Getting it Right: The Endurance of Improvised Explosive Device Education in the US Army

A Monograph

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While the major Global War on Terrorism (GWOT) conflicts close, other powers seek to counter United States dominance with methods that do not involve major combat operations. The use of cheap and easily acquired parts for IEDs will support their continued use. Therefore, a key to success in future conflicts is retaining and institutionalizing the knowledge gained through recent experiences while understanding the evolution of threats.

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Abstract

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As the United States seeks to maintain its influence abroad, hostile nations and non-state actors will attempt to leverage the low-cost effectiveness of improvised explosive devices (IEDs) to disrupt US military operations. These cheap devices, made from relatively easily acquired components, will enable the continued use of the IED on the modern battlefield. While the US spent billions of dollars to counter this seemingly new IED threat, the devices used in Iraq and Afghanistan were similar in nature and effect to the booby traps used in Vietnam. The Army's failure to retain the institutional knowledge gained from its experiences with booby traps in Vietnam resulted in an initial inability to provide support for the detection and clearance of these devices and targeting of assembly/emplacement networks. Instead, the Army rushed the force management process, specifically within the Engineer Regiment, to refocus its efforts, regrow the skillset, and organize to meet the threat.

While the major Global War on Terrorism (GWOT) conflicts close, other powers seek to counter United States dominance with methods that do not involve major combat operations. The use of cheap and easily acquired parts for IEDs will support their continued use. Therefore, a key to success in future conflicts is retaining and institutionalizing the knowledge gained through recent experiences while understanding the evolution of threats.

Contents

Acronyms

AHD	Anti-Handling Device
AIT	Advanced Individual Training
AN/PSS	Army-Navy/Portable Special Search
APC	Armored Personnel Carrier
BEB	Brigade Engineer Battalion
BSTB	Brigade Special Troops Battalion
CC	Clearance Company
C-IED	Counter-Improvised Explosive Device
COIN	Counterinsurgency
COTS	Commercial Off-the-Shelf
CREW	Counter Radio Controlled Improvised Explosive Device Electronic Warfare
DOD	Department of Defense
DOTMLPF-P	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy
DtD	Defeat the Device
EH	Explosive Hazard
EOD	Explosive Ordnance Disposal
ERW	Explosive Remnant of War
GWOT	Global War on Terrorism
HSTAMIDS	Hand-held Standoff Mine Detection System
IED	Improvised Explosive Device
IED-D	Improvised Explosive Device-Defeat
JCIDS	Joint Capability Integration and Development System
JIDO	Joint Improvised-Threat Defeat Organization
LMC	Low Metallic Content

MACV	Military Assistance Command, Vietnam
MTOE	Modified Table of Organization and Equipment
NCO	Non-Commissioned Officer
PME	Professional Military Education
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
RCC	Route Clearance Company
RCIED	Radio Controlled Improvised Explosive Device
RCP	Route Clearance Package
USARV	US Army, Vietnam
UXO	Unexploded Ordnance
VCTS	Virtual Clearance Training System
VOIED	Victim Operated Improvised Explosive Device

Introduction

> . . . Because of the pervasive misconception that our current operational dilemma was unique, theater-specific, and of a limited duration, there was little incentive to alter the status quo and rectify our training strategy.
>
> —Dorian D'Aria, *Adapting the Army*

Studies of historically noteworthy conflicts often evoke comparison. While history does not repeat itself, common themes emerge regarding actions of each participant and their success or failure. These themes provide a basis for future militaries to incorporate, adapt, or otherwise prepare for encountering these situational eventualities on the battlefield.

The US military left Vietnam with robust counter-improvised explosive device (C-IED) experiences and knowledge, part of the greater counter-insurgency skillset developed by soldiers assigned to the Military Assistance Command, Vietnam (MACV) between February 1962 and March 1973. However, the military retained little of this experience in doctrine, training, or force structure as the Army's focus shifted to a new operating concept focused on maneuver-centric warfare against a near-peer threat from the Soviet Union throughout the 1970s and 80s. The close of the Cold War in 1990s ended the perceived threat of large scale, force-on-force, warfare for the moment. New threats emerged in Africa and the Balkans; old threats gained renewed interest in the Middle East.

From the mid-1990s to the summer of 2001, the Army's focus was on limited warfare and peacekeeping operations. Non-state actors, under the banner of the terrorist organization Al-Qaeda, attacked the United States on September 11, 2001, forcing the Army to again reassess its focus. The war that followed led to significant investments of time, money, and blood in relearning the C-IED lessons forgotten during thirty years spent avoiding guerrilla warfare using conventional ground forces. While lessons learned from Iraq and Afghanistan guide today's engineer force structure and training in the C-IED fight, the Engineer Regiment must not lose interest as the focus for the training of tactical and operational units pivots back to major combat operations. Letting today's lessons suffer a fate similar to that of lessons learned during the Vietnam War will place the US Army at a disadvantage if the common threat of effective, low-cost weapons, fades and then reemerges to challenge US maneuver formations.

Faced with the significant costs of relearning C-IED lessons from Vietnam during the Global War on Terrorism (GWOT), the US Army has carefully and deliberately integrated existing and emerging C-IED knowledge, formations, and solutions into the modernization of the Engineer Regiment, enabling a robust force capable of responding to current low-cost threats and poised to overcome future challenges. To demonstrate this, through comparisons of Vietnam and Iraq, one must answer how the Engineer Regiment: identified what was happening; what was required; what was available, or being done and thus, what was the gap between requirements and resources; what were the solutions for filling those gaps; and what the Engineer Regiment did, or failed to do, to help the solution endure.

The examination of institutional response to the challenges presented by these low-cost threats, primarily improvised explosive devices (IEDs), is broken into three parts, each examining a different aspect of the threat's challenge to US ground forces. The standard for low-cost can be difficult to qualify with a specific dollar amount alone; therefore, factors considered for categorization as low cost are those easily available through homemade techniques, at local commercial establishments, or via online retailers, without requiring special training or licensing beyond the capability of the average individual.

The first section, Parallel Lessons, examines links between Vietnam and the GWOT, composed of Operation Iraqi Freedom (OIF) in Iraq and Operation Enduring Freedom (OEF) in Afghanistan, through unit histories and experiences of those on the ground. Each location and period uses a historical narrative to develop pertinent parallels between the two. Despite a separation of over forty years, engineers in the GWOT encountered similar challenges to their predecessors in Vietnam. Interim solutions, developed by those executing the missions each day, bear striking similarities between the two conflicts, despite decades of separation. Ultimately, the more favorable attention paid to the GWOT campaigns supported better institutional response through enduring defense organizations such as the Joint Improvised Threat Defeat Organization (JIDO), formally known as the Joint IED Defeat Organization (JIEEDO). While there were known problems in search of solutions after Vietnam, those same problems were generally addressed during the GWOT.

The second section, Institutional Adaptation, focuses on examining those institutional changes, both past and present, to meet and counter the threats posed by IEDs. Changes to the Engineer Regiment, with closely associated specialties such as Explosive Ordnance Disposal (EOD), are the focus. Analysis includes examination through the Department of Defense (DOD) Joint Capabilities Integration and Development System (JCIDS) and the Army Force Management process and their resulting recommendations for Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P). Of note, there is no examination of the Facilities domain. Facilities constructed to support efforts against the IED threat are subordinate to one of the other DOTMLPF-P domains.

Regarding discussions of lessons learned, the Engineer Regiment post-Vietnam did not fail across the board. Many changes and updates made their way into the Army education system and doctrine, although stripped of much of the context that would have made these lessons readily apparent in GWOT. This loss of context allowed many of the relevant lessons to languish in the schoolhouse. The similarity in equipment used simplifies many of the comparisons between the two periods, especially at the start of the GWOT. The basic mechanized transport for both periods remained the M113 Armored Personnel Carrier (APC), the primary area clearance vehicle was still the D7 bulldozer, and the mine detecting sets only went through one upgrade, from the Army-Navy/Portable Special Search (AN/PSS)-11 to AN/PSS-12.

The third section, Emerging Threats, examines potential challenges to Army forces, with a focus on how engineers contribute to the response. The section examines how the current force structure is prepared to overcome these challenges and avoid the mistakes of past conflicts. Examination of emerging technology on the home front follows, highlighting proactive measures to avoid future hazards. The concluding discussion includes potential intra-governmental opportunities to improve readiness for Soldiers abroad and for local institutions in the United States to mitigate the potential for these threats to cross from warzones to the home front.

To lessen confusion between military terms that have changed over time, the terms booby trap and IED share a common meaning and are thus used interchangeably. Though they share meaning, most written histories use the term booby trap when referring to Vietnam and IED in the context of the GWOT. These devices consist of five essential components: a switch or trigger, an initiator or fuze, a main charge or bulk explosive, a power source, and a container. Military munitions, employed as intended, are not IEDs; however, those modified for alternate initiation or used outside of commonly used tactics, techniques, and procedures are included. To clarify, a properly fuzed artillery round fired from an M777 howitzer is not an IED. The round, failing to detonate and now abandoned on the ground, is unexploded ordnance (UXO). That same round, collected up by an adversary who packs its fuze well with a non-standard high explosive charge and an initiator is now IED. Regarding landmines, any landmine used outside of a marked minefield or paired with an anti-handling device (AHD) is an IED. This alleviates difficulty separating casualty counts, especially in Vietnam, where the North Vietnamese did not employ doctrinal minefields and where booby trap casualty numbers often included US mine deaths.[1] Similarly, though minefields were plentiful in Afghanistan, they were generally relics of the Soviet-Afghan war and not employed to counter coalition military efforts.[2]

Parallel Lessons: Vietnam and the Global War on Terrorism

The US military's involvement in both Vietnam and the main GWOT theaters, Afghanistan and Iraq, grew well beyond initial expectations. Decisive campaigns, relegated to the past, gave way to stability operations with a strong counterinsurgency (COIN) focus. Although drastically different when examined through operational or mission variables, US Soldiers, especially engineers, faced similar challenges and developed similar responses. In both cases, adaptive enemies made use of low-cost means — or no-cost in terms of explosive remnants of war (ERW) and unexploded ordnance (UXO) — to effectively target US military patrols operating within their respective theaters without exposing themselves to direct engagement.

Vietnam

Though the initial US military involvement in Vietnam began in the 1950s, mostly with military advisors rather than a combat force commitment, it was not until the 1960s that significant engineer forces arrived in theater. The majority of this effort, under the newly established 18th Engineer Brigade, focused on facilities and fell to construction battalions, backed up by combat

[1] Andrew Cooper, "In Its Own Words: The US Army and Antipersonnel Mines in the Korean and Vietnam Wars," Human Rights Watch Arms Project (Washington, DC: Human Rights Watch, July 1997), 9, accessed December 10, 2016, https://www.hrw.org/sites/default/files/reports/general977.pdf.

[2] Human Rights Watch, "Global Progress on Banning Landmines," *Human Rights Watch*, September 9, 2003, accessed February 16, 2017, https://www.hrw.org/news/2003/09/09/global-progress-banning-landmines.

engineers, to meet the infrastructure related demands.[3] With the official buildup of forces in 1965, the number of non-divisional engineers in South Vietnam increased dramatically, from 2,500 in May, to 6,200 in September, and 9,500 by December, in order to support the arrival of maneuver units.[4] With the arrival of 173rd Airborne Brigade and 1st Infantry Division, with their organic combat engineer units, engineer efforts shifted priority to maneuver support over construction missions. [5]

As MACV increased the intensity of combat operations in Vietnam, the North Vietnamese Army (NVA) and Viet Cong (VC) guerillas countered with an increase in the use of booby traps. By 1966, mine-clearing teams in 1st Engineer Battalion were conducting route clearance in support of named operations. Each day the teams would demine along the ground lines of communication, clearing both improvised and designed mines in areas frequented by US patrols. To reduce the threat of constant ambushes, engineers brought in bulldozers to clear the jungle on each side of the road in select vulnerable areas. [6]

The Tet Offensive in 1968 generated an uptick in landmine and booby-trap threats faced by US forces, a result of greater NVA activity outside of major population areas. As maneuver units pushed the enemy back, engineers increased their efforts along the roads. Deeply buried mines posed a significant challenge due to the inability of mine detectors to sense their presence. Similarly, improvised low metallic content mines were closer to the surface, but avoided detection

[3] Adrian George Traas, *Engineers at War*, CMH Pub 91-14–1 (Center of Military History, United States Army, 2010), 42–44.

[4] Robert Ploger, *Vietnam Studies: US Army Engineers 1965-1970*, CMH Pub 90–22 (Washington, DC: Government Printing Office, 1974), 36–66; Traas, *Engineers at War*, 49.

[5] Traas, *Engineers at War*, 51.

[6] Ibid., 170–73.

due to the lack of ground penetrating radar mine detectors. The presence of these devices on roads and beach areas challenged logistical basing for the counteroffensive operations.[7]

Threats to military assault bridging and non-standard fixed bridging presented more unique challenges to units accustomed to focusing only on explosive hazards on land. The VC, using floating explosives, could easily degrade engineer mobility efforts and forcing the expenditure of limited bridging assets. Since traditional minesweeping would not work, engineers employed improvised mine protection systems made from various forms of wire and fencing.[8]

Engineer support to maneuver operations in Cambodia in 1970 saw the first use of a new type of organizational unit, a response to earlier challenges. The 62nd Engineer Battalion became the first land-clearing battalion, dedicated to supporting maneuver units by clearing explosive hazards and other mobility impediments from large areas, a task previously only assigned to specialized platoons or companies.[9] Using Rome plows—D-7 bulldozers featuring reinforced cabs and an oversized bulldozer blade with a special section used for felling trees—engineer units accompanied maneuver formations to allow the clearing of mass swaths of land for occupation by US forces. The plow, due to its increased weight over traditional bulldozer plows, proved remarkably survivable against mine detonations.[10]

Global War on Terrorism

The start of operations against Afghanistan in 2001 and Iraq in 2003 found an Army in the midst of transformation. Published in the summer of 2001, the new operational doctrine, Field

[7] Ibid., 348–51.

[8] Ploger, *Vietnam Studies: US Army Engineers 1965-1970*, 120–21.

[9] Traas, *Engineers at War*, 477–78.

[10] Ibid., 501–2.

Manual (FM) 3-0, *Operations*, set the goal of a more capable and rapidly employable Army. Based around three types of Brigade Combat Teams (BCTs) —heavy, light, and new Stryker — the Army did not have a full understanding of how this change would affect the capabilities and limitations by September 11, 2001.[11] This same gap in understanding applied to the Engineer Regiment.

Unlike early engineer deployments in Vietnam, initial deployments of Army engineers into Afghanistan were combat focused. Task Force Mountain, arriving at the end of 2001, provided the first such deployment. Engineers from the 92nd Engineer Battalion, and eventually the 307th and 769th Engineer Battalions supported the early maneuver operations, old landmines being a constant threat to the movement of coalition forces operating off common routes.[12] Eventually, enemies converted these mines, and other cached explosives, for non-standard uses as IEDs.[13] Employed sparingly in the early days of Afghanistan operations, these devices were not yet the extreme hazard that another theater in the GWOT would bring to the forefront.

It was not until late 2003, during operations in Iraq, that IEDs became a common occurrence. IED attacks increased from twenty attacks a day in 2003 to forty attacks per day by 2004.[14] In addition to supporting maneuver units and maintaining mobility, engineers provided support to UXO reduction, eliminating numerous cache sites in and around the major cities.[15] As

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[11] Gregory Fontenot, E. J Degen, and David Tohn, *On Point: US Army in Operation Iraqi Freedom* (Fort Leavenworth, KS: Combat Studies Institute Press, 2004), 20–24.

[12] Donald P Wright et al., *A Different Kind of War: The United States Army in Operation Enduring Freedom (OEF), October 2001-September 2005* (Fort Leavenworth, KS: Combat Studies Institute Press, 2010), 331–33.

[13] Ibid., 113, 251, 260.

[14] Donald P Wright and Timothy R Reese, *On Point II: The United States Army in Operation Iraqi Freedom, May 2003-January 2005 : Transition to the New Campaign* (Fort Leavenworth, KS: Combat Studies Institute Press, 2008), 313–15.

[15] Ibid., 373.

the GWOT campaigns continued and the IED threat persisted, combat engineers maintained their traditional focus of mobility, countermobility, and survivability support; however, the arrival of specialized route clearance equipment in 2005 made engineers synonymous with route clearance patrols for much of the next decade. It was important for the engineers to enable maneuver, necessitating special attention on bridges and culverts, popular targets for insurgent activity.[16] This led to the expanded role for engineers conducting route clearance, developing and installing culvert denial devices aimed at preventing critical losses.[17] This same pattern generally continued for combat engineers throughout the GWOT campaign. Occasionally, unique opportunities presented themselves to combat engineers. In 2006, for instance, engineers put their demolitions skills to test. The unit removed a full quarter mile of IED infested buildings along Ramadi's government center, leveling eight city blocks with explosive and mechanical assets.[18]

To address satisfactorily the role of IEDs in the threat environment, the US Army needed to implement change at the institutional level, standardizing common practices and systems. While the ingenuity of individual soldiers proved capable of overcoming local challenges, sharing this success across different areas of operation proved difficult. C-IED teams and programs were coordinated throughout provinces and theaters, with the goal of ensuring broad situational awareness, and coordinating reachback to programs and institutions in the United States. As the wars wound down, funding cuts, lagging interest and responsibility for institutionalizing these experiences

[16] Ibid., 524.

[17] Chad Nelson, "Engineers Deny Enemy Access for IED Placement," *DVIDS*, April 22, 2010, accessed March 22, 2017, https://www.dvidshub.net/news/48498/engineers-deny-enemy-access-ied-placement.

[18] Monte Morin, "US Troops Razing Ramadi Buildings to Renew Security," *Stars and Stripes*, September 2, 2006, accessed March 22, 2017, https://www.stripes.com/news/u-s-troops-razing-ramadi-buildings-to-renew-security-1.53652#.WO7jF6K1uM8.

subsequently fell on the services and their internal branches. While the military wanted to put Vietnam behind it in the 1970s, and thus failed to inculcate the lessons associated with booby traps, the GWOT lessons learned received continuous attention.

Institutional Adaptation

The constant rotation of different units and augmentees through combat theaters highlights the importance of the institutional Army in capturing the lessons, determining evolving needs, and guiding adjustments to keep the forces relevant and prepared for the next fight. The Army uses the Force Management System, similar to the DOD's JCIDS, to bridge the gap between capabilities and requirements for the overall organization.[19] Additionally, the US Army Engineer School (USAES), as reflected in their mission statement, is responsible for "synchronizing and integrating along the DOTMLPF-P domains to ensure the Engineer Regiment is prepared to provide Engineer support now and into the future."[20] To this end, the Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities and Policy (DOTMLPF-P) framework serves as a lens to examine the Engineer Regiment's actions in each conflict.

Anticipating the requirements of the next fight is akin to forecasting in complex systems. While it is possible to make generalized assumptions about the equipment necessary in a certain subset of situations, the opponent is free to develop in opposition to those presupposed notions.[21]

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[19] Louis Yuengert, ed., *How the Army Runs*, 2015-2016 (Carlisle, PA: US Army War College, 2015), 3–1, accessed November 1, 2016, http://www.carlisle.army.mil/orgs/SSL/dclm/pubs/HTAR.pdf.

[20] "The United States Army | U.S. Army Engineer School," accessed December 10, 2016, http://www.wood.army.mil/usaes/.

[21] Henry Mintzberg, *The Rise and Fall of Strategic Planning: Reconceiving Roles for Planning, Plans, Planners* (New York; Toronto: Free Press ; Maxwell Macmillan Canada, 1994), 228–39.

This is the challenge faced by the military force management personnel. Each section of the DOTMLPF-P construct examined below begins with an overview of that domain, and then examines challenges and responses associated with IEDs in Vietnam and during the GWOT, and finally concludes with a summary of how the institution has integrated or is currently integrating the lessons associated with those hazards to maintain skills as the force prepares to once again transition to a focus on major combat operations.

Doctrine

The US Army defines doctrine as "fundamental principles, with supporting tactics, techniques, procedures, and terms and symbols used for the conduct of operations and which the operating force, and elements of the institutional Army that directly support operations, guide their actions in support of national objectives."[22] The development and updating of doctrine, like everything in the Force Management Process, is time consuming; however, since doctrine is the cornerstone of continuity between organizations, doctrine must be clear and easily understood. As operations evolve, the Army publishes lessons learned to bridge perceived gaps between doctrine reflected in field manuals and, more recently, ADPs, ADRPs, and ATPs, and ongoing operations. These lessons learned are widely disseminated to aid situational awareness and recommendations for planning. Although not considered foundational doctrine, they offer an important view into the development and advancement of programs designed to improve the Army's response to various crisis.

[22] Army Doctrine Reference Publication 1-02, *Terms and Military Symbols* (Washington, DC: Government Printing Office, 2015), 1–6.

Vietnam

The end of the Second World War left the US Army with a wealth of experience dealing with explosive hazards. Though the primary responsibility for identification and reduction or removal of these hazards fell to Engineers, Infantry, and EOD, the 1965 edition of FM 5-31 *Boobytraps* highlights the expectation that all units be prepared to conduct limited operations without additional support. Although US military advisors had a decade of experience in Vietnam, as well as experience in Korea, the manual pays little focus to regionally specific threats and instead focuses on generalized categorization and clearance methods. The field manual provides tactics, techniques, and procedures (TTPs) for conducing these operations, written and illustrated in a way that is easily understandable, regardless of unit type. This includes common methods styles of booby traps, such as victim operated or timed, as well as generic detection techniques such as using detection teams armed with grapnels and bayonets.[23] This reference, while important, lacked the nuanced details to enable maneuver success on the complex battlefields of Vietnam.

To bridge the gap in understanding of common mines and booby traps with those specific to Vietnam, the MACV published its first lessons learned manual on improvised explosives, Counterinsurgency Lessons Learned Number 53: *Viet Cong Improvised Explosive Mines and Booby Traps*, in 1965, followed by a revised edition in 1966. Unlike FM 5-31, the lesson learned manual focused on highlighting common TTPs of the North Vietnamese forces, supported by specific incidents and illustrations, to reinforce the threat. Additional guidance from MACV highlighted the understanding that a significant number of boobytraps and improvised explosives consisted of

[23] Field Manual 5-31, *Boobytraps* (Washington, DC: Department of the Army, 1965).

abandoned or dud US military munitions.[24] While this lessons learned manual was not actual doctrine, it provided a temporary fix while the Army system worked to close the identified gap.

By 1967, the US Army published Training Circular 5-31 *Vietcong Boobytraps, Mines and Mine Warfare* as a guide to units preparing to deploy in support of operations in Vietnam. This document filled the shortage between the MACV's lessons learned and the field manual on boobytraps by synthesizing the relevant information of the two into a format for wider circulation. The circular combined the specificity of hazards found in Vietnam, without the reference to actual incidents, and categorized them into an easy to use reference. Additional details in the manual provide updated identification and clearance tailored to these specific types of devices, such as common Vietnamese marking techniques to alert villagers to the hazards.[25] Unfortunately, the specific nature of the circular did not make for enduring change. The solution was sufficient to meet the needs of the engineer force without requiring greater assessment of counter booby trap planning above the tactical level. As the Army's focus shifted to Europe, FM 5-31 fell out of use and was eventually absorbed, although in a streamlined format, into the traditional mine warfare field manual.

GWOT

Published in 1992 and updated in 1998, 2001, 2003, and 2004, FM 20-32, *Mine/Countermine Operations*, was a cornerstone of engineer doctrine during the 1990s and early portions of the GWOT. While focused primarily on landmines, the latter sections discussed booby

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[24] Counterinsurgecy Lessons Learned Number 53 (Revised), *Viet Cong Improvised Explosive Mines and Booby Traps* (San Francisco, CA: US Military Assistance Command, Vietnam, 1966).

[25] Training Circular 5-31, *Viet Cong Boobytraps, Mines and Mine Warfare Techniques* (Washington, DC: Government Printing Office, 1967).

traps and clearance techniques pulled from the old FM 5-31. While there were differences in techniques, the FM 20-32 retained the essential principles of IED function and employment, matching common trends found in the early stages of the GWOT theaters. The increasing IED phenomenon, similar to that faced in Vietnam, drew more attention that the preceding conflict, and therefore garnered more focused effort by doctrine writers and updaters. The large commitment and annual rotation of forces generated enough interest that two separate manuals evolved after the 2004 update of FM 20-32.

As operations during the GWOT deepened, the Army realized the need for greater focus on common IED-Defeat (IED-D) planning guidance, targeting methods, and supporting assets. IED-D focuses on location, identification, and elimination of the device whereas C-IED is a broader, system focused, effort to eliminate personnel, resources, and structure networks. Because the Army understood the need to codify the rapidly evolving field of the IED-D operations, and given the lengthy formal process timeline, the Army chose a provisional work. Published in 2005, Field Manual Interim (FMI) 3-34.119, helped solidify the term IED in place of booby trap and provided broad guidance to synchronize IED-D efforts. As the interim manual reached its mandated expiration of two years, the Army published the approved replacement, FM 3-90.119, *Combined Arms Improvised Explosive Devise Defeat Operations*, in September of 2007. Also in 2007, as part of the Army's transformation of doctrine, a new manual, FM 3-34.210, *Explosive Hazard Operations*, replaced FM 20-32. These updates provided supporting details to the Army's backbone manual FM 3-0, *Operations*, and the FM 3-34, *Engineer Operations*. To ensure the lessons developed during the GWOT did not fall by the wayside, the Army continued to update the doctrine despite having the majority of forces withdrawn from the GWOT theaters. In 2014, the Army published ATP 3-90.37, *Countering Improvised Explosive Devices*, as the replacement to FM 3-90.119. This publication also replaced IED-D with Defeat the Device (DtD), clarifying its subordination to the larger C-IED framework. Then, in January 2016, the Army published, ATP 3-34.20, *Countering Explosive Hazards*, as the replacement to FM 3-34.210.

Summary

Despite the specific nature of threats in a theater of operations, certain trends evolve that transcend a specific time or location, especially when they prove effective. Doctrine is a useful method of recording these lessons and ensuring preparedness of future Soldiers for similar situations. The booby trap was not new in Vietnam, nor the IED to the GWOT theaters; they shared a common thread, especially at the tactical level. While the Vietnam era institution incorporated essential details for operation and clearance, the boob trap remained a footnote of the engineer history. By splitting the IED lessons of the GWOT between planning and execution level details and incorporating more than just engineer responsibilities, today's lessons are better positioned to endure revisions and remain relevant to the total Army force.

Organization

The basic structure required to meet the anticipated challenges of future engagements drives the organization of US Army combat formations. While combat arms units, such as infantry and armor, rarely face significant changes to their structure, others, especially engineers, must continuously adapt to the needs of those branches. This type of organization does not include ad hoc task organizing for a specific mission or operation, such as attaching a platoon of engineers to an infantry battalion; rather it is the fixed list of equipment and personnel known as the modified table of organization and equipment (MTOE) set during the force management process for the branch as a whole. Engineer force structure follows two broad paths, those organized to operate as a combined arms team, deploying as an element of the division, and those organized as non-divisional units, augmenting maneuver units or serving a higher echelon headquarters.

Vietnam

The combat troop buildup in 1965 presented an especially challenging problem for the Engineer Regiment. President Johnson's announcement of the intention to meet increased troop requirements without activation of the Army Reserve ran counter to engineer organization, where nearly half of the men and equipment within the branch resided in the Reserve component. A massive reorganization of equipment and reassignments of personnel were the only way to meet the directed requirements.[26] Engineer force structure in 1960s followed the two broad paths of divisional and non-divisional engineers. A battalion of combat engineers supported each division, with three or four companies per battalion, depending on whether the division was airmobile or light respectively.[27] Those subordinate compositions did not vary widely throughout the war.

Early engineer deployments to Vietnam were typically non-divisional units, such as the 35th Engineer Group, and its 62nd, 87th, and 864th Engineer Battalions, supporting US Army Vietnam (USARV), with the 18th Engineer Brigade overseeing all non-divisional engineer operations in 1965. By 1967, the growing span of control led to the establishment of a provisional Engineer Command, with two non-divisional brigades supporting USARV headquarters.[28] While numerous battalions and numbered companies rotated through Engineer Command, each with varying specialties, that headquarters was not responsible for tactical divisional support; rather, it coordinated overall engineer effort. As non-divisional assets, the command mixed and matched battalion, and occasionally company, task organization to meet the needs in a given area. As combat operations escalated, the deployments of divisional maneuver units with organic engineers

[26] Ploger, *Vietnam Studies: US Army Engineers 1965-1970*, 6–8.

[27] Ibid., 215–18.

[28] Ibid., 179–80.

altered the focus of engineer assets to combat roles rather than construction. Maneuver divisions placed great importance on the engineers' role in supporting freedom of maneuver and establishing protective earthworks for defensive positions. Although divisional engineer elements were not under the control of the MACV engineer command, those not actively supporting maneuver operations often worked with their non-divisional counterparts to meet demands and expand proficiency in areas such as military construction and protective earthworks. Likewise, divisional units would request attachment of non-divisional assets to support maneuver operations, often land clearing or construction, if new roads or basecamps were required.[29] The overall organization of US Army Engineer forces, that is, the allocation of forces between divisional and non-divisional units, did not see significant adjustment until the implementation of the Army's transformation just prior to the start of the GWOT conflicts.

GWOT

At the onset of the wars in Afghanistan and Iraq in 2001 to 2003, combat brigades within a division received their engineer support from the division's engineer brigade. As the duration of occupation increased, engineer missions expanded from traditional support to maneuver operations into frequently independent operations that strained the division's organic support. Additional companies and battalions, from non-divisional engineer brigades, augmented where required, often having their subordinate battalions attached to division level headquarters. As the Army modernized into the modular force structure of the Brigade Combat Team (BCT) in 2006 to 2007, the Army inactivated divisional engineer brigades and reallocated the associated battalions and companies to the new Brigade Special Troops Battalions (BSTBs) or to the non-divisional engineer

[29] Ibid., 182–83.

brigades. This change, meant to provide greater modularity for the BCT without growing the force, cut a division's organic Engineer support by one third, with only one company of combat engineers supporting a brigade, instead of one battalion per brigade that had been in place before the change. Augmentation from non-divisional engineer brigades and battalions increased significantly to cover the demand as the GWOT campaigns persisted past 2010.[30]

The multiple requirements for engineers found brigade and division commanders needing more and wanting them for all training leading up to deployments. Challenged to maintain commitment with the non-divisional engineer brigades, the BSTBs transformed into Brigade Engineer Battalions (BEBs) starting in 2012, returning a battalion level engineer headquarters to the BCT, adding a second combat engineer company, and creating an additional forward support company for maintenance issues. Rather than establishing new units, owing partially to the Army's end strength drawdown, the headquarters and companies returned from the non-divisional engineer brigades to the BCTs.

While the overall transition from a divisional engineer brigade, to BSTBs, to BEBs appears to be a full three hundred sixty degree turn, this is not the case. The BEBs still maintain a lighter profile—with only two engineer companies instead of three—than the old engineer battalions, and field primarily mobility and survivability assets, with less emphasis on counter-mobility in the BCTs. This was a reflection of the roles during the GWOT and the intertwining of counter-mobility and survivability; the results were easily observable, with concrete barriers and concertina wire replacing the mines and other traditional obstacles of the past.

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[30] Andrew Smith, *Improvised Explosive Devices in Iraq, 2003-09: A Case of Operational Surprise and Institutional Response*, Letort Paper (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2011), 16.

Not content to change only headquarters or authorizations, other significant adjustments during the GWOT included new types of companies. The introduction of Clearance Companies (CCs), often identified as Route Clearance Companies (RCCs), was a response to the greater emphasis placed on the clearance of IEDs in Iraq and demining in Afghanistan. As materiel solutions caught pace, these units became the home of much of the new C-IED technology, specifically the Route Clearance Packages (RCPs). With the introduction of the BEB to the BCT, the second combat engineer company incorporated elements of the traditional combat engineers, the Sapper platoon, with a revised engineer support platoon to provide bridge, breach, and dig support, and a new clearance platoon with RCPs. This additional company increased the flexibility of the BCT as a self-sustaining, combined arms force, providing specialized assets, such as route clearance equipment, not previously available without support from non-divisional Engineer brigades.

The structure of the Engineer Regiment has undergone significant changes since September 11, 2001. Partially to adapt to the Army's goal of modularity and partially to make up for lost capacity, the current Brigade Engineer Battalion (BEB) construct, supported by three non-divisional engineer brigades, serves the active duty force. Additional support, which makes up seventy percent of the total Army Engineer force, resides in the National Guard and Reserve BEBs and engineer brigades. Though the GWOT reflected a transformation, adjustment, and retransformation, the current BEB construct still lacks the numerical depth of the divisional engineers from the Vietnam era up to the BCT transformation.

Summary

Despite being limited by only using active duty units, engineer organizations in Vietnam, specifically those focused on combat operations, proved generally effective at meeting the demands placed on them by MACV and the maneuver divisions. With the Army's trend toward lighter, more rapidly deployable brigades in the late 1990s, the capacity to support maneuver formations below the brigade level became significantly smaller. Fortunately, the Engineer Regiment identified the shortfall and implemented an updated transformation to support the BCTs, but at the expense of the non-divisional units. While still lacking the robustness of divisional engineer brigade formations, the BEB construct, like its Vietnam predecessors, seems poised to meet the anticipated demands for future conflicts featuring an emphasis on mobility support.

Training

Allied armies, such as the United Kingdom, Australia, and Canada, place responsibility for managing explosive hazards (EH) under their engineers. While there is a subset of the engineers that specifically manage these hazards, they are under the control of one branch. The US Army, quite differently, separates duties for managing EH between two different branches; the responsible authority for dealing with an explosive hazard is based on the scenario encountered. The Ordnance branch manages explosive ordnance disposal (EOD) while the Engineer branch has the combat engineers. Engineers focus on EH associated with assured mobility, often minefield clearance, in support of combined arms maneuver. This involves explosive reduction of the hazards. EOD have a much broader purview, covering all EHs, and have the sole authority to conduct render-safe procedures. The relationship and authority between combat engineers and EOD emerges as a gray area during combat operations in a COIN environment, especially when maneuver commanders emphasis speed and are willing to accept greater risk. Due to the significant training that results in their specialization of explosives and their supporting systems, EOD technicians were unable to meet the demands presented by countess UXO and IED finds.[31] While engineers have always trained to conduct standard mine and countermine operations, the challenges provided by specialized booby traps and IEDs required additional focus.[32]

Vietnam

Combat engineer operations in Vietnam differed significantly from those in the Second World War. Gone were the large minefields and prefabricated tank traps of Europe, replaced by smaller booby traps and vehicle restricting terrain. No specialized training existed for units to prepare their engineers for conditions in theater. Instead, units slated to deploy to Vietnam established their own training programs to ensure widest dissemination of current enemy TTPs.[33] Since visual means were the method of identifying the majority of booby traps, detection lanes became a staple of unit preparation programs.

The primary training for engineers, especially the junior soldiers, took place on the job.[34] The use of different explosives and accelerants led to improvisation among units, many developing new TTPs to meet evolving demands. Tunnels and underground networks used as cache points or escape routes for NVA were difficult to collapse with ordinary explosives; however, engineers discovered "an effective method to destroy deeper tunnels by using conventional demolitions with

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[31] Aaron P. Magan, "Improving the Engineer Battalion's Combat Power: Lessons Learned in Iraq," *Engineer: The Professional Bulletin for Army Engineers* 33, no. PB 5-03-3 (September 1, 2003): 25.

[32] Craig Jolly, "EOD and Engineers Close the Gap," *Engineer: The Professional Bulletin for Army Engineers* 35, no. PB 5-05-1 (March 1, 2005): 40–42.

[33] William Keech, "Countering Mines and Boobytraps" (Command and General Staff College, 1971), 7.

[34] Ploger, *Vietnam Studies: US Army Engineers 1965-1970*, 193; Traas, *Engineers at War*, 58.

acetylene gas."[35] This on the job training, while effective in certain units, did not help to maintain continuity between deploying elements. At the end of each rotation, new units would enter with the limited skills practiced on their own training lanes and, once in theater, relied on whatever knowledge or skills they could glean from departing units to fill gaps in their training. There evolved no significant institutional training solution to this problem.

GWOT

To meet the evolving needs of the GWOT campaigns, the US Army Engineer School (USAES) in Fort Leonard Wood, Missouri, developed several courses to prepare units and individuals for the new challenges. Under the auspices of one of the school's subordinate organizations, the Counter Explosive Hazards Center (CEHC), new programs focusing on route and area clearance, mine detectors, and EH planning became the norm for pre-deployment certification by 2005. Each course focused on different special skills expected of engineers, from the private to lieutenant colonel, aimed at reducing and eliminating the IED threat.

Unlike Vietnam, during the GWOT the IED fight included significant efforts at exploitation of IED intelligence, the goal being to render safe enemy devices for the capture of biometric data as well as understanding construction TTPs. As the DOD lead agency for EOD training and certification, the US Navy's Naval School Explosive Ordnance Disposal (NAVSCOLEOD) maintained the responsibility for instructing these techniques to all military EOD technicians. Engineers, while familiar with UXO reduction, lacked the tools, training time, and skills to safely conduct these same types of exploitation operations.[36] As route clearance gained increasing focus in

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[35] Traas, *Engineers at War*, 226.

[36] Michael Silva, "IEDs: The Obstacle in the Path to Assured Mobility," *Engineer: The Professional Bulletin for Army Engineers*, March 2007, 14–15.

both Iraq and Afghanistan, EOD units were unable to meet the demand for traditional EOD QRF missions and support to engineers during route clearance.[37] To alleviate the burden on overworked EOD units, the Engineer School developed and certified the Engineer Explosive Ordnance Clearance Agent (EEOCA) course, focused on enhancing specialized UXO and IED reduction skills for non-commissioned officers (NCOs) and junior officers within limitations approved by NAVSCOLEOD. Instructors were both EOD and engineer NCOs with recent experience to help relate nuances between the different branches and specialties. On arriving in a GWOT theater, qualified personnel were required to attend an additional course hosted by the theater's EOD and C-IED trainers to ensure understanding of the latest TTPs and area specific limitations.[38] To ensure the endurance of these skills, the EEOCA course provided an Additional Skill Identifier for enlisted graduates, with certain organizations requiring the skill on their MTOE.

With route clearance dominating engineer requirements in theater, all new route clearance training equipment immediately went forward to Iraq. To solve the dilemma of units preparing to deploy and fall in on equipment they had never trained on, the Army invested significantly in digital training systems as a substitute for actual route clearance systems. The Virtual Clearance Training Suite (VCTS) featured a system of two or more semi-trailers, linked through computer networks, with mock vehicle cockpits and replica controls. Administrators would project computer-based scenarios on screens in place of the vehicle's windows. Soldiers could then interact in the digital world, using controls identical to those found in route clearance vehicles, as a part of a larger convoy. While these systems remain in use even today, the demand for route clearance packages has slowed, allowing all BEBs to receive their complement of clearance equipment.

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[37] Jolly, "EOD and Engineers Close the Gap," 40.

[38] David M. Clark, "Explosive Ordnance Clearance Agent-Closing the UXO Gap," *Engineer: The Professional Bulletin for Army Engineers* 35, no. PB 5-05-2 (June 1, 2005): 21–23.

Coordination of C-IED programs and resourcing presented a problem in both Afghanistan and Iraq. To ensure consistency of training, standards of exploitation, and a single responsible organization, the JIEDDO sought to provide each theater with a specialized C-IED sub-organization—Task Force Paladin in Afghanistan and Task Force Troy in Iraq.[39] Each TF assigned training teams to its Regional Command (RC) and Multinational Force (MNF)/Multinational Division (MND) with the responsibility to teach C-IED training, available in three tiered levels, and a specialized search course, Tactical Site Exploitation. Each of these teams consisted of EOD and combat engineers to assist the education of the deployed forces. Different RC and MNF/MND commanders provided different requirements for forces under their commands, but all deployed personnel attended C-IED Level 1 on arrival in theater. Level 2 and Level 3 training built on Level 1's basic skills, provided non-commissioned officers and key leaders with additional recognition skills and granted train-the-trainer certification. These organizations, like JIEDDO itself, did not endure the drawdown of the GWOT theaters in their original form.

Summary

Maintaining specialized skills, especially those associated with EHs, is a challenge for all organizations. The Engineer Regiment failed in Vietnam to resource and implement standardized training for all engineer units. However, USAES attempted to remedy this between Vietnam and the GWOT. The CEHC implemented programs to provide better resourced, and consistent, training throughout the force. When the GWOT demanded additional skills of the Engineer Regiment, the

[39] Elizabeth Allen, "EOD School Dedicates Joint Task Force Troy Memorial," *Official Website of the US Navy*, April 11, 2013, accessed February 22, 2017, http://www.navy.mil/submit/display.asp?story_id=73309.

USAES met the challenge with new and updated courses, as well as gaining new authorities for engineers to conduct EOD-like operations.

Materiel

Due to acquisition requirements, the US military faces a steep climb to keep pace with technological innovation. Burdened by the cumbersome system highlighted above, a physical solution to counter an emerging threat takes significant investments of time and money. These two assets are on a somewhat opposing scale where the greater the money available to address a specific problem, the less time required to acquire a pre-existing solution and vice versa. Commercially available systems, known as commercial off-the-shelf (COTS), are sometimes found in other countries or markets and provide interim solutions. Generally, these are the least preferred by the military due to the significant cost associated with purchasing and licensing requirements for COTS system. If the Army has time to develop its own solution, especially if it is needed in large quantities, it can go through full acquisition process and use completion between companies to achieve a better price.

Vietnam

Mine warfare was not a new concept in Vietnam; however, new technology changed the methods of countering such threats. Up through the mid-1960s, anti-personnel and anti-vehicle mines with significant metal content dominated the battlefields of Vietnam. While detection of deliberately placed devices without mechanical assistance was difficult, standard metal detectors such as the AN/PSS-7 mine detector met the requirements. Low metallic content (LMC) mines, used by the Germans in the Second World War, made their way to Vietnam. Though these mines existed at least twenty years earlier, development of a materiel solution between 1944 and 1965 to detect LMC mines, especially the anti-personnel variety, fell short due to the lack of a continued requirement for such as system.[40] By the early 1970s, proliferation of mines with plastic casings and few metallic parts made detection by US engineers increasingly difficult.[41]

When materiel solutions were not available, engineers adapted other systems to meet their needs. Modifications to the M113 armored personnel carrier enabled the mounting of flamethrowers, designed to work in conjunction with bulldozers for tunnel clearing. An unintended use of this system, saw mounted engineers clear heavily booby-trapped areas by burning rather than focused, deliberate, clearing.[42] Clearance by fire worked in areas with a minimal subsurface threat, the heat detonating mines near the surface or booby-traps on and in trees, but the thorough clearance need to rid an area of more deeply buried threats necessitated the more robust capability provided by bulldozers with a Rome plow.[43] Though this solved the problem of clearing large areas during non-covert, off-road, operations, roadway clearance required a more refined solution. In 1970, mine rollers for the M48 tank arrived in time to support operations in Cambodia. Fielded through the Expediting Non-Standard Urgent Requirements for Equipment (ENSURE) system, the rollers filled a critical role in allowing hasty clearance of roads where dismounted mine sweeping teams proved inefficient. Though there were tradeoffs and limitations, especially speed and mobility, the rollers provided a fifty percent reduction in clearance times.[44] This solution remained in use for tanks, but a similar version for armored personnel carriers and wheeled vehicles did not materialize until the GWOT.

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[40] Blanche D. Coll, *The Corps of Engineers: Troops and Equipment*, vol. 1, CMH Pub 10–4 (Office of the Chief of Military History, Dept. of the Army, 1958), 478.

[41] Cooper, "In Its Own Words: The US Army and Antipersonnel Mines in the Korean and Vietnam Wars," 8.

[42] Traas, *Engineers at War*, 222.

[43] Ibid., 195–98.

[44] Ibid., 507.

Despite supporting armored units, armored engineer equipment aside from the M113 was minimal. The notable exception was the M728 Combat Engineer Vehicle (CEV). Entering service in 1965 and built around an M60 chassis, the CEV came armed with a short-barreled 165mm cannon and an M2 machine gun, the CEV sported a bulldozer blade and an A-frame crane for engineer work. While the CEV could mount mine rollers with a fabricated bracket, the specialized nature of the equipment meant this was a last resort rather than primary configuration.[45] Despite the cannon's intended use for obstacle reduction in support of maneuver operations, engineer units with the 1st Infantry Division used it against enemy ambushes with great success.[46]

GWOT

Countering the challenge presented by LMC mines took until 1991 for the development of initial solutions and 2001 for the fielding of a system capable of detecting the majority of subsurface threats. While the technology existed throughout the 1980s, development did not receive significant focus until 1991.[47] Replacing the AN/PSS-11 mine detector in 1991, the AN/PSS-12 added the ability to detect LMC mines. The AN/PSS-12 relied on some metallic feedback and could not detect fully nonmetallic mines. The addition of ground penetrating radar in a compact, backpack-sized package, met the requirements. Arriving via the Rapid Fielding Initiative (RFI) in 2001, the AN/PSS-14, or Hand-held Standoff Mine Detection System (HSTAMIDS) combined metal detection with Ground Penetrating Radar (GPR) to provide maximum feedback to the

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[45] Ibid.

[46] Ibid., 471–72.

[47] Kellyn Ritter, "AN/PSS-14 Mine Detection System Offers Improved Countermine Capability," *Army AL&T Magazine* January-March 2007, no. PB 70-07-01 (2007): 55.

operator.[48] After meeting the RFI requirement, the Engineer Regiment added the AN/PSS-14 to the equipment tables of all combat engineer organizations.

While mine detection and removal is important, there are times that rapid solutions are required to meet the demands of maneuver units, especially during breaching operations. The trailered Mine Clearing Line Charge (MICLIC) and its smaller, dismounted sibling, the Antipersonnel Obstacle Breaching System (APOBS) assist engineers with the rapid clearance of a lane through a minefield or similar obstacle laden terrain. The system is designed so that an unguided rocket, fired from the MICLIC trailer, pulls a rope net of C4 explosive in a generally straight path across one hundred meters of minefield. The engineers initiate the explosive, thereby detonating the mines around the net, and provide a single lane for tanks through the minefield. Towed behind an engineer transport, usually an M113 APC or M2 Bradley Fighting Vehicle, the MICLIC is useful but dangerous to employ under fire, requiring dismounts to setup, and drawing enemy fire due to its distinctive silhouette and unarmored case. The heavy presence of IEDs on roads frequented by insurgents in the GWOT led to the use of MICLICs in non-standard combined arms breaching operations.[49] To meet this challenge, as well as part of the force modernization, a new Assault Breach Vehicle (ABV) helped alleviate MICLIC vulnerability and access concerns by minimizing the risk to the engineers and improving the mobility of the platform. Built on an M1 Abrams chassis, the ABV has two MICLIC systems mounted in place of its turret, and it can be equipped with a mine plow or rollers to proof the breach lane it clears with the MICLIC. Despite

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[48] David Holbrook, "Mine Detection Moves into the Future: The AN/PSS-14 Mine Detector Requires a License" (DTIC Document, 2007), 39, accessed February 18, 2017, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA596520.

[49] Wright and Reese, *On Point II*, 373.

the lack of defensive minefields in the GWOT campaigns, engineers used the ABV with great success on roads and trails suspected of being heavily booby-trapped.

The long distances and more open terrain in Iraq led to an increase in mounted movement and patrolling over that in Vietnam. Even when dismounted, gun trucks often accompanied troops to provide overwatch support.[50] After the success of the initial invasion in 2003, post-war operations faced increasingly deadly enemy targeting of convoys with IEDs. To maintain ground lines of communication (GLOCs) and ensure freedom of movement, engineers grew a new type of route clearance formation in 2005 that would dominate their deployments for the next decade. Route clearance, initially from a HMMWV or M113, proved to be an unnecessarily high-risk option for commanders in the GWOT. To solve this problem, a new commercial off-the-shelf (COTS) systems used in demining emerged as suitable replacements. The three vehicles formed the core of a new RCP: a visual observation platform, the RG-31 Medium Mine Protected Vehicle; a subsurface detection platform, the Husky Interim Vehicle Mounted Mine Detecting Vehicle; and a platform to search and uncover a potential IED, the Buffalo Mine Protected Clearance Vehicle. This package enabled engineers to better identify and clear IEDs threatening friendly lines of communication without exposing them to direct fire or placing them too close to the potential IED. The Army incorporated these systems into the Clearance Company MTOE in 2007 and BEB MTOE in 2012, helping ensure their continued training and use.

While M1 tanks can equip mine rollers and plows, the weight of these systems limited their usefulness on paved roads as well as with any vehicles smaller than a tank. Picking up the unresolved problem identified in Vietnam, units began constructing improvised roller systems to

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[50] Bing West, “Vietnam, Iraq & Afghanistan: Different or the Same?,” Text, *Hoover Institution*, (November 12, 2014), accessed April 20, 2017, http://www.hoover.org/research/vietnam-iraq-afghanistan-different-or-same.

defeat Victim Operated IEDs (VOIEDs) that could be mounted on HMMWVs. Finally, the Army recognized the necessity for a standardized, modular, and easily repairable roller system. By the end of 2006, lighter and more maneuverable rollers for the majority of tactical wheeled military vehicles arrived in the GWOT theaters. The Army's primary system, the Self Protective Adaptive Roller Kit, or SPARK, was another COTS system that required little adaptation to meet the Army's needs on the ground.[51] These systems are not generally available for units in the US so although installation training programs do teach the skills prior to deployments, that training is obviously a limited resource.

As the enemy adapted to exploit Army vulnerabilities, the military similarly adapted to meet emerging threats. Remote controlled IEDs presented a particularly difficult challenge to engineers because the enemy command detonated the device rather than relying of the victim for activation. This proved especially dangerous to engineers and EOD technicians attempting to neutralize devices. To counter this threat, the Army borrowed from the Navy in developing electronic warfare solutions in the form of Counter Remote Controlled Improvised Explosive Device (RCIED) Electronic Warfare (CREW) systems to jam external radio signals while minimizing effect on friendly communications systems. Eventually used on almost all convoys and types of vehicles, CREW systems generated enough interest that the Army implemented a new Career Management Field, 29, to oversee these systems.

Another materiel solution designed to defeat Passive Infrared (PIR) sensors, is the Rhino system. PIR sensors were used to detonate IEDs when the heat signature of a vehicle's engine

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[51] Karl Borjes, "The Self-Protection Adaptive Roller Kit (SPARK)–Negating the Improvised Explosive Device (IED) Threat for Soldiers and Vehicles" (DTIC Document, 2008), 50–53, accessed February 18, 2017, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA492314.

passed in front of the sensor. These systems were smaller than other victim initiated IEDs, allowing the enemy to conceal them more efficiently. To defeat the system, a soldier bought a toaster, connected it to the vehicle's power supply, and mounted it to a bar extending out far in front of the vehicle. After the concept proved successful at prematurely activating PIR based IEDs, the Rhino system was born. By 2006, upgraded versions employed an emptied ammunition can, with a glow plug placed inside, to generate large amounts of heat. By presenting a significant heat signature, the Rhino would detonate these IEDs ahead of a vehicle's crew compartment, minimizing damage and casualties to the soldiers. As the enemy caught on to the system's effect and shifted the aiming point, the addition of an adjustable bar allowed soldiers to vary the distance of the Rhino to the crew compartment.[52] These systems, like the electronic warfare systems, are fielded only during specific training events and are not on engineer unit MTOEs, however mock Rhino systems were often constructed locally to use in convoy and mounted patrol training.

Summary

As the Army shifted from Vietnam's COIN fight to the Air/Land Battle of the 1980s and 1990s, funding for underdeveloped materiel solutions did not materialize. The LMC mine detectors and rollers for wheeled vehicles went undeveloped until the GWOT created the urgent need for the spending. While some solutions are limited in their applicability outside certain theaters, such as the Rhino in Iraq, the systems now exist for future fielding if similar threats reemerge elsewhere. New systems, such as new route clearance equipment like the ABV, are an essential part of the engineer equipment set and appear to remain a key capability for future operations.

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[52] Adam Higginbotham, "U.S. Military Learns to Fight Deadliest Weapons," *WIRED*, July 28, 2010, accessed May 4, 2017, https://www.wired.com/2010/07/ff_roadside_bombs/.

Leadership and Education

Managing the engineer professional military education (PME) and preparing engineer leaders for operational challenges falls under the purview of the US Army Engineer School. Enlisted engineers receive initial experience during advanced individual training (AIT) and return to the school as squad leaders, and then mid-level platoon sergeants, to refine fundamental skills and learn how to plan and lead engineer operations. Engineer officers, trained on the fundamentals during the Engineer basic course, return after three to five years for the Engineer Captain's Career Course. Engineer specific educational opportunities outside these windows generally fall under the Training domain. The primary focus of each of the PME courses is not theater specific tactics, techniques, and procedures, but engineer and leadership fundamentals.

Vietnam

Split between Fort Belvoir, Virginia and Fort Leonard Wood, Missouri, engineer education during the Vietnam era found itself stressed to meet the demand. Whether a shortage of men before the draft, or material throughout, the specialized nature of engineering meant the onus fell to deploying units to cover gaps in their training. As the backbone of the Army, NCO leadership and education was critical to success. This was especially true in divisional engineer units where squad operations in support of maneuver companies and platoons were more common. Major General Charles Noble pointed to an obvious lack of leadership training, criticizing the engineer school and its NCO graduates classroom focus rather than practical leadership education.[53] Because the majority of draftees left the Army, the NCO corps remained underdeveloped throughout the war, and well into the 1980s.

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[53] Traas, *Engineers at War*, 585–86.

Education for officers was just as critical, since the lieutenants and captains would end up with responsibility for planning and organizing engineer assets to support maneuver operations. While few specialized schools existed to train large formations to face the challenges of mines and booby traps during the Vietnam era, the Engineer School did include relevant updates during the officer basic and career courses for lieutenants and captains. Incorporating the key lessons coming back from Vietnam, the officer advanced course added classes on land clearance of mines and booby-traps. Unfortunately, such focus was short lived, and these classes lost their emphasis and largely disappeared from the curriculum.[54] This skill, refined in Vietnam and the core of certain units such as the 62nd Engineer Battalion (Land Clearance), became an afterthought.

GWOT

As the realization that the GWOT campaigns contained enduring lessons for engineers, the USAES identified the gap between PME and expectations of units preparing for deployment. Originating in the CEHC, a 2010 plan highlighted a divergence between the institutional and operational domains. To minimize this divergence, Mr. Dorian D'Aria and Mrs. Tahnee L. Moore wrote that, "Standardization and required implementation of common C-IED training in initial military training and professional military education (PME) is the first step."[55] By providing this initial education, the USAES ensured that new engineers joined the operational force with skills common to both theaters and likely to endure. This would lighten the requirements for units receiving new soldiers and leaders to fill gaps just prior to deployment. This plan reflects the principles developed in the C-IED and EH doctrine developed during the GWOT.

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[54] Ibid., 583.

[55] Dorian D'Aria and Tahnee L. Moore, "Adapting the Army: Institutionalizing Counter-IED Training Efforts," 2010, 10, accessed August 13, 2016, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA560120.

Summary

It is important to note that initial entry and basic branch education is foundational and should provide generalized skills applicable in a variety of scenarios. The engineer school met this requirement in Vietnam and the GWOT; however, the institution also recognized the growing need for specific emphasis on certain skills, such as land clearing or C-IED planning, and eventually sought to provide the operational force with the best future leaders possible. Although this effort diminished after the end of the Vietnam War, the training emerging from the, such as those under the C-IED programs, stand a greater chance of enduring through the next several decades due to the growing suite of specialized equipment and units, and the continued threat of IEDs on the battlefield.

Personnel

Maintaining the manpower required to conduct combat operations becomes increasingly difficult as conflicts drag on because of an inability to achieve decisive results. This is especially true for low-density skillsets, such as EOD, and even specialized units such as combat engineers. Additional difficulty comes as the stringent standards for these specialties disqualify an already small population of new recruits from serving in these roles. A DOD study in 2014 found that nearly seventy-one percent of the Nation's seventeen to twenty-four year old population is unfit for service. While some standards are eligible for a waiver, such as minimum General-Technical (GT) scores, genetic defects, such as red-green colorblindness, cannot be waived without generating additional risk.[56]

[56] Miriam Jordan, "Recruits' Ineligibility Tests the Military," *Wall Street Journal*, June 27, 2014, sec. US, accessed December 13, 2016, http://www.wsj.com/articles/recruits-ineligibility-tests-the-military-1403909945.

Vietnam

Over the course of the conflict in Vietnam, 200,000 soldiers served in engineer units with the largest concentration, 40,000, in 1969. Of these, 1,500 were killed or died of injuries sustained while deployed.[57] The inability to use the bulk of the Army's reserve forces in Vietnam led to incredible manpower shortages within the deployable engineer force. To solve this, the Engineer Regiment resorted to accelerated promotion and facilitated branch transfers to help mitigate shortages in junior officers and NCOs, but these solutions generated additional problems. The inexperienced personnel in these key leadership positions led to perceived crisis of confidence when dealing with the rigors of combat and a lack of understanding when experience-based skills proved essential.[58]

Short, one-year tours proved a tradeoff between experience and casualties. The mass rotation of units after completion of a year in Vietnam meant new units of inexperienced and unfamiliar engineers arrived. Without the aid of a holistic Army approach to mitigate the risks associated with large-scale personnel turnover, enterprising engineer headquarters mandated limitations on turnover, some setting a maximum of twenty-five percent or less per month. As noted in *Engineers at War*, "The long duration of the war also meant second and sometimes third tours for career soldiers. By 1970, frequent family separation caused some captains and majors to leave the service." The problem manifested in both the officer and NCO camps, damaging the foundation of the Engineer Regiment.[59] This turnover due to numerous deployments may not necessarily

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[57] Traas, *Engineers at War*, 580.

[58] Ibid., 585.

[59] Ibid., 586.

project a different outcome in personnel numbers than if deployments were longer or lasted the duration of a conflict.

GWOT

The GWOT proved less damaging to the Active duty force because of the president's call up of the Reserve, and National Guard early in the conflict. At the start of the invasions, the preponderance of the non-divisional engineer units in the Reserves meant that divisional engineer brigades provided the manpower to support combat operations; however, the arrival of the BSTBs in 2006 began shifting that burden. Non-divisional brigades provided additional capacity as the transition occurred, but this brought its own challenges. These units were heavy with support from the Reserve and National Guard and brought different skill sets, often with an emphasis on general engineering instead of combat, than maneuver commanders were used to having. A convenient solution presented itself with the route clearance teams. Because RCPs were generally new to the Army, reserve units could fill these teams as effectively as active units.[60] Additionally, many reservist had civilian skills in construction jobs, allowing them to operate the heavy equipment associated with these missions while active units supported maneuver forces.[61] Eventually, the implementation of the BEB would help return the personnel balance with the second engineer company and its mix of mobility and survivability specialists.

Similar to the challenge in Vietnam, the annual rotation of units initially resurrected the tradeoff of casualties for experience. While the GWOT Army took a different approach than the engineer units in Vietnam, incorporating fifteen-month tours in 2007, the engineers achieved experience balance with offset deployments between BCTs and the non-divisional engineer

[60] Wright and Reese, *On Point II*, 315, 371–73.

[61] Ibid., 373.

brigades supporting the area of operations. This supported continuity by allowing experienced engineer units to support newly deployed engineers longer than the typical two week relief in place. While there would still be learning curves for newly deployed units, this rotation allowed better unit continuity and minimized the wholesale swap of engineers supporting key areas.

Summary

In sum, personnel problems during wartime are not a new or surprising challenge. The challenges faced by the Engineer Regiment during Vietnam, however, indicate a significant cause for concern when seventy percent of a branch's capacity sits outside the active force. Because of the inability to activate reservists, the Engineer Regiment was not in a position to correct this particular failure in Vietnam since creating new units would take several years to man and equip. Additionally, the tradeoff between casualties and experience can only be minimized, but not eliminated, as engineer units rotate through the phases of their deployments.

Policy

Military development and planning are routinely subject to political decisions. While the effects of government policy constrain available military responses, especially concerning collateral damage estimates, policy may also enhance innovation and institutionalization under certain conditions. This is particularly true concerning the challenges of low-cost threats, a challenge to security both abroad and at home.

Vietnam

Aside from Presidential decision to avoid activating the US Army Reserve, there were no apparent policy decisions affecting engineer responses to low-cost hazards.

GWOT

The nature of operations in Afghanistan and Iraq renewed the emphasis on landmine and C-IED education and training for the US military. Similarly, the executive branch took steps to pressure international partners while maintaining a modicum of secrecy in an increasingly transparent, social media laden, world.

On 27 February 2004, the White House published an update to US landmine policy. The effort, as a part of the Amended Mines Protocol to the Convention on Conventional Weapons, eliminated the use of LMC and nonmetallic mines, and set dates in 2006 and 2010 for the destruction of persistent landmines outside of the Korean peninsula and the use of only non-persistent landmines, respectively. The reasoning for the change, outline in the white paper, relates directly to the C-IED fight and US legitimacy:

> Complicating the hazards posed by persistent, non-detectable landmines has been their employment by unprofessional, untrained and undisciplined militant groups that have often used landmines not as a weapon of war, but as a weapon of terror…. Sadly, in the last thirty years rebel groups, terrorists, and unscrupulous governments have deliberately used mines against civilian populations. This new U.S. policy continues the process of stigmatizing such abhorrent practices and calls for more stringent restrictions on the trade in persistent landmines than any found in any existing treaties today. [62]

While the engineers in the GWOT campaigns may have noticed little effect from the policy, with the exception of using mines as protective obstacles to outposts, the effort showed the United States as willing to support the international coalition against the use of landmines and to silence critics charging the US with similar threats as the insurgents. Furthermore, the Obama administration expanded US landmine policy in September 2014 with a ban on all anti-personnel landmines,

[62] Department Of State, "Landmine Policy White Paper," *US Department of State Archive*, February 27, 2004, accessed December 29, 2016, https://2001-2009.state.gov/t/pm/rls/fs/30047.htm.

keeping only the Korean Peninsula exemption in place. This action restricted the US military to the use of only non-persistent, anti-vehicle landmines.[63]

Despite the positive humanitarian aspect of the policy, there is a downside for combat engineers, the inability to use and train on these now banned systems. While programs like EOCA are beneficial for engineers, the true success would be a return to the days of institutional knowledge and training on mines and other EH to make specialized course like EOCA unnecessary. However, since only anti-vehicles landmines are authorized, and these must be capable of deactivation or self-destruct, the ability for engineers to gain proficiency on the non-persistent systems they may encounter overseas no longer exists.

As the landmines policy focused on one aspect of the problem, the importance of remaining ahead of the IED threat was not lost on the administration. In an April 2006 memorandum, the Deputy Secretary of Defense issued guidance limiting discussion on IED and IED-D operations on open sources.[64] The Secretary of the Navy, as the DoD Executive Agent for joint EOD countermeasures and training, published an unclassified follow-up directive highlighting relevant details.[65] Though directed at EOD personnel, their close relationship with engineers during the GWOT implied similar application.

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[63] White House Office of the Press Secretary, "FACT SHEET: Changes to U.S. Anti-Personnel Landmine Policy," *Whitehouse.gov*, September 23, 2014, accessed May 6, 2017, https://obamawhitehouse.archives.gov/the-press-office/2014/09/23/fact-sheet-changes-us-anti-personnel-landmine-policy.

[64] Wright and Reese, *On Point II*, 111.

[65] Donald Winter, "Limitations on Public Release and Disclosure of Information and Technical Data about Improvised Explosive Device (IED) Defeat Efforts," April 18, 2006, accessed December 29, 2016, https://fas.org/sgp/othergov/dod/navyied.pdf.

Summary

In sum, policy can play an important role in defining the operating conditions for a deployed force. While engineers in Vietnam were directly affected by the inability to activate the majority of the engineer force, those participating in the GWOT faced policy implications indirectly. One pitfall of mine policies during the GWOT resulted the inability to train on the emplacement of the banned types of landmines. While this reflects a commitment by the US to support a better future, it also hinders the ability to prepare for encountering such devices without using EOD or conducting a controlled detonation. Additionally, this generates concerns for the future of engineer countermobility and anti-access/area denial training and support should the US military face a near-peer threat.

Emerging Threats and Homeland Defense

The increasing availability of low-cost but high-tech equipment stands to improve the effectiveness of threat capabilities. Future adversaries, whether insurgents or near-peers, will likely continue employ similar IED-like counter-mobility effects against US formations due to the low cost and mass availability of materials. The Joint Operating Environment 2035, published in July 2016, outlines potential advancements brought about by the privatization of violence, or violence on behalf of radicalized individuals or groups without particular state affiliation. Among these trends are "disruptive manufacturing technologies and the urban arsenal" and "weaponization of commercial technologies."[66]

It is with such understanding that the Engineer Regiment sustains the institutionalization of the important lessons of the GWOT campaigns. While the US military as a whole, and the US

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[66] Joint Chiefs of Staff, *Joint Operating Environment 2035* (Washington, DC: Government Printing Office, 2016), 14.

Army as a subset, will keep or discard lessons based on a wide variety of factors, the expectation is that the ability of engineers to respond to improvised explosive threats has not ended. This is evident in the continued existence of JIDO, despite its frequent name and control changes.[67] The importance of maintaining the skillset developed over the past decade and a half is evident by examining other theaters of active conflict as well as measures taken to deter and prevent similar methods in the United States. This does not assume the current construct is poised to counter all types of future threats, only that the Engineer Regiment is better positioned to respond to myriad potential crises coming out of the GWOT than it was going in.

With terrorism continuing to find its way across borders and into the United States, leaders responsible for national security recognize the importance of C-IED training. In February 2013, President Obama issued a policy letter highlighting the importance of maintaining the skills learned overseas and applying that same knowledge to protect citizens in the US. "To better meet the IED threat at home, we will seek to incorporate lessons learned abroad, while respecting legal and policy factors relevant to domestic counter-IED operations."[68] Placed under the supervision of the Attorney General of the United States, responsibility for C-IED programs resides cross several departments, including Justice, Treasury, Homeland Security, and Defense.

One potentially significant threat, early in maturation but necessitating a larger than DOD approach, involves geofence-based terrorism. A geofence is a digital boundary, based on GPS or

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[67] William Arkin, "From JIEDDO to JIDA to JIDO: Playing America's National Security Name-Changing Game," *VICE News*, March 24, 2016, accessed December 1, 2016, https://news.vice.com/article/united-states-national-security-pentagon-name-changing-game.

[68] Barack Obama, "Countering Improvised Explosive Devices" (DTIC Document, 2013), 3, accessed August 17, 2016, http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA574504.

RFID systems, that triggers a software based response in an electronic device.[69] Smartphone based geofencing can activate or deactivate home security systems, allow advertisements for nearby shops, provide specific information on locations, or in the wrong hands, allow an attacker to employ an ostensibly "smart" IED that would only respond to the actions of a specific targeted individual. While such a strategy is unlikely to be employed in the GWOT theaters due to necessary network infrastructure, its potential use in modern cities poses a significant threat that is difficult to counter. There are also benefits to geofencing, especially as it concerns unmanned vehicles and drones. Though not yet mandated, drone manufacturers are establishing geofences around restricted fly zones such as airports or key governmental buildings.[70] While there are many ways around such systems, the attempt, without government direction, shows an increased concern from manufacturers for potential use of their products. Additionally, it is extremely likely to add US military installations overseas to the list of restricted zones or generate a materiel solution that serves as a standalone geofence system similar to CREW devices in the GWOT.

Increasing globalization stands to continue the reduction in costs for once limited materials, be they specifically designed for destruction or those modified to fit a particular need. Additionally, increased capability to acquire such materials, whether through the global marketplace or homemade techniques, will also likely continue. The conflicts in Israel, Syria, Pakistan, and India demonstrate this danger daily, with rebel or insurgent groups inciting terror in increasingly adaptive ways. While vigilance at home is necessary, it will not be enough to prevent the spread of such methods to the United States.

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[69] Margaret Rouse, "What Is Geo-Fencing (Geofencing)?," *WhatIs.com*, accessed February 14, 2017, http://whatis.techtarget.com/definition/geofencing.

[70] Kevin Poulsen, "Why the US Government Is Terrified of Hobbyist Drones," *WIRED*, February 5, 2015, accessed February 4, 2017, https://www.wired.com/2015/02/white-house-drone/.

Conclusion

The United States' experiences in Vietnam and during the Global War on Terror provide critical learning points for improving institutional responses and anticipating future needs. Engineers in both conflicts encountered similar challenges, albeit under entirely different environmental conditions, and in both instances, these forces emerged with greater understanding for their role in supporting mobility, countermobility, and survivability. Both conflicts demonstrated the challenges associated with evolving low-cost threats that required continuous adaptation.

The Engineer Regiment's tumultuous transitions over the past decade indicate the flexibility necessary to support a variety of operations during different phases of conflict. Matched with a similar backdrop in Vietnam, when the Engineer Regiment did not face as significant an organizational transition, today's force provides hope for continued improvement. The DOTMLPF-P construct is one of many potential methodologies for comparing the challenge and response dynamic of the two periods. While not every problem found its solution, or some problems found only specific, localized solutions, the framework enables a better understanding of the gap between existing and required capabilities to counter threats.

What is clear, after reviewing the many challenges faced by engineers in Vietnam and the GWOT, is that there are many similarities between the two periods. Within those similarities, the Engineer Regiment, as the responsible institution within the US Army, established solutions with greater endurance after the GWOT conflict than after the cessation of hostilities in Vietnam. Many Vietnam era problems were either never satisfactorily solved or were not properly addressed to ensure longevity. Where there were solutions from the GWOT not meant to endure, those solutions were generally materiel based and still exist in COTS form.

There are many parallels between the Engineer Regiment today, ten years ago, and even fifty years ago worthy of further examination. Focusing solely on combat engineering, especially as it pertains to low-cost explosive hazards, leaves significant portions of rich engineer history unexplored. While the challenge presented by low-cost threats to the United States is unlikely to decline while the US military is present across so much of the world. The importance of seeking proactive solutions to emerging trends, especially as they manifest in other theaters or countries, enables the US government to share the wealth of knowledge on the subject across the many federal departments responsible for defense and security.

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