossing the Rapido: A Tragedy of World War II,* Westholme Publishing, Yardley, Pennsylvania, 2010, p.134.

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Captain Gold serves as the assistant regimental operations officer for the 3d Cavalry Regiment at Fort Hood, Texas. He holds a bachelor's degree in business management from Widener University, Chester, Pennsylvania.

Developing Small-Unit Leadership in the U.S. Army Corps of Engineers



By Major John K. Johannes

Small-unit leadership, particularly that of U.S. Army team leaders, is becoming an increasingly critical node of command in the current operational environment. In the U.S. Army, team leaders get mission orders and are directed to execute them. In the U.S. Army Corps of Engineers (USACE), leadermen are the first-line leaders who execute operations. USACE, Memphis District, has 19 leadermen who serve in a variety of positions and trades, including on vessels operating on U.S. inland waterways, in land-based earthmoving and construction projects, in ground and maritime maintenance, and in other trades connected to the Memphis District mission of channel improvement on the Mississippi River. Like team leaders in the Army, leadermen are working leaders who oversee three to five employees but also work alongside their employees.

The typical day for a leaderman in the Memphis District varies according to the skill or trade of the leaderman. Leadermen working on one of the district vessels during the river working season can spend months away from Ensley Engineer Yard, the Memphis District shipyard in Memphis, Tennessee. They live and work on the vessel with their coworkers for long periods of time, much like Soldiers on a deployment. Leadermen who work on construction crews may spend weeks or months on projects, living in hotels with their subordinates. These leadermen usually



The master of the dredge *Hurley* explains to a group of Army engineers how the ship's dustpan head and ladder assembly work.

"Regardless of the leadermen's trade, they are asked to oversee a small unit, execute complicated tasks based on mission type orders, and work closely with subordinates, just like a team leader in the Army."

interact with their supervisors via telephone and work with minimal guidance while on a project. Other leadermen work predominantly at Ensley Engineer Yard, but are still relied upon to work in small-unit settings. Regardless of the leadermen's trade, they are asked to oversee a small unit, execute complicated tasks based on mission type orders, and work closely with subordinates, just like a team leader in the Army.

In fiscal year 2014, Memphis District officials identified a gap in leadership training for leadermen. The traditional development method for Department of the Army civilians does not translate well to the diverse and unique work conditions and job requirements of USACE leadermen. A training method was needed to cultivate motivated and disciplined small-unit leaders capable of operating like U.S. Army team leaders in adverse and dynamic environments. Memphis District officials contacted the U.S. Army Engineer School at Fort Leonard Wood, Missouri, for assistance.

Officials at the Engineer School Directorate of Leadership Training and Development worked with the Memphis District to mature this concept and better define the problems and shortcomings in the current district training plan. They requested assistance from the Maneuver Support Center of Excellence Noncommissioned Officer Academy (MNCOA), also at Fort Leonard Wood, to adapt the Army Warrior Leader Course curriculum and provide instructors to train the Memphis District leadermen.

The MNCOA identified three noncommissioned officer (NCO) instructors to train the leadermen. Horizontal construction engineers were chosen because their technical skills and experience mirror a large portion of the trades that the Memphis District leadermen perform. After several months of planning and coordination, the NCO instructors traveled to Ensley Engineer Yard and conducted 3 days of training in February 2015. The instructors spent 1 day each on the topics of communication, problem solving, and time management, which are critical skills for the leadermen to develop as they execute tasks. The NCO instructors used the MNCOA teaching methods—the Army learning model—to encourage student participation and yield positive results. The NCOs delivered quality instruction, but the engagement was not limited to improving the leadership skills of the Memphis District leadermen. It was also an opportunity to introduce the three NCO instructors to USACE civil works operations. The NCOs were exposed to all aspects of the district, including design, construction, project management, emergency management, and operations at Ensley Engineer Yard. This exchange gave the NCOs insight into what USACE can provide to Army units, and it enriched USACE-related training at the MNCOA.

The NCOs also received professional development instruction from Memphis District employees, several of whom are recently transitioned veterans. The employees advised the NCOs on developing their technical résumés with experiences and certifications that could help them readily transfer their Army expertise to employment with USACE or elsewhere in the private sector.



Memphis District leadermen and Army engineers inspect eggs that were dropped as part of a problem-solving exercise.

The leadermen students received the expert training enthusiastically. The NCOs were the optimal instructors since they could relate their experiences as team leaders and emphasize the importance of training. The professional development that the NCOs received about USACE civil works and résumés for future employment will mutually benefit the Army and USACE as the knowledge is propagated through students attending courses at the MNCOA. The Memphis District plans to hold another similar session for a different group of leaders in fiscal year 2016.

Major Johannes is an active duty engineer officer serving as the operations officer at the Memphis District. He holds bachelor's and master's degrees in civil engineering.

ENGINEER WRITER'S GUIDE

Engineer is a Department of the Army-authenticated publication that contains instructions, guidance, and other materials to continuously improve the professional development of Army engineers. It also provides a forum for exchanging information and ideas within the Army engineer community. *Engineer* includes articles by and about commissioned officers, warrant officers, enlisted Soldiers, Department of the Army civilians, and others. Writers may discuss training, current operations and exercises, doctrine, equipment, history, personal viewpoints, or other areas of general interest to engineers. Articles may share good ideas and lessons learned or explore better ways of doing things. Shorter, after action type articles and reviews of books on engineer topics are also welcome.

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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ENGINEER DOCTRINE UPDATE

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

Publication Number	Title	Date	Description (and Current Status)
Publication Revisions			
ATP 3-34.22 (FM 3-34.22)	*Engineer Operations—Brigade Combat Team and Below*	Dec 14	This is a revision and conversion of Field Manual (FM) 3-34.22, *Engineer Operations—Brigade Combat Team and Below*, to Army Techniques Publication (ATP) 3-34.22. It is under development and will include information on the brigade engineer battalion (BEB). **Status:** Current.
ATP 3-34.23 (ATTP 3-34.23)	*Engineer Operations—Echelons Above Brigade Combat Team*	Jul 10	This is a revision and conversion from Army Tactics, Techniques, and Procedures (ATTP) 3-34.23, *Engineer Operations—Echelons Above Brigade Combat Team*, to ATP 3-34.23. **Status**: To be published 3d quarter fiscal year (FY), 2015.
ATP 3-90.61 (FM 3-90.61)	*Brigade Special Troops Battalion*	Dec 06	This is a revision and conversion from FM 3-90.61, *The Brigade Special Troops Battalion*, to ATP 3-90.61. **Status:** Staffing of the final draft is complete, and the final approved draft is being prepared. To be published 4th quarter, FY 15.
Combat Engineering			
ATP 3-34.20 (FM 3-34.210)	*Explosive Hazard Operations*	Mar 07	This is a multi-Service manual and conversion from FM 3-34.210, *Explosive Hazards Operations,* to ATP 3-34.20. **Status:** Staffing of final draft is complete, and the final approved draft is being prepared. To be published 3d quarter, FY 15.
ATP 3-90.4 (ATTP 3-90.4)	*Combined Arms Mobility Operations*	Aug 11	This is a multi-Service manual and conversion from ATTP 3-90.4, *Combined Arms Mobility Operations*, to ATP 3-90.4. **Status:** Staffing of the final draft is complete, and the final approved draft is being prepared. To be published 3d quarter, FY 15.
ATP 3-90.8 (FM 3-90) (FM 5-102) (FM 90-7)	*Combined Arms Countermobility Operations*	Sep 14	This multi-Service manual is a full revision that consolidates FM 3-90, *Tactics*; FM 5-102, *Countermobility*; and FM 90-7, *Combined Arms Obstacle Integration*. It discusses countermobility and combined arms obstacle integration and their relationship to the combined arms defense and warfighting functions with regard to wide area security. **Status:** Current.

"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

ENGINEER DOCTRINE UPDATE

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

Publication Number	Title	Date	Description (and Current Status)
General Engineering			
ATP 3-34.5 (FM 3-100.4)	*Environmental Considerations*	Feb 10	This is a conversion from FM 3-100.4, *Environmental Considerations in Military Operations*, to ATP 3-34.5. **Status:** Staffing of the final draft is complete, and the final approved draft is being prepared. To be published 3d quarter, FY 15.
ATP 3-34.40 (FM 3-34.400)	*General Engineering*	Dec 08	This multi-Service manual is a conversion from FM 3-34.400, *General Engineering*, to ATP 3-34.40. **Status:** Published 25 February 2015.
ATP 3-34.81 (FM 3-34.170)	*Engineer Reconnaissance*	Mar 08	This is a conversion from FM 3-34.170, *Engineer Reconnaissance*, to ATP 3-34.81. **Status:** Staffing of the final draft is complete, and the final approved draft is being prepared. To be published 3d quarter, FY 15.
Geospatial Engineering			
ATP 3-34.80 (FM 3-34.230)	*Geospatial Engineering*	Sep 14	This is a conversion from FM 3-34.230, *Topographic Operations*, to ATP 3-34.80. **Status:** Current.

Notes:

1. Current engineer publications can be downloaded from the Army Publishing Directorate Web site at <http://www.apd.army.mil>. The manuals discussed in this article are currently under development and/or recently published (within 6 months of review date). Drafts may be obtained during the staffing process by contacting the Engineer Doctrine Branch at commercial (573) 563-0003, DSN 676-0003, or <usarmy.leonardwood.mscoe.mbx.cdidcodddengdoc@mail.mil>. The development status of these manuals was current as of 11 May 2015.

2. Items in parentheses are publication numbers of current publications, which will be (or have been recently) superseded by the new number at the top of the entry. Multiple numbers in parentheses indicate consolidation into one manual.

3. Currently, all 30 Army doctrine publications/Army doctrine reference publications have been published. Every Army professional should have a basic knowledge of our fundamental principles since they rarely change quickly. They can be downloaded from the Army Publishing Directorate Web site at <http://www.apd.army.mil>.

Engineer leaders,

One of our key programs for the Engineer Regiment is the Doctrine Sponsorship Program. It was implemented as part of Doctrine 2015, which focused on the improvement and renewal of many of our publications. Commanders were asked to sponsor publications, based on resident skill and experience. We received great support, and the program has proven beneficial in the doctrine development process.

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Civic Action Team in Palau Starts With the ABCs—

Access Roads, Bus Stops, and Challenging Obstacles

By First Lieutenant Angela Smith

Civic Action Team (CAT) Palau 84-03 is a contingent of 11 enlisted Soldiers and two officers who are deployed to Camp Katuu in the Republic of Palau. This small but effective blend of construction engineers, mechanics, heavy-equipment operators, a welder, and a doctor comprise the only U.S. military presence in the Micronesian nation; but they play a critical role in the community and work closely with the government. After a rigorous process, they were hand-selected from the 84th Engineer Battalion, 130th Engineer Brigade, Schofield Barracks, Hawaii. Leaders chose this dynamic group for their maturity, cultural sensitivity, and ability to solve problems by thinking outside the box. Once selected, they completed a series of joint training exercises on the island of Oahu with the U.S. Navy and U.S. Coast Guard before going to Guam to gain accreditation as instructors for the National Center for Construction Education and Research. Their key missions on Palau include conducting community-driven construction projects; running an apprenticeship program to teach, mentor, and certify local Palauans in valuable trades; organizing and participating in community relations events; and providing medical outreach. As partners in a joint effort, the Army, Navy, and U.S. Air Force alternate rotations of this mission.



A Palauan apprentice stands by as his engineer mentor readies welding equipment.

Since their turnover ceremony with the Navy team that preceded them, the members of CAT 84-03 have made a significant impact on the people of Palau. They made local history as the first team to include a Palauan-American. Sergeant Mokokil Rechirei, who grew up near Camp Katuu, helped the team to mesh immediately with the local culture and community. CAT 84-03 was also the first team to participate in a local funeral, taking part in the ceremony for Specialist Miarca Sungino, a member of the 84th Engineer Battalion.

Upon arrival at Camp Katuu, the team realized that its equipment and supply system needed an overhaul. The team mechanics dove into repairing the bulldozer that was required to complete ongoing projects. In Palau's harsh



Members of CAT 84-03 and their apprentices work on the bypass road project.

tropical climate, they experienced constant hydraulic line leaks and breaks. The innovative team devised several courses of action to expedite shipments of new parts, which was an important accomplishment given the remote location and lack of other military facilities. They effectively reduced the turnaround time for identifying, ordering, and receiving necessary hydraulic lines from approximately 2 weeks to 2 days. The supply sergeant reorganized the supply system to improve tracking and prioritizing supply requests.

The team made progress on badly needed projects after assessing the needs of the community and coordinating the necessary permits, materials, and authorizations. The most important mission included starting construction on a 1-mile stretch of temporary access road that runs through overgrown vegetation and steeply sloping terrain. Once complete, this road will be the only access to the state of Ngardmau for its approximately 250 inhabitants. The road will provide passage for more than 180 days while an unsafe bridge on the main access road is under repair. Soldiers cleared and grubbed the route and installed additional drainage systems, a task deemed too daunting by other teams in the past. Members of CAT 84-03 are also fixing a septic system on a previously constructed emergency operations substation in Ngardmau. The team worked through some difficult logistical roadblocks to obtain a tank that meets specifications, fits within local Palauan practices, and requires the least amount of manpower and effort from team members so that they can focus their efforts on other important projects.

The team integrated its top three programs into one effort soon after arrival. Within a week, the team designed a mobile, quick-setup obstacle course that would provide a team-oriented physical and mental challenge for four-person teams of any age and capability in the community. The team ordered materials and constructed the obstacles with the help of apprentices, providing them with a unique training opportunity. CAT 84-03 set up and demonstrated the course and then graded members of a local fitness group as they completed the obstacle course. Other members of the community joined in, and 30 teams eventually ran through the course in a single 3-hour period. Since that event, leaders of the Palau National Olympic committee and local schools have requested the use of the obstacle course. The Honorable Amy Hyatt, U.S. ambassador to Palau, welcomed the popularity of the obstacle course since it falls in line with her efforts to instill healthy lifestyle behaviors in the younger Palauan generations.

In another project, CAT 84-03 members and apprentices constructed a bus stop for the elementary school in the town of Airai. Instead of standing in the rain or in a cramped shelter to wait for the bus, students now have a spacious, comfortable overhang complete with benches. The members of CAT 84-03 provide mentorship and training for apprentices, just as good noncommissioned officers do for their Soldiers. The CAT 84-03 apprentices recently had a surge in passing grades on the written tests and practical examinations that they took to gain certification. One apprentice even completed the entire program ahead of schedule. Since arriving, the team hired three new apprentices in an effort to pass their knowledge along to local workers who will remain in Palau.

The CAT members work hard to complete construction projects and maintain the following resources and facilities on the camp:

- Medical facility.
- Gymnasium.
- Basketball court.
- Outdoor movie screen.

The camp is open to the public daily. The team showcases movies on Friday and Saturday nights and at other times and locations throughout the week. It also hosts a weekly radio show to provide locals with entertainment, awareness of CAT activities, and medical and health tips.

Members of CAT Palau 84-03 have made significant contributions to the beautiful Republic of Palau and have big plans for the rest of their deployment. They are inspired by the phrase, *Ke Molasm!* (Palauan for "Let Us Try.")

First Lieutenant Smith is the officer in charge of CAT Palau 84-03. She is a graduate of the U.S. Army Airborne School, the Sapper Leader Course, and the Joint Humanitarian Operations Course. She holds a bachelor's degree in defense and strategic studies from the U.S. Military Academy–West Point, New York.

USE OF INDIGENOUS MATERIALS

For Construction in the Modern Base Camp

By Captain Aaron H. Ellinger, Captain Daniel B. Powell, Captain Jered L. Stokes, Dr. William Showalter, and Dr. Robert Tucker

Three U.S. Army captains recently worked with professors from the civil engineering and geology departments of Missouri University of Science and Technology (S&T) at Rolla to expand their engineering knowledge of environmental geochemistry by using natural materials to experiment with force protection alternatives. Force protection around expeditionary base camps is a key planning factor to ensure the safety of personnel living and working at the base. From the experience gained in many theaters of operations, a standard force protection package has been developed to provide personnel with physical and psychological security. However, these measures come with a huge cost and require resources that often are not readily available in the host nation. Using their own deployment experiences, the officers began a research program to investigate the use of indigenous materials to make adobe blocks for use as a base camp construction material.



A field expedient screen removes pebbles from clay.

The two types of barriers most commonly used as ballistic protection around base camps are reinforced concrete wall sections and earth- or rock-filled wire bastions. The reinforced concrete wall sections, called T-walls® for their cross-sectional shape, are made in a mold filled with a rebar cage reinforcement, and then covered with cement. The walls are typically 8 inches thick and can be made almost any height. The wide base offers stability, which can be reinforced when the tops are tied together with wire rope. The mass of these barriers

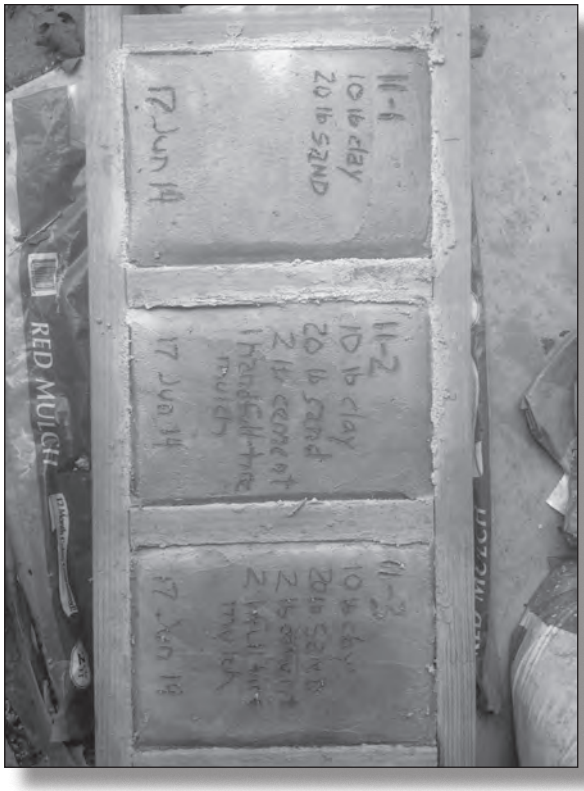
stops most bullet and shrapnel projectiles and absorbs larger blasts by falling down. T-walls require heavy-lift capability to haul them to a site and large cranes to construct a wall.

The wire bastions are manufactured in many sizes and are typically lined with geotextile fabric and filled with a variety of materials, including rocks and earth. They typically make walls 4 feet thick and usually are not constructed over 12 feet tall. They stop projectiles and blasts by their sheer mass. The U.S. military uses the version built by the Hesco® Bastion Corporation. The Hesco Concertainers® were initially used by the British military during the first Gulf War in 1991. After the 1996 Khobar Towers attack, the Hesco product line was chosen for force protection of U.S. military assets around the world.[1]



A fulcrum device tests the strength of an adobe block.

The current use of T-walls and Hesco bastions for ballistic force protection on expeditionary military bases is quickly becoming a resource-constrained option. The cost of purchasing, transporting, and emplacing these barriers is quickly outpacing the budget, policy, and philosophy of the future base camp. The goal for the future expeditionary force is to deploy to a safe, cost-effective, self-sustaining, and easily transferred base camp. Currently, the use of dimensional lumber to build hutments incurs a huge cost in materials, transportation, and manpower. Often, local workers are not trained in the use of these building materials. However, due to outmoded definitions of temporary, semipermanent, and permanent construction materials, military planners must use only dimensional wood products. This glaring disconnect is very costly and incredibly inefficient; fortunately, it is easy to remedy. One way to lower costs is to employ local populations and use indigenous materials to produce adobe blocks for construction.



Adobe blocks are marked with the materials used to formulate them.

The adobe block has been used to construct substantial structures for millennia. Basic adobe blocks are typically constructed of clay, sand, water, and a binder such as straw or Portland cement. These materials are present in most locales worldwide. Adobe blocks provide a customizable construction option because of their smaller unit size, low weight, and ability to be produced on-site to build structures by hand. Adobe is also well known for its insulating characteristics. Using binders and mass, adobe provides significant protection against heat, cold, projectiles, and blast. It is also nonflammable, which is a significant improvement over wood or canvas.

The authors worked to generate adobe block data with a three-part goal:

- To test the binding capacity of various fibers.
- To determine crushing strength (the ability to resist a mechanical piston).
- To test the ballistic penetration properties of the adobe blocks under field trials.

They conducted multiple experimental iterations by looking at three mixtures to identify recipes for creating adobe bricks to withstand ballistic impact and blasts. The construction techniques used were rudimentary or performed



A hand-cranked piston tests the compressive strength of a block.

by hand with easily constructed devices to mimic the most likely conditions in an expeditionary environment. For the bricks, they used a silica-based sand available from local home improvement stores. The clay came from two sources: red clay from Fort Leonard Wood in central Missouri and kaolin from a mine approximately 30 miles from Fort Leonard Wood. The water came from the local municipal supply.

The 5.5- by 5.5- by 11-inch molds were formed using standard 2- by 6-inch dimensional lumber. The 3.5- by 8- by 12-inch molds were made using 2- by 4-inch dimensional lumber. For making thick, interlocking walls, it is necessary to make the width and the length of the blocks even multiples of the thickness. For example, a 2-foot-thick wall could have interlocking adobe blocks that are 8 by 12 inches wide. A 12-inch by 12-inch block would not make an interlocking wall. The bricks were made in many batches over the course of a semester. Too much sand in the mixture caused bricks to fall apart under their own weight. Too much clay caused bricks to shrink too much during curing, forming too many cracks for the bricks to be used in construction. The bricks were left in the molds for a week to dry and then removed and left to dry for several more weeks to ensure a consistent moisture content before testing.



A block fails the compression test.

The base ratio of sand to clay for these experiments was 30–40 percent clay to 60–70 percent sand by volume.[2] This mix ratio was corroborated by different sources, including Mr. Quentin Wilson, a licensed contractor who has been building adobe homes commercially for more than 30 years.[3] Materials ranging from cement, to rubber mulch, to plastic sandbag fibers were added to the basic mix to determine their effects on brick compressive strength and penetration resistance.

The red clay from Fort Leonard Wood contained shards of chert more than 1 inch long and required sieving. The metal screen used for a sieve, known as a No. 4 sieve, had holes approximately 0.25 inches wide. The material that fell through the screen was shoveled into a wheelbarrow and combined with the remaining components of the adobe mix.

Sand and clay weigh about 5 pounds per shovelful, and Portland cement weighs about 8 pounds per



Right: Blocks of different composition display different results from the impact of 9-millimeter projectiles.

Below: A split block displays the depth of penetration of a projectile.

shovelful. The cement was measured in a calibrated plastic container. The remaining elements of the mix were added to the wheelbarrow and blended with a long-handled hoe. Water was added until the mixture reached a consistency that could easily be scooped into the molds. If cement was mixed into the adobe, water content was kept as low as possible to prevent a reduction in cement strength. To avoid layering in the molds, material was thoroughly mixed as it was added. Straw is the traditional fibrous material that has been used in adobe for thousands of years. While straw doesn't directly provide strength to the bricks, it provides excellent resistance to the cracking that can occur while the bricks dry. This study did not analyze the effects of different quantities of straw, but it is noted that a double handful (approximately 40 cubic inches) of loose straw added to the base adobe mix increased the cracking modulus (Pc), or resistance to cracking, and compressive strength (Pu) by about 50 percent. Although no bricks containing straw were tested for ballistic resistance, it is safe to assume that the increase in compressive strength due to straw would also increase resistance to penetration by projectiles in a fashion similar to sandbag fibers.

Plastic sandbag fibers were tested as an alternative to straw since they can be transported easily, weigh less than 0.5 pound per bag, and take up little space when empty. Woven plastic items such as sandbags, feedbags, and tarpaulins are common materials that are readily available in most U.S. Army locations. The sandbag fibers seemed to have an effect similar to natural straw, increasing compressive strength and resistance to cracking by roughly 50 percent. Sandbag fibers added to the bricks did not seem to have a significant impact on ballistic resistance compared to the base brick composition.

Burlap fibers were also tested as an alternative. Containers with burlap fibers are used for many bulk commodities, making them available in most local economies. The texture of burlap fibers provides a large surface area for adhesion



to the adobe materials. To ensure a comparable quantity of fibers, each burlap bag was cut to 14 by 26 inches before deconstruction into single fibers. The bricks containing burlap did very poorly during ballistic testing. One brick was completely penetrated while the other was penetrated over 50 percent more than the other bricks. The amount of burlap used in the adobe probably reduced the bonding strength of the clays, resulting in a weak structure.

Cement is the best additive for block strength. Obviously, the more cement added to a brick, the better it will perform, assuming that the other ingredients do not change. The blocks containing a minimal amount of cement set up within 24 hours, had virtually no shrinkage, and were significantly more stable in the rain and other elements. With few exceptions, the addition of 1 pound of cement in a block raised the ultimate compressive strength by about 100 pounds per square inch (psi). The addition of a second pound of cement raised the compressive strength to about 200 psi. When the amount of cement was increased to 4 pounds, the compressive strength rose to 350 psi. There are some discrepancies

"The compressive strength testing was performed with a hand-turned device that measured the applied force as a piston pushed down on a brick."

in these trends due to varying starting moisture content and the quantity and type of fiber added. A small amount of cement also provides considerable weather protection. There was no appreciable ballistic protection increase between the base adobe mix and the addition of 2 pounds of cement. Thus, the addition of cement allows an increase in wall height but not in ballistic protection unless significantly more cement is added.

Bricks were subjected to compressive testing and ballistic testing. The compressive strength testing was performed with a hand-turned device that measured the applied force as a piston pushed down on a brick. Failure generally came quickly. Brick failure was determined as the pressure at which the brick could no longer resist the machine. The modulus of cracking was determined to be the force at which the brick cracked along one entire face. To reflect the forces that would be applied during actual use, we oriented the bricks so that the pressure was applied along the shortest height of the brick. Mr. Duane Newcomb recommends a compressive strength of 300 psi to be safe for construction.[4] One brick was crushed to determine the representative strength for batches that were to undergo ballistic testing. For batches not to undergo ballistic testing, all bricks in the batch were tested using the compressive testing.

Our final exam was the ballistic testing. Bricks were shot from a distance of about 30 feet with a 124-grain, full metal jacket, 9-millimeter bullet with a muzzle velocity of about 1,100 feet per second. We calculated that the bullets hit the bricks with roughly 330 foot-pounds of penetration energy. After each shot, bricks were examined to document the amount of cracking and spall produced from the impact and the level of penetration of the bullet into the brick. By dividing the amount of penetration energy by the depth of penetration, we calculated a coefficient of penetration (Cp). We also fired .22-caliber and .38-caliber lead bullets into the blocks.

Results and Recommendations

Bricks from batch No. 3 (see Table 1), combining sand, clay, cement, and sandbag fibers, were the only ones that performed well enough in the crushing and ballistic tests to be recommended for use. We did not observe

Block	Dried weight (pounds)	Dried dimension (inches)	Pc (psi)	Pu (psi)	9-mm penetration (inches)	Ingredients	Quantity
C-1	16.2	5x5x10	93.7	187.4		Clay (shovelful)	13
C-2	16.6	5.1x5x10			8	Sand (shovelful)	0
C-3	19.5	5.1x5x10			8	Cement (pound)	0
						Other	0
1-1	19.5	5.5x5.5x11	115.3	118.9		Clay (shovelful)	9
1-2	20.4	5.3x5.6x10.8			2.6	Sand (shovelful)	4
1-3	19.6	5.3x5.5x10.8			2	Cement (pound)	0
						Other	0
2-1	20.9	5.5x5.5x11	185.2	216.2		Clay (shovelful)	9
2-2	20.9	5.4x5.3x11			2.5	Sand (shovelful)	4
2-3	19.6	5.1x5.4x10.8			1.6	Cement (pound)	0
						Sandbag fiber (sq in)	729
3-1	22.6	5.4x5.6x11	884.2	978.9		Clay (shovelful)	9
3-2	22.6	5.5x5.8x11			1.6	Sand (shovelful)	4
3-3	23.2	5.5x5.8x11			2.0	Cement (pound)	2
						Sandbag fiber (sq in)	729
4-1	22.5	5.5x5.5x11	137.1	400.0		Clay (shovelful)	13
4-2	23.0	5.5x5.5x11			8	Sand (shovelful)	0
4-3	22.3	5.5x5.5x11			3.5	Cement (pound)	0
						Burlap fiber (sq in)	729

Legend:
sq in - square inch mm - millimeter

Table 1. Compressive and ballistic testing of adobe bocks



Right: A fiber-filled block shows the results of ballistic testing.

Bottom: Finished adobe bricks await testing.

a strong correlation between brick compressive strength and ballistic penetration resistance. Individual bricks and bricks at the top of a wall will not perform as well as bricks located in a lower part of the same wall due to the added compressive strength and expansion resistance that results from having other bricks atop and beside the brick impacted by the projectile. We recommend that the batch recipes and results from this study be used only as a starting point for actual adobe construction composition. Once a recipe is selected, it is imperative that on-site testing be performed on at least 5 percent of each batch to ensure quality control since environmental conditions, local material type and quality, and construction methods have an enormous impact on the ultimate strength of the bricks. To determine the required thickness of a wall, calculate the penetration energy that the wall must be able to resist and then divide that energy by Cp to get a minimum thickness.



Endnotes:

[1]"History—About Us," November 2014, <www.hesco.com/about-us/history>, accessed on 23 March 2015.

[2]Duane Newcomb, *The Owner-Built Adobe House*, Scribner, New York, New York, 1980, cited by *Mother Earth News*, Ogden Publications Inc., March–April 1981, <http://www.motherearth-news.com/green-homes/making-adobe-bricks-zmaz81mazraw.aspx>, accessed on 23 March 2015.

[3]Quentin Wilson, "Appropriate Mixes for Adobe," Greenhomebuilding.com: Building Today for Tomorrow, <http://www.greenhomebuilding.com/QandA/adobeQandA.htm>, accessed on 23 March 2015.

[4]Duane Newcomb, Mother Earth News: The Original Guide to Living Wisely, <http://www.motherearthnews.com/green-homes/making-adobe-bricks-zmaz81mazraw.aspx?PageId=2>, accessed on 12 March 2015.

Reference:

"Ballistic Calculator," Gundata.org, <http://gundata.org/ballistic-calculator/>, accessed on 23 March 2015.

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FROM TRADESMAN TO JOURNEYMAN

The Unyielding Demand for Highly Skilled Construction Engineers

By Captain Matthew A. Wright

With the war in Iraq finished and the fighting in Afghanistan winding down, there came a change in the type of carpentry and masonry specialists—construction engineers—needed to meet the needs of the Army. The days of only needing proficiency in theater of operations construction are over. Today's Army demands construction engineers who are trained in more than expedient, light, or rough framing, flooring, and foundation installation. Army construction engineers today are frequently asked to conduct finish carpentry projects with little or no experience. The same is true of the leaders who manage these projects. The Soldiers of the 76th Engineer Company (Vertical), 19th Engineer Battalion, Fort Knox, Kentucky, repeatedly had to undertake such missions in Kuwait, for which they were ill-prepared. The problem lies not with the competent and capable noncommissioned officers who led these projects because these great leaders were never formally trained in these specialty skills either. Army construction engineers, who are often cross-trained as electricians and plumbers, lag far behind their peers in the U.S. Navy and U.S. Air Force who are offered longer, more detailed advanced individual training (AIT) and more opportunities to obtain professional construction certifications in their trades. The demands for highly skilled construction engineers will not cease. We owe our Soldiers better training and more opportunities to obtain civilian certification.



A Soldier installs drop ceiling components in a relocatable building at Camp Arifjan.

In November 2013, the 76th Engineer Company (Vertical) deployed to Kuwait to support Operation Enduring Freedom. Upon arrival at Camp Arifjan, the unit found an installation which had suffered a rainstorm, bringing amounts of precipitation that Kuwait had not seen in 60 years. Nearly 1 inch of rain fell in 4 hours in a country where rainfall averages less than 5 inches per year.[1] The installation was hastily built in 2000 with an inadequate drainage plan. Compounding the problem was a giant dirt wall that surrounded the installation and acted as a barrier to keep the water in. The lack of drainage caused buildings to flood, concrete walls to topple, and black mold to grow on the interior of structures. Installation and regional commanders looked to the 19th Engineer Battalion to quickly bring the installation back to life.



A construction engineer installs vinyl tile at the U.S. Army Materiel Command complex on Camp Arifjan.

While the 15th Engineer Company (Horizontal), 19th Engineer Battalion, established a drainage system, the construction engineers of the 76th Engineer Company (Vertical) and a unit of the Louisiana Army National Guard demolished the interior of buildings that were deemed uninhabitable due to mold and structural damage caused by flooding. Wood rot had set in quickly, and mold spores were found soon after the flood waters receded. Dozens of buildings in living areas had nearly a foot of standing water. Hundreds of floor systems, including vinyl, laminate, and tile flooring; floor joists; vapor barriers; and insulation had to be removed and disposed of properly. Standing water also damaged interior walls in these buildings. Thousands of linear feet of drywall and wall studs had to be removed and replaced. Many of these walls were constructed using sheetrock texturing techniques mentioned nowhere in Technical Manual 3-34.47, *Carpentry*.[2] Construction engineers developed bills of materials for items they were never trained to install. Online videos became an important resource for carpenters unfamiliar with the application techniques of these new skills. Their Army National Guard counterparts had greater exposure to these materials and skills because many of them worked as construction workers in their civilian lives. Only a handful of the Regular Army Soldiers of the 76th Engineer Company (Vertical) could make the same claim. There was a palpable lack of understanding about how to apply joint compound to drywall, how to sand it, and how to properly paint it. There was an even greater disparity of skill in the installation of floor systems, most noticeably in the application of floor tile adhesives. Too often, adhesive seeped through joints between pieces of tile or bubbles appeared when proper seals were not applied. This required the tedious removal of thousands of floor tiles that were already improperly bonded to the subfloor. There is no way to know the dollar value of material wasted on improperly applied adhesives, drywall, joint compound, and paint during the unit's 9-month deployment.

Technical Manual 3-34.47 addresses some aspects of the finish carpentry skills encountered. As many construction engineers would agree, learning construction skills from a textbook is not as valuable as learning the skills by performing them. Drop ceiling installation was a frequent requirement for vertical engineers who had never been trained for the task. Camp Arifan officials planned to refurbish 11 relocatable buildings from Ali Al Salem Air Base, each with rooms that had drop ceilings. When the buildings were transported, their drop ceilings were removed and packed without organization. Parts were mixed and components were lost, which led to painstaking hours of trying to assemble a puzzle with missing pieces. Again the engineers created bills of materials for unfamiliar components. The Internet was invaluable in solving these puzzles. The results the Soldiers produced are evident from the awards they received and the accolades they garnered from the senior leaders of U.S. Army Central Command. However, the Army could offer them much more for very little cost.

Each year, more than 700 Soldiers graduate from a 7-week course at the Naval Construction Battalion Center at Gulfport, Mississippi. Carpentry and masonry (Military Occupational Specialty 12W) AIT is taught in two phases—A and B—that cover the basics of concrete construction, drawing and plan interpretation, masonry, wall framing, floor framing, door and window installation, and a few other carpentry tasks. The curriculum seldom addresses finish carpentry. Alongside the Army carpenters, Navy and Air Force carpentry specialists attend



Flooding caused the road collapse that trapped a vehicle at Camp Arifjan.

the same classes. However, after the Soldiers leave at the end of the Phase B, Sailors and Airmen attend an additional Service-specific phase. For example, the Navy Phase C covers finish carpentry and lasts 1 1/2 weeks. The Air Force Phase C lasts slightly longer and covers finish carpentry, welding, and prefabricated structures. The instruction on welding would be valuable for Army construction engineer units whose modified table of organization and equipment calls for one welding trailer per platoon, yet whose members receive no formal training in welding techniques. Only a small fraction of Army students are able to attend the additional phases and only if they are held over at the training center for administrative reasons. Army instructors occasionally attend the courses between AIT classes. Vertical engineer companies will only have these skills if they have Soldiers who were AIT holdovers or instructors or had experience in finishing techniques before joining the Army. All three cases are uncommon.

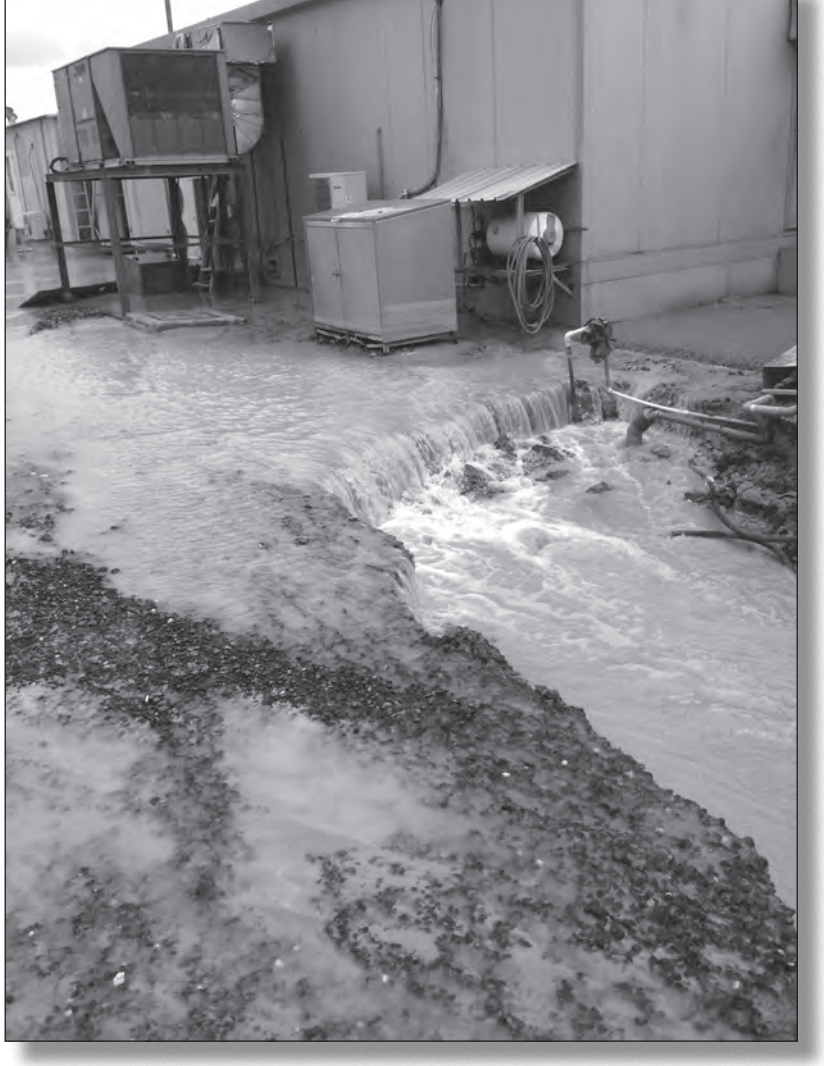
This is not the first call for more technical training for construction engineers. In November 1989, *Engineer* published an article, "Leadership and Quality Construction," that discusses construction standards, training, and the establishment of quality control measures in construction. The article distinguishes between theater of operations construction and troop construction, which is defined as any structure built to last longer than 24 months. At the time, no doctrine existed to address troop construction.[3] This is still the case since the preface of Technical Manual 3-34.47 states that it is only to be used for theater of operations construction.[4] The book knowledge is available to Soldiers on commercial bookshelves, but the Army must draft its own manual to address permanent troop construction. The Army should train carpenters in the basics of finish carpentry by developing doctrine and giving Soldiers greater opportunities to obtain civilian certifications. Only then can the construction engineers in vertical construction units reasonably be asked to perform these tasks.

The requests for quality construction work continued even after the 76th Engineer Company (Vertical) redeployed from Kuwait. In March 2015, the company began



Roads and sidewalks failed across the installation after flood waters hit. This roadway shoulder and electrical junction box were destroyed by the flood.

remodeling the Kouma Child Development Center at Fort Knox, Kentucky. The building was a dining facility before being remodeled into a child development center in 2012. After just 11 months in operation, the center closed its doors and the engineers were asked to return the building to its role as a dining facility. This will require Soldiers to lay tile, texture or paint walls, install kitchen appliances, and perform many other tasks they are not formally trained to do. This type of training is an outstanding opportunity for the construction engineers of the company and is in line with what Colonel Adam Roth, Chief of Staff for Reserve Affairs in the Office of the Chief of Engineers, envisioned for a program he called "Net Zero for Training Through Construction."[5] As this program takes hold on Fort Knox and other installations, construction engineers will be asked to perform tasks that exceed their level of training and will be expected to meet the quality standards of the International Building Code and the ASTM International. Colonel Roth suggested that units place Soldiers at installation directorates of public works to help engineer units gain access to this sort of construction. The Engineer Regiment is actively seeking challenging construction missions, and it is obvious that Army engineers cost taxpayers much less than other sources of skilled carpentry. It seems only right that the Army train its Soldiers in the basics and help them obtain civilian certifications so that they can accomplish these missions to standard.



Roadways collapsed due to poor soil quality and lack of drainage.

In 2012, Army Chief of Staff General Raymond T. Odierno instituted a new transition program titled "Soldier for Life." The program ensures that eligible Soldiers have the education, training, and counseling to be career-ready when they leave active duty service. It helps them make informed career decisions through benefits counseling and employment assistance. The best way to benefit transitioning construction engineers would be to help them obtain civilian training certifications while serving on active duty. Before deploying to Kuwait, the 76th Engineer Company (Vertical) accomplished this by sending 24 Soldiers to a community college near Fort Knox for training to repair heating, ventilation, and air conditioning. The training certified them as technicians in refrigerant recycling and was used during the deployment. The training also included welding and electrical systems evaluation and was secured through an acquisition review board packet submitted through the chain of command to the corps level. Also, one of the unit's junior leaders built a lasting relationship with a local branch of a home repair retail giant. The manager of the store near Fort Knox brought in an industry specialist to teach the construction engineers the latest techniques in drywall repair and finishing. The 1-day event cost more than $1,000 in materials, a bill that was paid by the store. Both of these instances were exceptional and only came to fruition because leaders saw the long-term benefits for the unit and Soldiers in seeking out specialty training. It is time that these exceptions became standard operating procedures among vertical engineer companies.

Endnotes:

[1]"Average Precipitation in Depth (Millimeters Per Year) in Kuwait," Trading Economics, <http://www.tradingeconomics.com/kuwait/average-precipitation-in-depth-mm-per-year-wb-data.html>, accessed on 23 March 2015.

[2]Technical Manual 3-34.47, *Carpentry*, 20 September 2013.

[3]Edward Hayes and Terry Wendt, "Leadership and Quality Construction," *Engineer*, 1 November 1989, pp. 16–19.

[4]Technical Manual 3-34.47.

[5]Adam Roth, "Net Zero for Training Through Construction," *Engineer*, January–April 2014, pp. 14–16.

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FORT PICKETT OFFERS ENGINEER PROJECT OPPORTUNITIES

By Captain Andrew J. Czaplicki

The constant loud booms and clouds of dust coming from the U.S. Army National Guard Maneuver Training Center at Fort Pickett, Virginia, for the past year are not just the result of cannon fire but are the sounds and signs of progress. Construction contractors, employees, and military engineers have been building and renovating more than 53 buildings, roads, and training areas throughout more than 42,000 acres of the facility. Crews have been demolishing structures that are outdated or no longer required, renovating 1940s-era barracks, upgrading and refurbishing dining facilities, and incorporating advanced environmental controls over the past year.

> ***"Units can crack rock, haul it to project sites, and meet job-specific training requirements at the same time [as quarry training]."***

During 2014, the Fort Pickett Directorate of Public Works (DPW) identified, evaluated, designed, and awarded contracts for 75 projects, totaling more than $2 million. Construction scheduled for 2015 will reach nearly $1 million. However, as the need for fiscal efficiency increases due to declining resources, officials are looking for alternative measures to reduce costs. The Fort Pickett director of public works said that military engineers have the required skill sets to perform much of the construction needed. DPW officials consulted with the garrison command and tenant organizations and pored over a stack of nonpriority projects. Then they loaded the projects into the U.S. Army Corps of Engineer (USACE) Reachback Engineer Data Integration (REDI) portal, becoming the first Army National Guard maneuver training center to use the system. It provides a common database, a robust user interface, and fully integrated mapping tools to receive, manage, track, and archive the data and engineering reachback support provided by USACE. The REDI portal allows users to submit requests for information, receive updates, and track the status of requests. Users can search the historical database and request support for other USACE capabilities. They can also search worldwide for engineer projects or zoom into a geographical area using an interactive map to locate projects with the Army Facilities Components System.



U.S. Army National Guard photo by Staff Sergeant Terra C. Gatti

Soldiers from the 1033d Engineer Support Company, 276th Engineer Battalion, prepare to install a culvert at Fort Pickett. The engineers improved roads and installed culverts during their 2-week annual training period.

The REDI Web site provides a single-source database for uploading and downloading many types of projects. Unit users can query by geographic area, state, type of construction, or type of equipment to find a project for their unit to complete. The site also allows facility users to search nationwide to see the location of various units and the type of projects they might be interested in performing.

Fort Pickett has carpenters, electricians, plumbers, and other engineers on staff who can recommend projects for particular units. Every project has an environmental impact and must be reviewed and approved by the installation environmental office. Each project is evaluated on a case-by-case basis, and the assessments can take up to a year to complete. Once environmental and real property evaluations are completed, the project can be published on the Web site and coordination with units can begin.

There are roads to be graded or recrowned, culverts to be installed, and electrical and plumbing retrofitting projects to be completed. There are projects to match nearly every skill that military engineers are trained to perform. The REDI Web site allows users to upload a generic scope of work for each project, which allows custom tailoring of each project to meet the training needs of the supporting unit.

The program seeks to blend the two schools of thought on Army engineer training: one that focuses on training, missions, and deployments and the other that focuses on facilities engineering and civil works. Ideal projects last 7 to 9 days so that units can complete the project during mandatory unit training. A DPW spokesman said that there are many vertical and horizontal construction projects that can challenge levels of experience from novice to skilled tradesman. There are also a variety of specialty projects such as well drilling and quarry operations. Fort Pickett is home to one of the only training quarries available for military quarry units. Units can crack rock, haul it to project sites, and meet job-specific training requirements at the same time. The installation will provide the bill of materials for projects and may also cover other costs. Fort Pickett maximizes its limited resources and units receive hands-on training that would be difficult to get elsewhere.

Units from the U.S. Marines, U.S. Navy, Army National Guard, and U.S. Army Reserve have participated. Even quartermaster and pipeline units have completed projects at Fort Pickett. Beginning in 2016, projects at the Camp Pendleton Collective Training Center, Virginia Beach, Virginia, will be loaded onto the REDI system so that units can complete a variety of projects in a different environment.

Captain Czaplicki is the public affairs officer at the Fort Pickett Army National Guard Maneuver Training Center. He holds a bachelor of arts degree from the Virginia Military Institute at Lexington, Virginia. He is a graduate of the U.S. Army Chemical, Biological, Radiological, and Nuclear Basic Officer Leaders Course and the U.S. Army Adjutant General Captains Career Course.

We Need Your Photographs!

Engineer **is always looking for good-quality, action photographs (no "grip and grins," please) to use on the outside covers. If you have photographs of Soldiers who are in the proper, current uniform and are participating in training events or operations or photographs of current, branch-related equipment that is being used during training or operations, please send them to us at <usarmy.leonardwood.mscoe.mbx .engineer@mail.mil>. Ensure that photographs depict proper safety and security procedures, and do not send copyrighted photographs. All photographs must be high-resolution; most photographs obtained from the Internet, made smaller for e-mailing, or saved from an electronic file such as a Microsoft® PowerPoint or Word document cannot be used for print. In addition, please include a caption that describes the photograph and identifies the subject(s) and photographer (if known). Please see our photograph guide at <http://www.wood .army.mil/engrmag/Photograph%20Illustration%20Guide.htm> for more detailed information.**


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